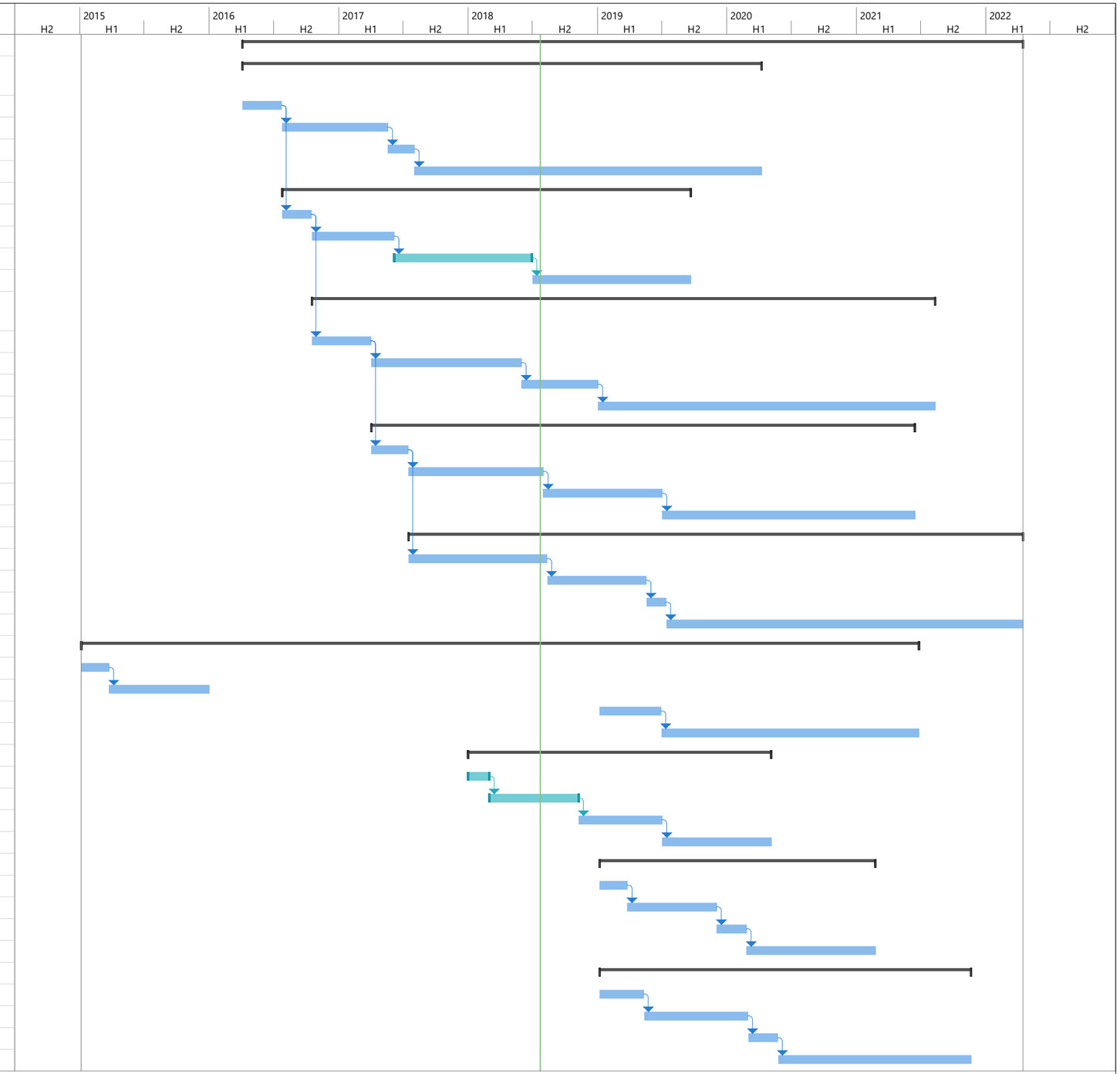
Attachment 1 – Project Schedule

ID	Task Name	Duration	Start	Finish
1	**Maxson Process Upgrades DN/CMAR**	**1575 days**	**Mon 4/4/16**	**Fri 4/15/22**
2	**GMP 1 - PAA Disinfection Tank and Effluent Piping Structurea Upgrades**	**1047 days**	**Mon 4/4/16**	**Tue 4/7/20**
3	PER	80 days	Mon 4/4/16	Fri 7/22/16
4	Final Design	214 days	Mon 7/25/16	Thu 5/18/17
5	Permitting/Funding Approval	53 days	Fri 5/19/17	Tue 8/1/17
6	Construction	700 days	Wed 8/2/17	Tue 4/7/20
7	**GMP 2 - Headworks Improvements**	**825 days**	**Mon 7/25/16**	**Fri 9/20/19**
8	PER	60 days	Mon 7/25/16	Fri 10/14/16
9	Final Design	166 days	Mon 10/17/16	Mon 6/5/17
10	Permitting/Funding Approval	279 days	Tue 6/6/17	Fri 6/29/18
11	Construction	320 days	Mon 7/2/18	Fri 9/20/19
12	**GMP 3 - Two Secondary Clarifiers, Odor Control, Fine-Bubble Aeration Conversion**	**1257 days**	**Mon 10/17/16**	**Tue 8/10/21**
13	PER	120 days	Mon 10/17/16	Fri 3/31/17
14	Final Design	303 days	Mon 4/3/17	Wed 5/30/18
15	Permitting/Funding Approval	154 days	Thu 5/31/18	Tue 1/1/19
16	Construction	680 days	Wed 1/2/19	Tue 8/10/21
17	**GMP 4 - RAS Re-aration**	**1096 days**	**Mon 4/3/17**	**Mon 6/14/21**
18	PER	75 days	Mon 4/3/17	Fri 7/14/17
19	Final Design	272 days	Mon 7/17/17	Tue 7/31/18
20	Permitting/Funding Approval*	239 days	Wed 8/1/18	Mon 7/1/19
21	Construction*	510 days	Tue 7/2/19	Mon 6/14/21
22	**GMP 5 - Existing Trickling Filter Upgrades**	**1240 days**	**Mon 7/17/17**	**Fri 4/15/22**
23	PER	280 days	Mon 7/17/17	Fri 8/10/18
24	Final Design	200 days	Mon 8/13/18	Fri 5/17/19
25	Permitting/Funding Approval*	2 mons	Mon 5/20/19	Fri 7/12/19
26	Construction*	720 days	Mon 7/15/19	Fri 4/15/22
27	**Biosolids Lagoon 5 Renovation**	**1690 days**	**Mon 1/5/15**	**Fri 6/25/21**
28	PER	56 days	Mon 1/5/15	Mon 3/23/15
29	Final Design	203 days	Tue 3/24/15	Thu 12/31/15
30	Permitting/Funding Approval*	125 days	Mon 1/7/19	Fri 6/28/19
31	Construction*	520 days	Mon 7/1/19	Fri 6/25/21
32	**Maxson WWTF Administration Building**	**611 days**	**Mon 1/1/18**	**Mon 5/4/20**
33	PER	44 days	Mon 1/1/18	Thu 3/1/18
34	Final Design	180 days	Fri 3/2/18	Thu 11/8/18
35	Permitting/Funding Approval*	167 days	Fri 11/9/18	Mon 7/1/19
36	Construction*	220 days	Tue 7/2/19	Mon 5/4/20
37	**Lagoon 2A Renovation***	**556 days**	**Mon 1/7/19**	**Mon 2/22/21**
38	PER*	56 days	Mon 1/7/19	Mon 3/25/19
39	Final Design*	180 days	Tue 3/26/19	Mon 12/2/19
40	Permitting/Funding Approval*	60 days	Tue 12/3/19	Mon 2/24/20
41	Construction*	260 days	Tue 2/25/20	Mon 2/22/21
42	**Primary Clarifier Pumping and BFP Improvements***	**750 days**	**Mon 1/7/19**	**Fri 11/19/21**
43	PER*	90 days	Mon 1/7/19	Fri 5/10/19
44	Final Design*	210 days	Mon 5/13/19	Fri 2/28/20
45	Permitting/Funding Approval*	60 days	Mon 3/2/20	Fri 5/22/20
46	Construction*	390 days	Mon 5/25/20	Fri 11/19/21



Project: Overall Project Schedul
Date: Tue 7/24/18

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Any items (*) the schedule shown is based on receipt of WIFIA funding.

Attachment 2 – Documents Supporting Project Analysis

Feasibility Studies:

- March 25, 2013 (SRF 2013-309) Facilities Plan Approval
- T.E. Maxson Lagoon Improvements and M.C. Stiles Outfall Modifications Facilities Plan (SRF 2013-309) August 2012
- May 26, 2016 (SRF 2015-355) Facility Plan Tennessee Department of Environment and Conservation (TDEC) Approval Letter
- T.E. Maxson WWTF Improvements Facilities Plan (SRF 2015-355) January 2015

Preliminary Engineering Reports

- *Package 1 Final Preliminary Engineering Report, February 2017*
  (Disinfection Improvements) – Approved by TDEC
- *Package 2 Final Preliminary Engineering Report, September 2016*
  (Headworks Improvements) – Approved by TDEC
- *Package 2A Final Preliminary Engineering Report, July 2017*
  (Two New Secondary Clarifiers, Odor Control Improvements and Fine-Bubble Conversion) – Submitted to TDEC in July 2017
- *Package 2B Final Preliminary Engineering Report, January 2018*
  (RAS Re-aeration Basin) – Submitted to TDEC in July 2017

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
State Revolving Fund Loan Program
L & C Tower, 8th Floor
401 Church Street
Nashville, TN 37243
Phone: (615) 532-0445

March 25, 2013

The Honorable A. C. Wharton, Jr.
Mayor, City of Memphis
City Hall
125 North Main Street, Room 700
Memphis, TN 38103

RE: Facilities Plan Approval
Memphis (Shelby County), Tennessee
Loan Nos. SRF 2013-309, SRF 2013-310, and SRF 2013-311
T. E. Maxson Wastewater Treatment Plant Sludge Lagoon Improvements and
M. C. Stiles Wastewater Treatment Plant Outfall Improvements (SRF 2013-309)
Mary's Creek Interceptor Sewer – Phase 2 (SRF 2013-310)
City-Wide Sewer Assessment and Rehabilitation (SRF 2013-311)

Dear Mayor Wharton:

The State Revolving Fund Loan Program acknowledges the receipt of four copies of a Facilities Plan on August 28, 2012. The documents associated with your facilities plan have been reviewed in accordance with appropriate State rules, policies, regional guidance, and technical publications. Based on our review, a Finding of No Significant Impact (FNSI) was issued on February 19, 2013, for these projects. The 30-day comment period for the FNSI has expired, and no significant public objections have been received. Therefore, full approval of this Facilities Plan is now granted. The related documents concerning this approval are as follows:

> "Facilities Plan, Clean Water State Revolving Fund Loan Application, T. E. Maxson Lagoon Improvements and M. C. Stiles Outfall Modifications (SRF 2013-309), Mary's Creek Interceptor Sewer – Phase 2 (SRF 2013-310), City-Wide Sewer Assessment and Rehabilitation (SRF 2013-311), City of Memphis, Tennessee" dated August 2012.

It has been determined that the subject plan is complete as described under provisions of the State Revolving Fund Rule 1200-22-6-.06. The projects associated with these loans are described as follows:

- The T. E. Maxson Lagoon Improvements project consists of converting the existing single cell Sludge Lagoon 5 to a three-cell lagoon. The project includes installing high-density polyethylene (HDPE) liners and floating covers in each of the three cells, outfall modifications, and biogas collection modifications. The project also includes modifications at the existing Primary Sludge Pump Station and miscellaneous piping, valves, and concrete work.

- The M. C. Stiles Outfall project consists of modifications to the existing outfall structure that will eliminate foaming in the Mississippi River at the outfall.
- The Mary's Creek Interceptor Sewer – Phase 2 project consists of the construction of approximately 10,600 linear feet (LF) of gravity sewer with pipe sizes ranging from 24 to 30 inches in diameter and sewer manholes and is located east of Gray's Creek and north of the Wolf River in east Shelby County.
- The City-Wide Sewer Assessment and Rehabilitation project consists of evaluating the entire existing sewer system and rehabilitating sewers. The City of Memphis will complete approximately 240 miles of sewer evaluation per year. Sewer rehabilitation will be performed on gravity lines, manholes, force mains, and pumping stations utilizing point repairs, pipe lining, pipe bursting, sectional replacements, and manhole rehabilitation and replacement.

The State Revolving Fund loan agreement for Loan No. SRF 2013-309 (T. E. Maxson Wastewater Treatment Plant Sludge Lagoon Improvements and M. C. Stiles Wastewater Treatment Plant Outfall Improvements project) will have the following special condition:

> The City of Memphis shall obtain applicable Section 10/404 Permits for the M. C. Stiles Outfall Modification project from the United States Army Corps of Engineers (USACE) (Mr. Mitch Elcan, 901-544-0737, File No. MVM-2012-367) to meet the requirements of wetlands protection and stream-crossing statutes. A letter from the USACE stating that the permits are not needed will obviate this requirement.

The State Revolving Fund loan agreement for Loan No. SRF 2013-310 (Mary's Creek Interceptor Sewer – Phase 2 project) will have the following special conditions:

1. A qualified archaeologist shall conduct an archaeological assessment for the potential presence of intact cultural resources (including human burials). Copies of the assessment and findings must be submitted to the Tennessee Historical Commission (Jennifer Barnett, 615-741-1588, ext. 105, *jennifer.barnett@tn.gov*), the Division of Archaeology (Mr. Mark Norton, 615-741-1588, ext. 20, *mark.norton@tn.gov*), and the State Revolving Fund Loan Program. Any findings that must be preserved shall be removed/protected/preserved in accordance with state and federal laws, regulations, and/or policies.
2. A qualified biologist shall conduct a biological assessment for the federally-listed endangered Indiana bat (Myotis sodalis). Copies of the assessment and findings must be submitted to the United States Fish and Wildlife Service (Mr. David Pelren, 931-525-4974, *david_pelren@fws.gov*) and the State Revolving Fund Loan Program.

The State Revolving Fund loan agreement for Loan No. SRF 2013-311 (City-Wide Sewer Assessment and Rehabilitation project) will have the following special conditions:

1. The City of Memphis shall obtain applicable Section 10/404 Permits from the USACE to meet the requirements of wetlands protection and stream-crossing statutes. A letter from the USACE stating that the permits are not needed will obviate this requirement.

2. Rehabilitation maps must be sent independently to the Division of Archaeology (Mr. Mark Norton, 615-741-1588, ext. 20, *mark.norton@tn.gov*) so that specific sections (historic districts) can be reviewed accordingly prior to the approval of plans and specifications.
3. Rehabilitation maps involving any ground-disturbing activities associated with the City-Wide Sewer Assessment and Rehabilitation project must be sent to the Tennessee Historical Commission (Jennifer Barnett, 615-741-1588, ext. 105, *jennifer.barnett@tn.gov*) for additional review prior to the approval of plans and specifications.

Thus, the City of Memphis may be eligible to receive financial assistance through the State Revolving Fund as established under T.C.A. 68-221-1001, et seq.

Sincerely,

Sherwin N. Shirdi
Deputy Director
Division of Water Resources

Enclosure: Copy of the Approved Facilities Plan

cc: Mr. Scott Morgan, Administrator of Environmental Construction, Division of Public Works; Memphis, TN (via e-mail)
Mr. Ed Hargraves, P.E., Askew Hargraves Harcourt, Memphis, TN (Copy of the Approved Facilities Plan)
Mr. Phil Simmons, P.E., TDEC-DWR, Water Quality Branch, Nashville, TN (via e-mail)
Ms. Cindy Patton, Regional Director for External Affairs, Memphis Field Office (via e-mail)
Mr. Vaughn Cassidy, Environmental Coordinator, Memphis Field Office (via e-mail)
Mr. Sam Gaddipati, Environmental Manager, SRF Loan Program (via e-mail)
Ms. Felicia Freeman, Manager, SRF Technical Section (via e-mail)
Dr. Bagher Sami, Manager, SRF Administrative Section (via e-mail)

FACILITIES PLAN

CLEAN WATER STATE REVOLVING FUND LOAN APPLICATION

T.E. MAXSON LAGOON IMPROVEMENTS AND M.C. STILES OUTFALL MODIFICATIONS (SRF 2013-309)

MARY'S CREEK GRAVITY INTERCEPTOR SEWER – PHASE 2 (SRF2013-310)

CITY-WIDE SEWER ASSESSMENT AND REHABILITATION (SRF2013-311)

CITY OF MEMPHIS, TENNESSEE

Prepared by

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SECTION 1 – SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

1.1 – STATEMENT OF THE PROBLEM

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970's. In 2000, the City retained a professional engineering consultant to review the lagoon conditions at the plant and the consultant has recommended the modification of the existing Lagoon 5. The purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work.

In 2001, TDEC WPC approved various portions of the Maxson improvements. The improvements were never constructed and approval has since expired. This project is located inside the existing Maxson WWTP site and will not require any additional easements or land acquisition.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTF located at 2303 North Second Street was constructed in the early 1970's. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this project is to design and construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical

drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

This project is located inside the existing Stiles WWTP site and will not require any additional easements or land acquisition.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Due to growth and development that the Memphis area has experienced, there now exists a demand for new housing and commercial space in the area known as the Mary's Creek Drainage Basin. The expansion of residential and commercial development into areas previously considered to be "rural" has created a unique problem: growth is now inhibited by the lack of public utility services (in particular, sewer services) in these previously "rural" areas.

The traditional method for handling sewage created by new residences/businesses in rural areas is to install septic tanks and drain fields - rural areas have enough "space" to create a buffer between drain fields and wells used for water supplies, and rural residences/businesses are not in close enough proximity to create high amounts of sewage per land area. Because some of the undeveloped land, which is now on the edge of developed areas, lies near or within floodplains, septic tanks/drain field systems are not a proper method for handling sewage created by new developments. Therefore, another method of handling sewage is needed in these areas in order to "open up" new land for highly-demanded residential and commercial development.

One area in particular that is experiencing the problems described herein is a Memphis annexation area north of Collierville (north of the Wolf River and east of Gray's Creek, excluding the Collierville annexation area) in the vicinity of Mary's Creek.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

1.2 – SUMMARY OF THE ALTERNATIVE SOLUTIONS CONSIDERED

Project No. 1: T.E. Maxson Lagoon Improvements

Two alternatives were considered during the preliminary design of this project, as follows:

- Alternative No. 1 – "No Action" – Do nothing to make corrections to the lagoon
- Alternative No. 2 – Install the recommended modifications to the existing lagoon 5.

Project No. 2: M.C. Stiles Outfall Modification

Two alternatives were considered during the preliminary design of this project, as follows:

- Alternative No. 1 – "No Action" – Do nothing to eliminate the foaming problems at the discharge structure
- Alternative No. 2 – Install the recommended effluent discharge structure to ensure foaming problems in the Mississippi River are eliminated.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Four alternatives were considered during the preliminary design of this project, as follows:

- Alternative No. 1 – "No Action" – Do nothing to help facilitate further development and growth in project areas.

- Alternative No. 2 – Build a large-lot septic tank to handle the sewage from new residential and commercial development.

- Alternative No. 3 – Require on-site treatment of sewage at each new residential and commercial development.

- Alternative No. 4 – Install additional sewer lines (gravity lines and force mains, as required by topography) to collect and transport sewage from new residential and commercial developments to existing treatment facilities.

Project No. 4: Sewer Assessment and Rehabilitation

Two alternatives were considered during the preliminary design of this project, as follows:

- Alternative No. 1 – "No Action" – Do nothing to correct the inflow and infiltration problems with the sewer collection system
- Alternative No. 2 – Install the recommended repairs and replacement of the various sewer infrastructure items as recommended in the City-wide Sewer System Assessment and Evaluation Study.

1.3 – RECOMMENDED SOLUTION

Project No. 1: T.E. Maxson Lagoon Improvements

The recommended alternative will require the City to have the plans originally prepared for this project revised to meet current standards as well as review existing conditions that might have changed since when the plans were prepared. As previously stated, the purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge

Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work. This project has previously received TDEC approval, but because that approval has expired and to receive approval for SRF funding the construction documents will be resubmitted for TDEC for review and approval.

Project No. 2: M.C. Stiles Outfall Modification

The recommended alternative is to eliminate periodic foaming, which is observed in the Mississippi River at Outfall 001 from the WWTF. The intent is to have this project proceed as a design/build project. The selected effluent discharge structure will be designed to accommodate the large variance in the water surface elevation of the Mississippi River. The elevation difference between high water elevation at flood stage and low water elevation can be as much as fifty (50) feet. The intent of the final design will be to construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Of the four alternatives considered during the preliminary design of this project, the recommended solution is Alternative No. 4 - install additional sewer lines (gravity lines and force mains, as required by topography) to collect and transport sewage from new residential and commercial developments to existing treatment facilities. This alternative is the most efficient solution, has the least impact on development costs, has the least environmental impact of the four, and was, therefore, selected as the best solution to help facilitate further development in the project areas. Alternative No. 4 directly addresses the problem of inhibited growth due to lack of sewer service in undeveloped Memphis annexation areas. The addition of sewer lines will "open up" new land to meet the high demand for new housing in the Memphis area.

Project No. 4: Sewer Assessment and Rehabilitation

The recommended alternative was developed in a consent decree agreed to by the City of Memphis, and is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

SECTION 2 – PURPOSE AND NEED

2.1 – STUDY PURPOSE

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970's. In 2000, the City retained a professional engineering consultant to review the lagoon conditions at the plant and the consultant has recommended the modification of the existing Lagoon 5. The purpose of this study is to identify the issues associated with lagoon 5, and recommend funding necessary to make corrections to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project will consist of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTF located at 2303 North Second Street was constructed in the early 1970's. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this study is to recommend funding necessary to design and construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Due to growth and development that the Memphis area has experienced, there now exists a demand for sewer service in the area known as the Mary's Creek Drainage Basin. The expansion of residential and commercial development into areas previously considered to be "rural" has created a problem: growth is now inhibited by the lack of public utility services (in particular, sewer services) in these previously "rural" areas. The traditional method for handling sewage created by new residences/businesses in rural areas is to install septic tanks and drain fields. The purpose of this study is to identify the issues and recommend funding necessary to have an adequate gravity sewer collection system installed in the Mary's Creek sewer basin

Project No. 4: Sewer Assessment and Rehabilitation

The purpose is to develop a city wide sewer assessment program, and implement the rehabilitation of the entire sewer system. A Consent Decree agreed to by the City of Memphis requires the City to assess approximately 10% of the sewer system per year. The rehabilitation areas will be dependent on the assessment data. The rehabilitation could include repairs to gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

2.2 – NEED FOR THE PROJECT

Project No. 1: T.E. Maxson Lagoon Improvements

The need for this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility.

Project No. 2: M.C. Stiles Outfall Modification

Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The need for this project is to design and construct a modification to the existing outfall structure that will eliminate foam.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

The proposed project is needed in order to avoid potential health hazards and to avoid stifling growth in the project areas. There exists in the Memphis area a great demand for new housing and commercial space due to the rapid growth experienced in recent years. The proposed project will "open up" previously undeveloped land for continued growth and development of the City of Memphis.

Project No. 4: Sewer Assessment and Rehabilitation

The need for the sewer assessment and rehabilitation of the sewer system is to identify areas of the collection system that are in need of repair which can cause sewer overflows. These overflows when they occur are violations of the City's NPDES permits. It is imperative that these areas are identified and a plan of corrective measures are undertaken to eliminate these overflows.

SECTION 3 – GENERAL INFORMATION

3.1 – EXISTING FACILITIES AND AREAS SERVED

The Memphis Sanitary Sewer System serves approximately 265,000 households. The sewer lines extend throughout the entire city and throughout many populated areas of Shelby County, transporting the City's sewage to each of the City's three existing waste water treatment plants - the T.E. Maxson WWTP in southwest Memphis, the M.C. Stiles WWTP in northwest Memphis, and the Chapel Hill WWTP in northeast Shelby County. These three plants treat an estimated sixty billion gallons of wastewater each year. The Maxson and Stiles WWTPs each have several sludge lagoons that handle an estimated 215 million pounds of bio-sludge each year. Treated effluent from both the Maxson and Stiles plants is released into the Mississippi River, and treated effluent from the Chapel Hill plant is released into an unnamed tributary of Crooked Creek.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

The proposed sewer lines for this project area will transport sewage for treatment to the M.C. Stiles WWTP in northwest Memphis.

3.2 – OPTIMUM PERFORMANCE AVAILABLE WITH THE EXISTING FACILITIES/OPERATIONAL PROBLEMS

The Memphis Sanitary Sewer System is capable of treating over 225 million gallons per day, with capacities of each plant as follows:

- Maxson plant capacity = 90 MGD (90 million gallons per day),
- Stiles plant capacity = 135 MGD (135 million gallons per day),
- Chapel Hill plant capacity = 0.045 MGD (45,000 gallons per day).

The normal (dry weather) demand on the Memphis Sanitary Sewer System is over 145 million gallons per day, with normal (dry weather) demand at each plant as follows:

- Maxson plant demand = 70 MGD (70 million gallons per day),
- Stiles plant demand = 75 MGD (75 million gallons per day),
- Chapel Hill plant demand = 0.020 MGD (20,000 gallons per day).

These normal (dry weather) demands are well below the capacities of each plant.

As noted above, the Stiles WWTP, which will treat sewage from the proposed sewer lines from Mary's Creek Interceptor Gravity Sewer Phases 1A and 1B project, has a normal demand that is well below the plant's capacity and will easily handle the additional sewage from the Mary's Creek Gravity Interceptor Sewer Phase 2 project area, even when it is fully developed.

SECTION 3 – GENERAL INFORMATION

Project No. 1: T.E. Maxson Lagoon Operational Problem

The operational issues associated with the Maxson WWTP are with lagoon 5, and the corrections necessary to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project will consist of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work. Specific details regarding effluent limitations and monitoring requirements are available in the NPDES permit included in *APPENDIX A* at the end of this document.

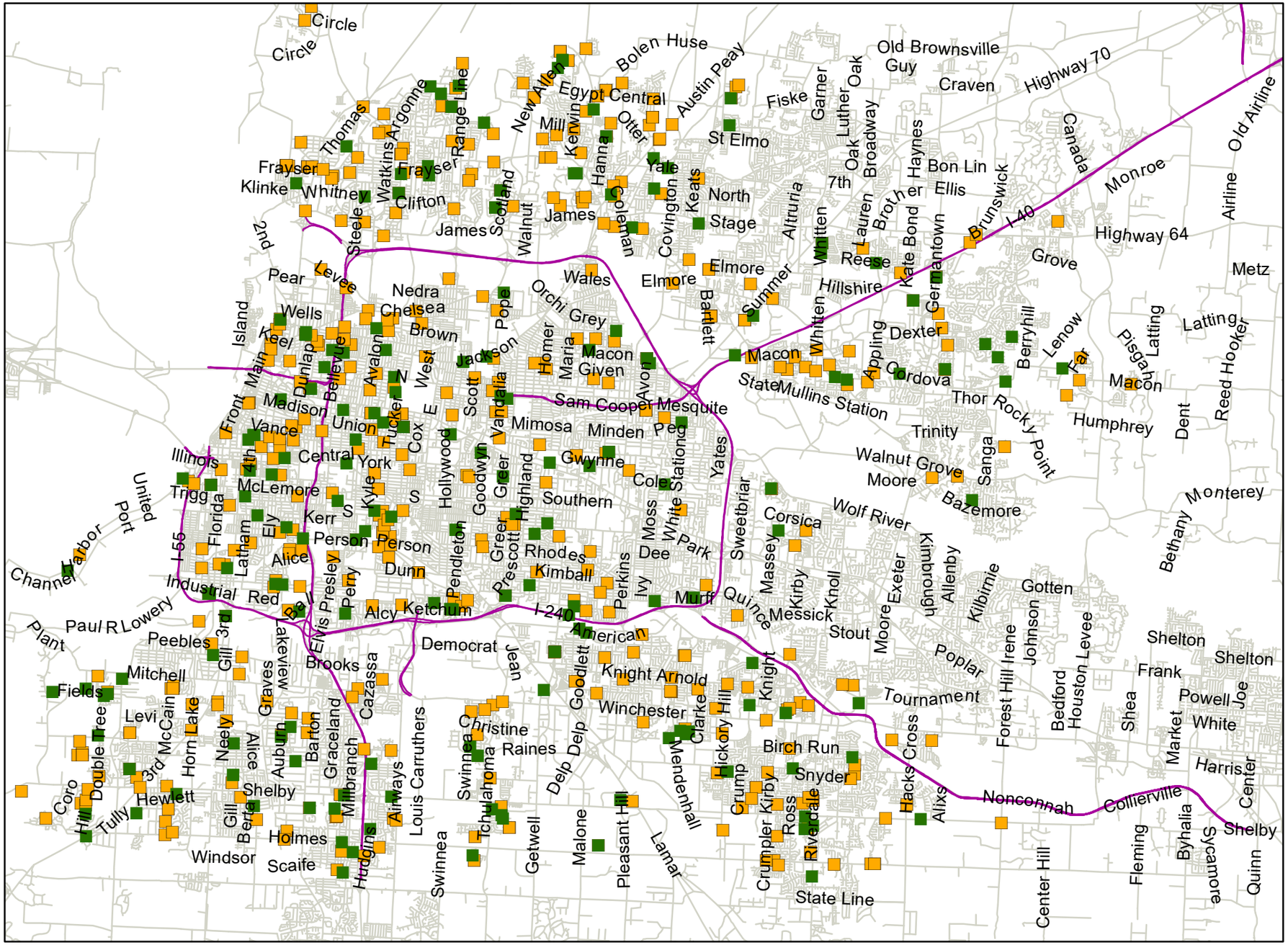
Project No. 2: M.C. Stiles Operational Problem

The operational issues concern the periodic foaming observed in the Mississippi River at Outfall 001 from the Stiles WWTF. The corrections will require the design and construction of a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates. Specific details regarding effluent limitations and monitoring requirements are available in the NPDES permit included in *APPENDIX A* at the end of this document.

Project No. 4: Sewer Assessment and Rehabilitation

The operational issues associated with the collection system are primarily caused by sewer system overflows in various locations throughout the system. A key map included at the end of this section locates the general areas of sewer overflows that occurred in 2011 and 2012. More detailed maps of sewer overflows are included in Appendix D of this report.

The solution is to develop a city wide sewer assessment program, and implement the rehabilitations recommended in the areas identified in the assessment. A Consent Decree agreed to by the City of Memphis requires the City to assess approximately 10% of the sewer system per year. The rehabilitation areas will be dependent on the assessment data. The rehabilitation could include repairs to gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).



Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 1 2 4 Miles

City Overview

Note: 2012 SSO's thru June

3.3 – EXISTING COLLECTION SYSTEM

The Memphis Sanitary Sewer Collection System is comprised of approximately 2,600 linear miles of gravity sewer mains and force mains running throughout the entire city and throughout many populated areas of Shelby County. There are approximately 100 sewer lift stations at various locations throughout the city and county, as topography dictates. The existing sewer lines are constructed of various materials, including clay, ductile iron, concrete, and plastic, and pipe diameters range from as small as six inches to as large as 120 inches. The existing manholes are constructed with brick and mortar or concrete, or a combination of the two.

The existing interceptor sewer in the Mary's Creek project area is the Wolf River Interceptor, which is currently under construction south of Walnut Grove Road at Grays Creek. This interceptor transports sewage to the Stiles WWTP in northwest Memphis. Once it is constructed, the pipeline proposed in the Mary's Creek Phase 1A and 1B projects, which are funded through a Clean Water State Revolving Fund loan via a previous application, will connect to the Wolf River Interceptor just east of Gray's Creek. The Mary's Creek Gravity Interceptor Sewer Phase 2 project (described herein) will connect to the Mary's Creek Phase 1A and 1B pipeline at Pisgah Road.

3.4 – POTENTIAL FOR SERVING ADDITIONAL AREAS

Because of the continued demand for new housing in Memphis annexation areas and in anticipation of the continued development of rural areas of Shelby County to meet this demand, the Memphis Sanitary Sewer System has been purposely planned and designed for expansion into unsewered areas. As noted previously, the Stiles WWTP, which will treat sewage from the Mary's Creek Gravity Interceptor Sewer, has a normal demand that is well below the plant's capacity and can easily handle the additional sewage from the Mary's Creek Phase 2 project area, even when it is fully developed. The existing treatment facilities and sewer interceptors, including those interceptors being "connected to" via the project proposed herein, have been designed for a "fully developed" condition of land areas that are currently considered to be rural. Therefore, additional sewer collection lines can be added to the existing system without the need for upgrade to existing equipment or treatment processes or increases in existing sewer interceptor lines.

As mandated in the Consent Decree recently entered into by the City of Memphis, a sewer assessment will be under way in the near future that will identify areas of sewer overflows or bypasses. Once the areas are identified, a sewer rehabilitation program will commence to tale whatever corrective measures are necessary to ensure that the Memphis sewer collection system is fully functional and all sewer overflows have been eliminated.

SECTION 4 – INFILTRATION AND INFLOW

4.1 – ANALYSIS OF INFILTRATION AND INFLOW

The purpose is to develop a city wide sewer assessment program, and implement the rehabilitation of the entire sewer system. A Consent Decree agreed to by the City of Memphis requires the City to assess approximately 10% of the sewer system per year. The rehabilitation areas will be dependent on the assessment data. The rehabilitation could include repairs to gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

The analysis of the inflow and infiltration of the Stiles WWTP and the Maxson WWTP are as follows:

	% Rain Induced	%RiverStage Induced	% Total
Maxson WWTP	5.6%	6.4%	12%
Stiles WWTP	3.7%	22.3%	26%

4.2 – STEPS BEING TAKEN TO REDUCE EXCESSIVE INFILTRATION AND INFLOW

In the effort to eliminate sewer system overflows and as specified in the consent decree, the City will implement or update the following programs:

1) Management, Operations and Maintenance Program, which will require the development of the following:
   a) Sewer Overflow Response Plan which will require timely and effective methods of responding to, cleaning up, and/or minimizing the impact of Sewer system overflows;
   b) Fats, Oil, and Grease Management Program which will require a re-evaluation to expand or modify the existing program;
   c) Lift Station and Force Main Operations and Maintenance Program which will require periodic service and calibration of instrumentation, inspection and service of air release valves, predictive and physical inspection and service of lift stations, assessment of force mains such as potential sulfide and corrosion control options, inspection of force mains such as at creek crossings;
   d) Gravity Sewer System Operations and Maintenance Program to prevent sewer system overflows particularly caused by fats, oils and grease, and roots and/or debris obstructions;

e) Inter-Jurisdictional Agreement Program will be implemented to renew existing agreements or enter into new agreements that covers the collection, conveyance, and treatment of sewage by Memphis from municipal satellite sewer systems, with the exclusion of Collierville due to the minimal collection of sewage by Memphis from Collierville.

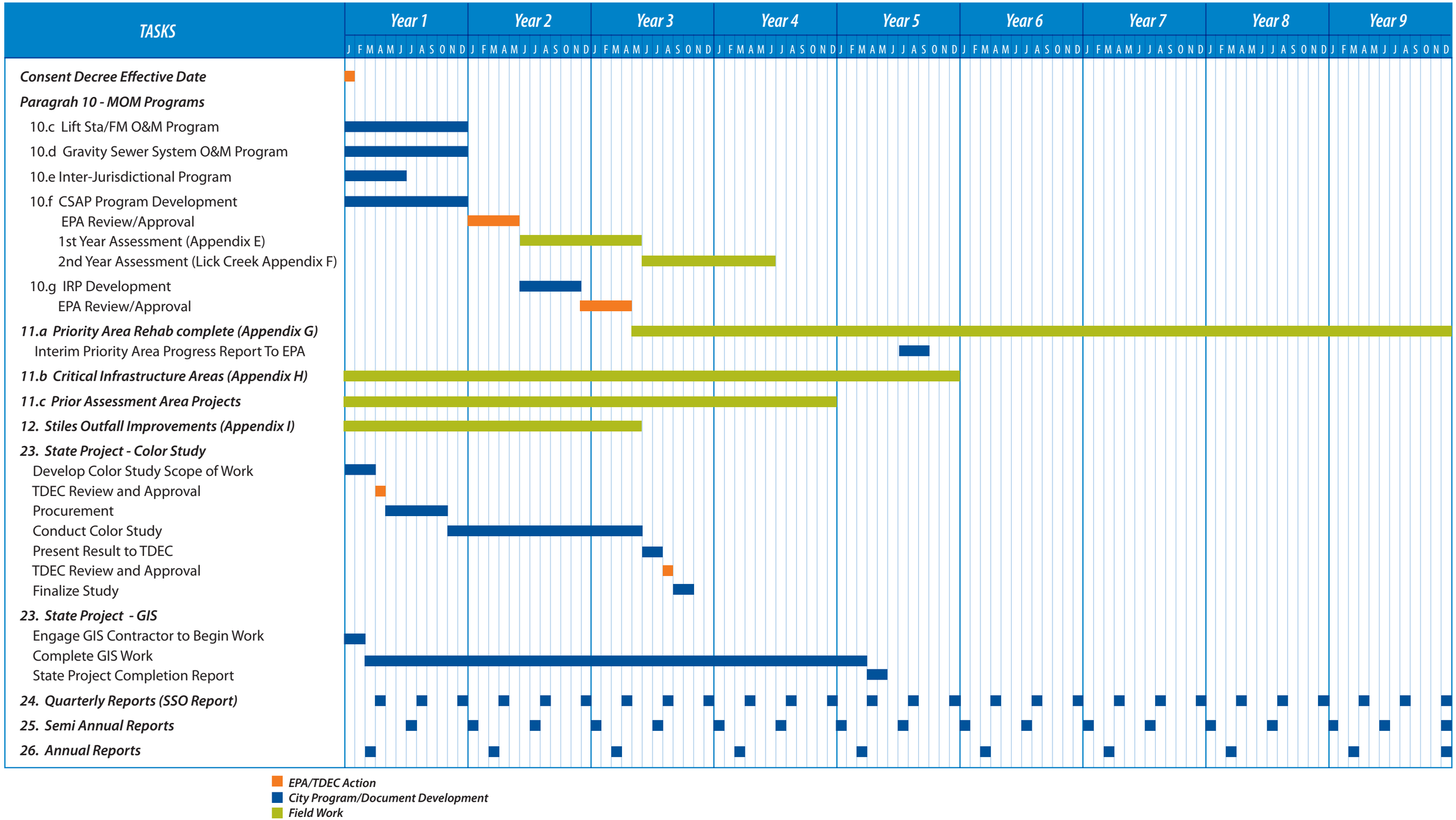
f) Continuing Sewer Assessment Program to set priorities and schedules for undertaking sewer assessment which may include dyed water, water flooding, corrosion defect identification, manhole assessment, flow monitoring, closed circuit television inspection, defect analysis, smoke testing, and lift station performance assessment;

g) Infrastructure Rehabilitation Program which will include gravity line rehabilitation, manhole rehabilitation, lift station rehabilitation, and force main rehabilitation.

2) Priority Assessment Areas will be completed as stipulated by the Consent Decree

3) Critical Infrastructure Areas Projects will receive priority rehabilitation due to the nature of the infrastructure and the potential consequences of large volumes of sewer overflows in the event of infrastructure failure.

Tentative schedule of compliance with the Consent Decree is include at the end of this section


TASKS
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
J F M A M J J A S O N D
Consent Decree Effective Date
Paragrah 10 - MOM Programs
10.c Lift Sta/FM O&M Program
10.d Gravity Sewer System O&M Program
10.e Inter-Jurisdictional Program
10.f CSAP Program Development
EPA Review/Approval
1st Year Assessment (Appendix E)
2nd Year Assessment (Lick Creek Appendix F)
10.g IRP Development
EPA Review/Approval
11.a Priority Area Rehab complete (Appendix G)
Interim Priority Area Progress Report To EPA
11.b Critical Infrastructure Areas (Appendix H)
11.c Prior Assessment Area Projects
12. Stiles Outfall Improvements (Appendix I)
23. State Project - Color Study
Develop Color Study Scope of Work
TDEC Review and Approval
Procurement
Conduct Color Study
Present Result to TDEC
TDEC Review and Approval
Finalize Study
23. State Project - GIS
Engage GIS Contractor to Begin Work
Complete GIS Work
State Project Completion Report
24. Quarterly Reports (SSO Report)
25. Semi Annual Reports
26. Annual Reports
EPA/TDEC Action
City Program/Document Development
Field Work

SECTION 5 – FUTURE CONDITIONS

5.1 – PLANNING PERIOD (20 YEARS)

In anticipation of the growth that the Memphis area has experienced throughout the past several decades, City leaders have been diligent throughout that time in planning for the future regarding the Memphis Sanitary Sewer System. Rather than plan for a specified number of future years (i.e. a planning period of 20 years), the treatment facilities and collection system have been designed and upgraded throughout the past several decades based on "full development" in areas where development was expected to occur. The proposed projects are "next steps" in a series of upgrades and expansions that are part of a long-range plan to handle increased sanitary sewer system demands. The "planning period" for the Memphis Sanitary Sewer System extends far beyond just twenty years.

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTP has sufficient excess capacity to handle the anticipated population growth during the twenty year planning period. As previously discussed in chapter 3 of this report the Maxson WWTP is currently operating at approximately 78% of capacity. Implementation of the Consent Decree mandated sewer assessment and rehabilitation and the modifications to the sludge lagoon should result in a significant reduction of inflow and infiltration, and will increase the reserve capacity of the plant.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTP has sufficient excess capacity to handle the anticipated population growth during the twenty year planning period. As previously discussed in chapter 3 of this report the Stiles WWTP is currently operating at approximately 56% of capacity. Implementation of the Consent Decree mandated sewer assessment and rehabilitation should result in a significant reduction of inflow and infiltration, and will increase the reserve capacity of the plant.

The modifications to the effluent outfall structure will eliminate the foaming problem at the effluent discharge at the Mississippi River.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

During a twenty-year planning period for the Mary's Creek project (including Phases 1 and 2), the City anticipates that the areas served will become fully developed due to the increasing demand for new housing in Memphis. Again, the existing treatment facilities and sewer interceptors have adequate capacity to handle the additional sewage associated with the proposed project.

Phase 1 of the Mary's Creek project will be constructed first, as development in this area is imminent because it is adjacent to already-developed areas, and further development has been hindered by the lack of sewer service. Phase 2 of the Mary's Creek project, for which funding is being requested via the CWSRF loan application accompanying this Facilities Plan, will be constructed as development progresses in the Phase 1 area and leads to the need for additional development in the Phase 2 area.

5.2 – LAND USE PROJECTIONS

Based on growth patterns in areas adjacent to the proposed project areas, the City anticipates that land uses in the Mary's Creek project area will change from sparsely-populated single-family dwellings to moderately/densely-populated single-family dwellings. The City also anticipates some minor commercial development in these areas typical of that associated with a "suburb" area. There are no anticipated changes to the land use in the project areas of the Stiles and Maxson WWTP.

5.3 – POPULATION FORECAST

The population forecasts for the city of Memphis during the planning period is modest increasing from approximately 657,000 to 667,000, or approximately 1.5% over the planning period. Population forecasts for the Mary's Creek project area (both Phase 1 and Phase 2) are based on a fully-developed condition. Based on the expected lot sizes of ½-acre lots north of Mary's Creek (which includes approximately 5,184 acres of suitable land) and 2-acre lots south of Mary's Creek (which includes approximately 2,185 acres of suitable land), the City anticipates approximately 11,460 total lots. Based on 3.5 people per household (or lot), the population forecast for a fully-developed condition of the 7,369 acres of suitable land is over 40,100 persons. Based on an average flow per capita of 100 gallons per day*, this population forecast represents an increase in average total flow of 4.0 MGD and an increase in peak flow (2.5 X average*) of 10.0 MGD.

* *Note: The average flow of 100 gallons per capita per day and a 2.5 peak-to-average ratio are City of Memphis standard design criteria.*

SECTION 6 – DEVELOPMENT OF ALTERNATIVES

6.1 – "NO ACTION" ALTERNATIVE

Project No. 1: T.E. Maxson Lagoon Improvements

Alternative No. 1 – "No Action" – This is not a viable alternative because of the large volume of sludge produced each day at the Maxson WWTP. In order to maintain operation and to continue to meet the sludge permit requirements, the project must be completed.

Project No. 2: M.C. Stiles Outfall Modification

Alternative No. 1 – "No Action" – This is not a viable alternative because the City has entered into a consent decree that mandates that the foam discharge in the Mississippi must be eliminated.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Alternative No. 1 – "No Action" – Do nothing to help facilitate further development and growth in project area. This is not a viable alternative because of the high demand for housing and commercial space in this Memphis annexation area of Shelby County. The land in this project area is greatly needed for new housing and commercial development, and growth here has been significantly impeded because of the lack of sewer service.

Project No. 4: Sewer Assessment and Rehabilitation

Alternative No. 1 – "No Action" – This is not a viable alternative because the City has entered into a consent decree that mandates that an assessment program followed by a rehabilitation program must be implemented.

6.2 ALTERNATIVES (OTHER THAN THE "NO ACTION" ALTERNATIVE) [COMPARED FOR COST-EFFECTIVENESS, ENVIRONMENTAL IMPACTS, AND FEASIBILITY]

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970's. In 2000, the City retained a professional engineering consultant to review the lagoon conditions at the plant and the consultant has recommended the modification of the existing Lagoon 5. The purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work.

This project is located inside the existing Maxson WWTP site and will not require any additional easements or land acquisition. The estimated cost for lagoon 5 improvements is $19,000,000.00.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTF located at 2303 North Second Street was constructed in the early 1970's. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this project is to design and construct a modification to the existing outfall

structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

This project is located inside the existing Stiles WWTP site and will not require any additional easements or land acquisition. The estimated cost for the outfall modifications is $3,000,000.00.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Due to growth and development that the Memphis area has experienced, there now exists a demand for new housing and commercial space in the area known as the Mary's Creek Drainage Basin. The expansion of residential and commercial development into areas previously considered to be "rural" has created a unique problem: growth is now inhibited by the lack of public utility services (in particular, sewer services) in these previously "rural" areas.

The traditional method for handling sewage created by new residences/businesses in rural areas is to install septic tanks and drain fields - rural areas have enough "space" to create a buffer between drain fields and wells used for water supplies, and rural residences/businesses are not in close enough proximity to create high amounts of sewage per land area. Because some of the undeveloped land, which is now on the edge of developed areas, lies near or within floodplains, septic tanks/drain field systems are not a proper method for handling sewage created by new developments. Therefore, another method of handling sewage is needed in these areas in order to "open up" new land for highly-demanded residential and commercial development.

One area in particular that is experiencing the problems described herein is a Memphis annexation area north of Collierville (north of the Wolf River and east of Gray's Creek, excluding the Collierville annexation area) in the vicinity of Mary's Creek.

SECTION 6 – DEVELOPMENT OF ALTERNATIVES

Assumptions Based on Current Zoning Maps:

Mary's Creek Interceptor Phase 2 will serve residential only based on the formula of 2 lots/acre north of Mary's Creek and 2 acres/lot south of Mary's Creek.

The above assumptions yield the following:

Mary's Creek Phase 2:	Industrial	0 Industries
	Residential	8720 Lots
Totals:	Industrial	0 Industries
	Residential	8720 Lots

Alternative No. 1 – "No Action" – See Section 6.1 for discussion.

Alternative No. 2 – Build a large-lot septic tank to handle the sewage from new residential and commercial development. This is not a viable alternative due to lack of adequate buffer space between potential drainfields and existing water wells at some residences. Also, as is the case in many other parts of the Memphis area, the soils may not be conducive to septic drainfields, and the area is too close to the Mary's Creek floodplain. Finally, the City of Memphis believes this alternative would increase development costs, limiting commercial development in the area.

Cost Estimate:

1) Large Lot Septic Tanks – Residential

175 ea @ $75,000/ea	$13,125,000

2) 8" Collection Lines to Community Septic Tanks

545,000 LF @ $20/LF	$10,900,000

3) 4' Diameter Sanitary Manholes

1360 SMH @ $4,500/ea	$6,120,000
	$30,145,000

Present Worth Assumptions:

Term: 20 years

Interest Rate: 7%

O&M:	$150/septic tank/year = 175 septic tanks @ $150/ea	$26,250
	$1,000/10,000 LF of sewer = 545,000 @ $1,000/10,000 LF	$54,500
		$80,750

Present Worth = $2,926,224

Refer to Section 8.1 for itemized cost estimate.

Alternative No. 3 – Require on-site treatment of sewage at each new residential and commercial development. This is not a viable alternative because this alternative would significantly increase development costs and, thus, would limit both residential and commercial development in the area. This alternative is also not an efficient solution since there are already sewer interceptors near the project area to which the proposed sewer collection lines can be connected in order to transport sewage to existing treatment facilities.

Cost Estimate:

1) Residential Lot Septic Tanks

8720 lots @ $8,000/lot	$69,760,000
	$69,760,000

Present Worth Assumptions:

Term: 20 years

Interest Rate: 7%

O&M: $150/septic tank/year = 8720 septic tanks @ $150/ea = $1,308,000

Present Worth = $7,892,850

Alternative No. 4 – Install a low pressure sewer collection system with grinder pumps at each individual house or commercial development. While this type of system is viable in certain instances, such as hilly terrain or small developments, it is not viewed as desirable or feasible for the City of Memphis. The City has always tried to maintain a system of gravity sewers for its customers. The City has not encouraged this type of system. It is opposed to this option for a variety of reasons, but primarily from maintenance and legal concerns because of the need for sewer easements on every lot within the development. Memphis has historically provided sewer service to the property line, requiring the property owner to maintain his own sewer service line. The additional obligation to maintain hundreds, if not thousands, of small grinder pump stations is not within the City's resources to adequately maintain.

Cost Estimate:

1) Residential Grinder Pumps	
8720 lots @ $5,000/lot	$43,600,000
2) Mary's Creek Phase 2 Interceptor	$3,000,000 *
3) Low Pressure Collection Lines	
545,000 LF @ $8.00/LF	$4,360,000
	$50,960,000

Present Worth Assumptions:

Term: 20 years

Interest Rate: 7%

O&M: $150/grinder pump/year = 8720 grinder pumps @ $150/ea $1,308,000

$1,000/10,000 LF of sewer = 545,000 @ $1,000/10,000 LF $54,500

$1,362,500

Present Worth = $6,130,286

* Refer to Section 8.1 for detailed estimate.

Alternative No. 5 – Install additional sewer lines (gravity lines and force mains, as required by topography) to collect and transport sewage from new residential and commercial developments to existing treatment facilities. This alternative is the most efficient solution, has the least impact on development costs, and has the least environmental impact of the four "action" alternatives and was, therefore, selected as the best solution to help facilitate further development in the project areas. See Section 6.3 for further discussion.

Cost Estimate:

1) 8" Collection Lines to Interceptor Sewer	
545,000LF @ $20/LF	$10,900,000
2) 4' Diameter Sanitary Manholes	
1360 SMH @ $4,500/ea	$6,120,000
3) Mary's Creek Phase 2 Interceptor	$3,000,000 *
	$20,020,000

Present Worth Assumptions:

Term: 20 years

Interest Rate: 7%

O&M: $1,000/10,000 LF of sewer = 545,000 @ $1,000/10,000 LF = $54,500

Present Worth = $1,901,769

* Refer to Section 8.1 for detailed estimate.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.). The estimated cost for sewer assessment and rehabilitation is $100,000,000.00

6.3 – CHOSEN ALTERNATIVE

Project No. 1: T.E. Maxson Lagoon Improvements

The purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work.

Project No. 2: M.C. Stiles Outfall Modification

. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this project is to design and construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Alternative No. 5 – Install additional sewer lines (gravity lines and force mains, as required by topography) to collect and transport sewage from new residential and commercial developments to existing treatment facilities. This alternative is the most efficient solution, has the least impact on development costs, has the least environmental impact of the four "action" alternatives, and was, therefore, selected as the best solution to help facilitate further development in the project areas. The proposed project is the most efficient solution because there are already sewer interceptors near the project area to which the proposed sewer collection lines can be

connected in order to transport sewage to existing treatment facilities; this project is a continuation of efforts already underway to provide sewer service to undeveloped Memphis annexation areas. The proposed project has the least impact on development costs because it saves developers/owners the expense of installing septic tank/drainfield systems or on-site treatment systems, neither of which is warranted when sewage can be easily transported and treated at existing facilities. Finally, the proposed project has the least environmental impact on the surrounding areas (which are near the Mary's Creek floodplain) because, rather than install septic tank/drainfield systems that may interfere with existing wells or install on-site treatment systems that may not be properly maintained by owners, the sewage will be transported to an existing treatment facility operated by the City of Memphis.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

SECTION 7 – SELECTED PLAN DESCRIPTION

7.1 – DETAILED DESCRIPTION OF CHOSEN ALTERNATIVE

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970's. In 2000, the City retained a professional engineering consultant to review the lagoon conditions at the plant and the consultant has recommended the modification of the existing Lagoon 5. The purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTF located at 2303 North Second Street was constructed in the early 1970's. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this project is to design and construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates.

SECTION 7 – SELECTED PLAN DESCRIPTION

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

The chosen alternative consists of construction of new sewer lines via the Mary's Creek Gravity Interceptor Sewer project. The Mary's Creek Gravity Interceptor Sewer project is comprised of an estimated 20,856 linear feet of gravity sewer with sewer manholes as required. This project is located north of the Collierville area, east of Gray's Creek and north of the Wolf River in east Shelby County. The project begins in a developing area at the Wolf River Interceptor, which is currently under construction south of Walnut Grove Road at Grays Creek. The proposed sewer lines will run east to Houston Levee Road and Pisgah Road (Phase 1) and then east to Reed Hooker Road (Phase 2). The project will terminate at Reed Hooker Road north of Stable View Drive. These new sewer lines will transport sewage for treatment to the Stiles WWTP in northwest Memphis.

The City of Memphis anticipates that this project will be installed in two phases, as follows:

Phase 1 - Wolf River Interceptor to Pisgah Road (10,297 linear feet); and
Phase 2* - Pisgah Road to Reed Hooker Road (10,559 linear feet).

For a graphical representation of the sewer lines included in both phases of the Mary's Creek project, see the attached Project No. 2 Quadrangle Maps (two pages) located in Section 9 of this Facilities Plan.

*Please note that the CWSRF loan application that accompanies this Facilities Plan is for **Phase 2 of the Mary's Creek project**. The City of Memphis, via a Clean Water Sate Revolving Fund Loan Application previously submitted, has already sought funding for the Mary's Creek Phase 1 project.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

7.2 – PUBLIC INVOLVEMENT / PUBLIC MEETING

A public hearing will be held in which the Mary's Creek Phase 2 project will be identified on a display map for public review and comment during the loan application process. Because of the great need for additional housing and the anticipated development in this future Memphis annexation area, the City of Memphis anticipates that public comments will be favorable. Once the Clean Water State Revolving Fund loan application has been approved, the City will proceed as quickly as possible to have these areas of the City's sewer system constructed and in optimal working condition.

SECTION 8 – PROJECT COSTS

8.1 – ESTIMATED CONSTRUCTION COSTS AND OVERALL PROJECT COSTS

Project No. 1: T.E. Maxson Lagoon Improvements

This project is located inside the existing Maxson WWTP site and will not require any additional easements or land acquisition. The estimated cost for lagoon 5 improvements is $19,000,000.00.

Project No. 2: M.C. Stiles Outfall Modification

This project is located inside the existing Stiles WWTP site and will not require any additional easements or land acquisition. The estimated cost for the outfall modifications is $3,000,000.00.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Item No.	Description	Unit	Quantity	Unit Price	Amount*
1	EROSION CONTROL	LF	20000	$6.50	$130,000.00
2	STONE RIP-RAP, GRADE C	TON	2000	$55.00	$110,000.00
3	UNDERCUT BACKFILL	TON	7500	$28.00	$210,000.00
4	15" SEWER PIPE	LF	16	$50.00	$800.00
5	18" SEWER PIPE	LF	8	$60.00	$480.00
6	24" SEWER PIPE	LF	5793	$90.00	$521,370.00
7	27" SEWER PIPE	LF	1856	$100.00	$185,600.00
8	30" SEWER PIPE	LF	2850	$120.00	$342,000.00
9	24" DUCTILE IRON PIPE, CLASS 50	LF	60	$130.00	$7,800.00
10	24" SEWER IN BORED HOLE WITH LINER PIPE	LF	60	$900.00	$54,000.00
11	6' DIAMETER STANDARD DEPTH SEWER MANHOLE	EA	24	$5,000.00	$120,000.00
12	6' DIAMETER EXTRA DEPTH CONCRETE MANHOLE	VF	409	$500.00	$204,500.00
13	NO. 7 MANHOLE RIM AND COVER	EA	11	$500.00	$5,500.00
14	BOLTED DOWN MANHOLE RIM AND COVER	EA	13	$500.00	$6,500.00
15	VENT STACK	EA	13	$400.00	$5,200.00
16	MOBILIZATION	LS	1	$100,000.00	$100,000.00
17	TRAFFIC CONTROL DEVICES FOR CONST. WORK ZONES	LS	1	$2,500.00	$2,500.00
18	SEEDING (WITH MULCH)	UNIT	500	$65.00	$32,500.00
19	FERNCO COUPLING	EA	2	$2,500.00	$5,000.00
				SUBTOTAL	$2,043,750.00
	Construction Contingency				$956,250.00

** rounded to the nearest whole dollar*

TOTAL $3,000,000.00

ESTIMATE OF CONSTRUCTION COST $3,000,000.00

TOTAL PROJECT COST

Please note that easements must still be acquired for the Mary's Creek Phase 2 project. The project costs of Easement Acquisition, Surveying, Engineering Design, Construction Inspection, and Construction Administration have been budgeted for and are being or will be paid for with funds already allocated in the City of Memphis Public Works Department operating budget. Thus, Total Project Costs are not presented herein. The City of Memphis is applying for a Clean Water State Revolving Fund loan only for construction of the proposed projects.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.). The estimated cost for sewer assessment and rehabilitation is $100,000,000.00.

8.2 – PROPOSED FINANCING

The City of Memphis intends to finance the proposed Mary's Creek Phase 2 sewer project with funding obtained via the Clean Water State Revolving Fund Loan Program (SRFLP), for which this Facilities Plan has been written. Based on anticipated growth in the project areas and the resulting additional sewer customers and additional sewer fees, the City of Memphis does not see any problems with repayment of the borrowed funds.

8.3 – PROJECTED OPERATING COSTS AND USER CHARGE STRUCTURE

The existing normal demand for the Memphis Sanitary Sewer System is 145 MGD. The anticipated increase in average total flow from the Mary's Creek project area (both phases, fully developed) is 4.0 MGD (please refer to Section 5.3). Thus, the anticipated increase in average total flow is less than three percent of the existing demand. Therefore, the City of Memphis anticipates little increase in operating costs associated with the project proposed herein. The City of Memphis believes that any additional operating costs can easily be absorbed into the operating budget of the sanitary sewer system since additional sewer customers and the establishment of a special sewer service area will result in additional fees being collected. These additional fees should easily offset any additional operating costs resulting from the increased demand on the system.

The normal user charge structure for new sewer should remain unchanged from present levels. Per the City of Memphis Sewer Use Ordinance, which is available for review by the public via the City of Memphis website (http://www.cityofmemphis.org/pdf_forms/sewerUse013006.pdf), the sewer service volumetric charge is 2.267 cents per one thousand gallons of flow, with a residential maximum volume fee of $50.00 per month and a residential minimum volume fee of $2.50 per month. There is also an additional charge to any customer (residential or commercial) who discharges wastewater with a strength greater than domestic sewerage levels. Historically, the City's sewer rates have been very stable. Prior to the sewer rate increase in 2004 (which resulted in the above-mentioned rates), the previous rate increase was in 1982 – the City operated the sanitary sewer system for twenty-two years without its customers experiencing a rate increase. Refer to *APPENDIX C* at the end of this document.

However, to offset the cost of designing, constructing, and financing a sewer system for the Mary's Creek drainage basin, a special sewer service area has been created (via city ordinance) which establishes sewer infrastructure surcharge fees for any person directly or indirectly served by these new sewer systems. In the Mary's Creek Special Sewer Service Area, these sewer infrastructure surcharge fees include surcharge development fees (in addition to the normal development fees) **AND** user surcharge fees (in addition to normal user fees mentioned in the previous paragraph). Details of surcharge fees for this special sewer service area are included in *APPENDIX B* at the end of this document.

SECTION 9 – ENVIRONMENTAL IMPACTS

9.1 – PLANNING AREA AND PROJECT AREA AND BRIEF PROJECT DESCRIPTION

The **Planning Area** for this project is the City of Memphis and adjacent unincorporated areas of Shelby County that are scheduled for annexation into the City of Memphis; these areas are experiencing high growth rates.

Project No. 1: T.E. Maxson Lagoon Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970's. In 2000, the City retained a professional engineering consultant to review the lagoon conditions at the plant and the consultant has recommended the modification of the existing Lagoon 5. The purpose of this project is to allow the Maxson WWTF to continue to meet the requirements of 40 CFR 503 (Sludge Regulations) and to facilitate sludge handling for the treatment facility. The project consists of the removal of sludge from the confines of existing Lagoon 5; earthwork to modify the existing Lagoon 5 into three lagoon cells; installing HDPE liners in each of the three cells; installing floating covers in each of the three cells; biogas collection modifications; piping and pump additions and modifications at the existing Primary Sludge Pump Station; Lagoon 5 outfall modification; and miscellaneous piping, valves, and concrete work. The project area is located in Southwest Memphis as shown on the Project Map included at the end of this section.

Project No. 2: M.C. Stiles Outfall Modification

The M.C. Stiles WWTF located at 2303 North Second Street was constructed in the early 1970's. Periodically, foam is observed in the Mississippi River at Outfall 001 from the WWTF. The purpose of this project is to design and construct a modification to the existing outfall structure that will eliminate foam. The design options being considered will require an effluent discharge through a portal in the river bank with a non-vertical drop structure or a non-vertical

drop structure with mechanical diffuser or a mechanical energy dissipater with pumps and gates. The project area is located in Northwest Memphis as shown on the Project Map included at the end of this section.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

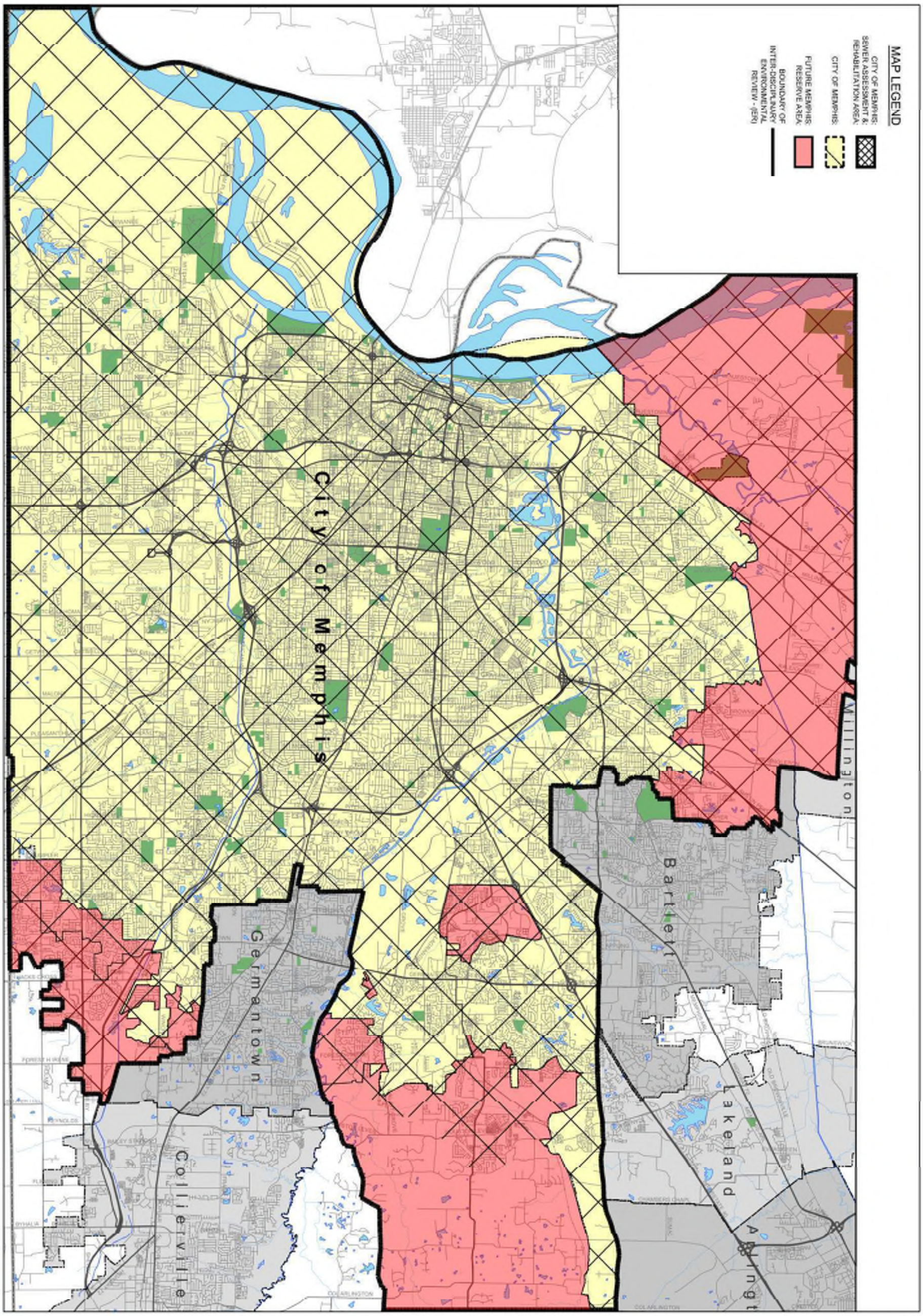
The **Project Area** is located north of Collierville in the Mary's Creek area, as illustrated on the Project Areas maps at the end of this section.

The proposed project will consist of installation of an estimated 10,559 linear feet of gravity interceptor sewer lines in the Mary's Creek area of east Shelby County, which is north of the Wolf River and east of Gray's Creek. Mary's Creek Phase 2, for which CWSRF funding is being sought via the application that accompanies this Facilities Plan, will begin at Pisgah Road and continue east to Reed Hooker Road, terminating north of Stable View Drive. Phase 2 is a continuation of the Mary's Creek Phase 1 project. The Phase 1 project included installation of an estimated 10,297 linear feet of gravity sewer lines from the existing Wolf River Interceptor (south of Walnut Road near Gray's Creek) east to Houston Levee Road and Pisgah Road.

Project No. 4: Sewer Assessment and Rehabilitation

This project is comprised of a city wide sewer assessment and rehabilitation of the entire sewer system. The City will complete approximately 240 miles of assessment per year. The rehabilitation areas will be dependent on the assessment data. We anticipate the original funding to carry the City approximately 4 years. This could include gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition

(i.e., CIPP, pipe burst, open cut, etc.). The project area is located throughout the City as shown on the Project Map included at the end of this section.



PROJECT NO. 4

SEWER ASSESSMENT AND REHABILITATION, MEMPHIS, TN.

NW, NE, SW & SE MEMPHIS, AND GERMANTOWN QUADRANGLE MAP

SHEET NO. 1

SHEET TITLE:

DRAWN: A2H | CHECKED: E.H.

DATE: APRIL 23, 2012

PROJECT NO. 12174

REVISIONS

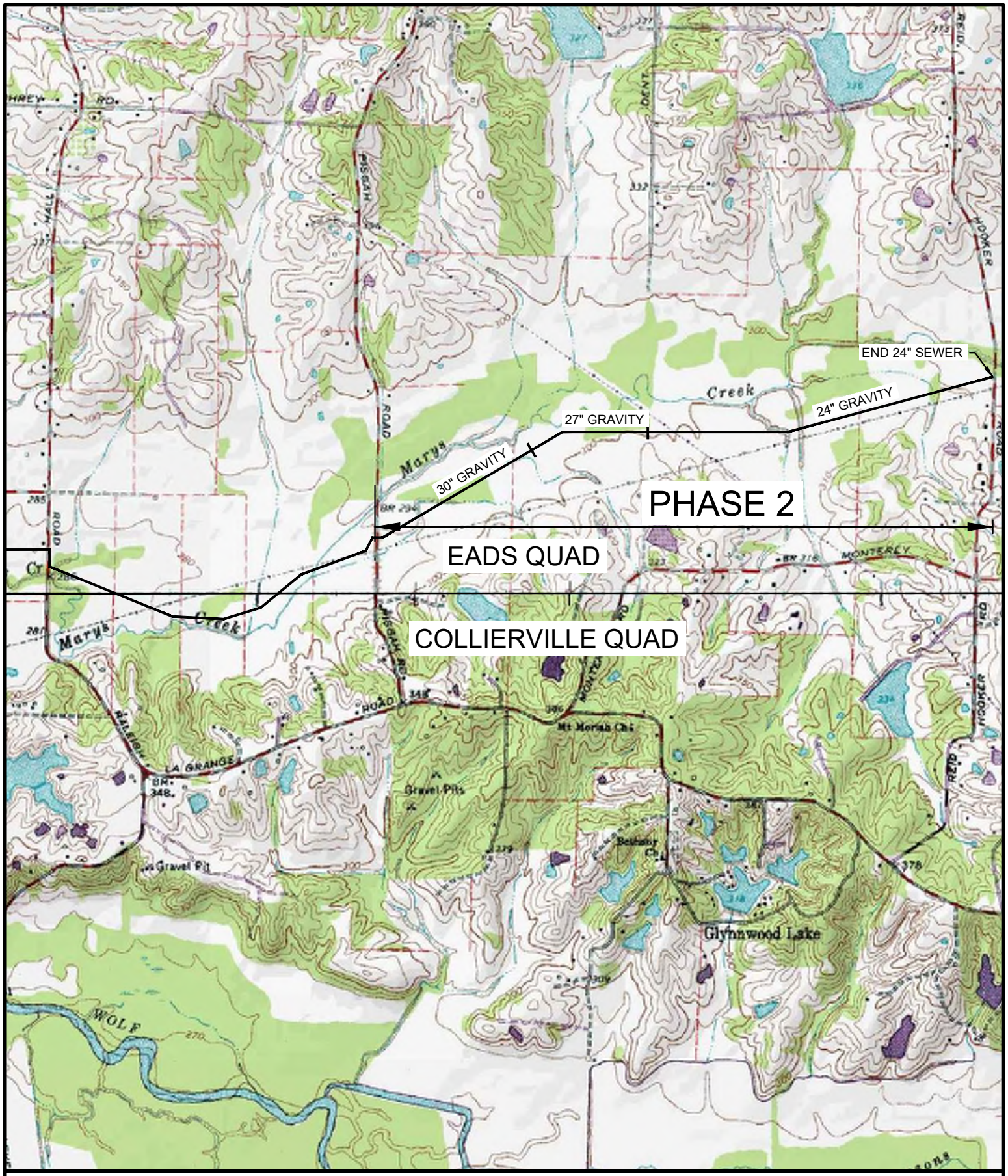
SEAL

A2H

ASKEW HARGRAVES HARCOURT & ASSOCIATES, INC.

Memphis, TN 901.372.0404 | Hernando, MS 662.298.2188

www.a2h.com



PROJECT NO. 3

MARY'S CREEK GRAVITY INTERCEPTOR SEWER PHASE 2

MEMPHIS, TENNESSEE. EADS AND COLLIERVILLE QUADRANGLE MAP

SCALE: 1" = 2,000'

A2H

ASKEW HARGROVES MERCURY & ASSOCIATES, INC.

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Hernando, MS 662.298.2168

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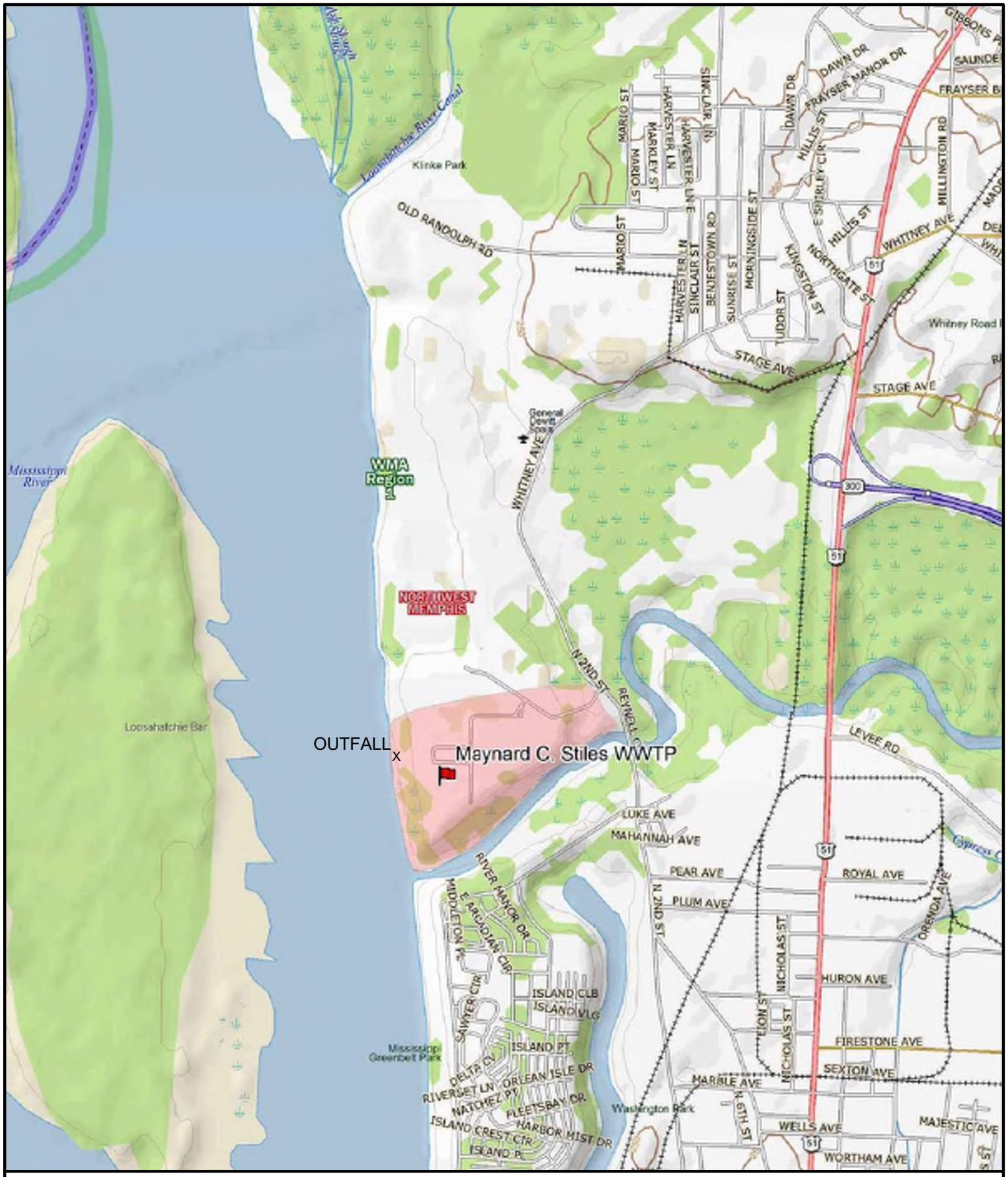

PROJECT NO. 2

MAYNARD C. STILES WWTP OUTFALL MODIFICATION

MEMPHIS, TENNESSEE. NORTHWEST MEMPHIS QUADRANGLE MAP

SCALE: 1" = 2,000'

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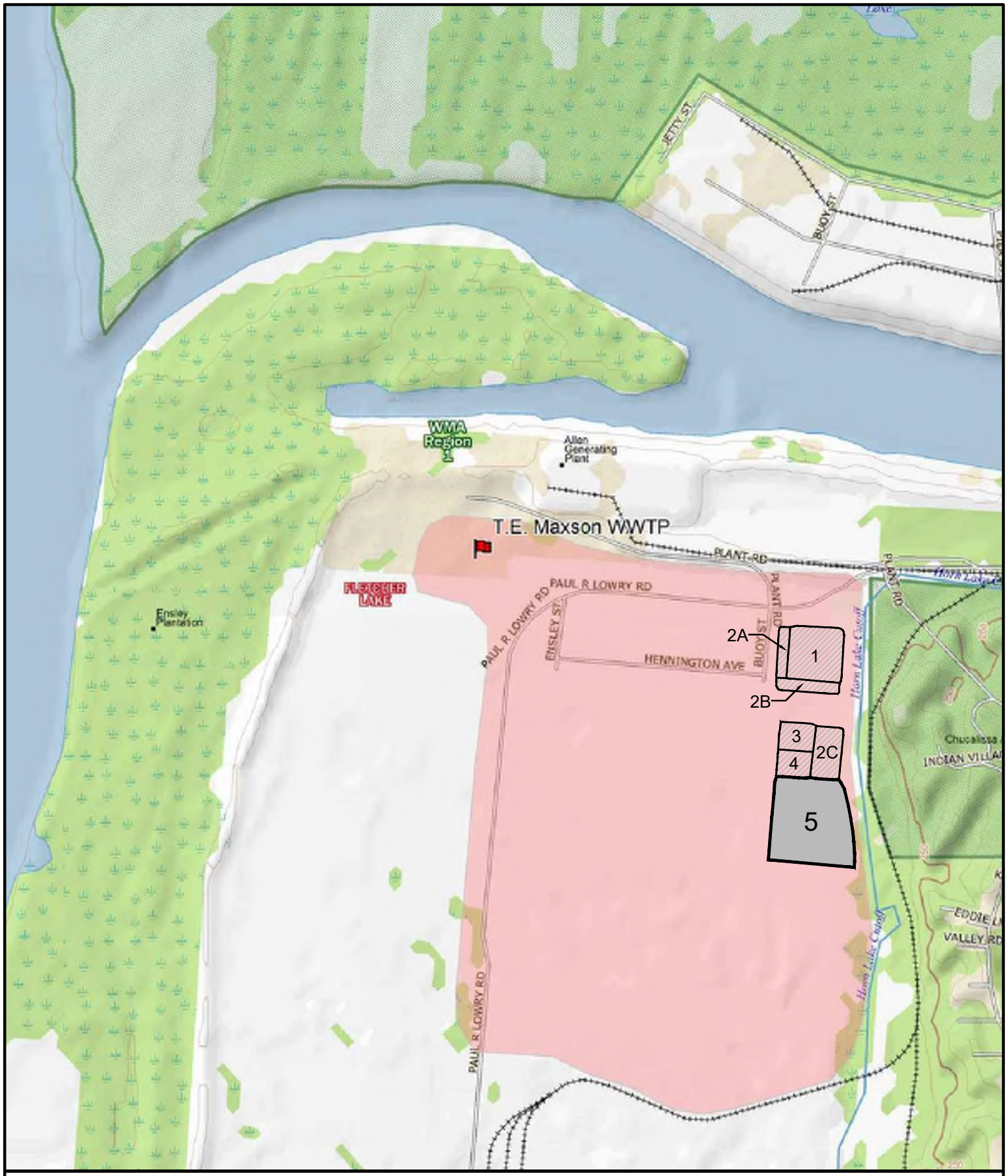

PROJECT NO.1

T.E. MAXSON WWTP LAGOON IMPROVEMENTS

MEMPHIS, TENNESSEE. FLETCHER LAKE QUADRANGLE MAP

SCALE: 1" = 2,000'

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9.2 – PROJECT SPECIFIC IMPACTS

Project No. 1: T.E. Maxson Lagoon Improvements

As discussed previously, the proposed T.E. Maxson Lagoon Improvements project is located in a remote area of Southwest Memphis. The City anticipates that growth in the project area will be primarily industrial. The topography of the project area varies from generally flat, and the area is drained by the Mississippi River system. The soils in the project area are generally deep, consisting of sand, silt, clay, and gravel.

The City of Memphis anticipates no adverse impacts to historical or archeological features as a result of the proposed project. The State of Tennessee Department of Environment and Conservation Division of Archaeology and the Tennessee Historical Commission both required a review of the proposed project.

The City of Memphis anticipates no adverse impacts to threatened, endangered, or otherwise protected flora or fauna species as a result of the proposed project. According to information obtained from the website of the State of Tennessee Department of Environment and Conservation Division of Natural Areas (www.state.tn.us/environment/na), There are a few flora/fauna species listed with a state status of Endangered (E), Threatened (T), Special Concern (S), or Deemed in need of management (D) including the following (common names are used herein) within the Nonconnah/Horn Lake Water Shed.:

Cedar Elm (S), Mississippi Kite (D), and Bald Eagle (D)

Locations of specific habitats of the above-mentioned flora and fauna species within the proposed project area, if any, are not known. The proposed project will disturb only areas immediate to the lagoon modifications; such disturbance will be temporary (only for the duration

of the construction itself), and the disturbed areas will be returned as close to their pre-construction states as possible. However, should information be revealed during the design or construction of the proposed project regarding disturbance of habitats of any threatened or endangered species, all necessary procedures required by federal or state law will be taken to reduce or eliminate such disturbances.

The City of Memphis anticipates no adverse impacts to the community's water supply as a result of the proposed project. The City of Memphis does not obtain drinking water from any surface lakes or rivers. Rather, the water is obtained from the Memphis aquifer, which sits beneath Shelby County and contains more than 100 trillion gallons of water. This water is drawn via wells, filtered and treated, and distributed to an estimated 265,000 customers. The proposed project should not threaten the City's water supply. Furthermore, this project promotes cleaner surface waters and ground water by improving the treatment capabilities of the T.E. Maxson WWTP.

The City of Memphis anticipates no adverse impacts to Wild or Scenic Rivers or wetlands as there are no National or State Scenic or Wild Rivers in Shelby County and no jurisdictional wetlands in the project area. Also, the City of Memphis anticipates no long-term adverse impacts to ambient air quality or fish and wildlife in the project area. While there may be temporary disturbances to air quality and fish and wildlife associated with normal construction activities, such as noise, dust, odor, and erosion, these impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, and restoring disturbed areas to their previous (or better than previous) condition.

SECTION 9 – ENVIRONMENTAL IMPACTS

Because the proposed project occurs in a remote area, the City of Memphis anticipates few adverse impacts to residential areas. No displacement of the population or alteration of the character of existing residential neighborhoods is expected. As stated previously, the only anticipated adverse environmental impacts are minor and temporary and include those associated with normal construction activities, such as noise, dust, odor, erosion, and inconvenience to nearby residents. These impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, limiting construction hours to avoid disturbing residents, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, maintaining access to residences and businesses, and restoring disturbed areas to their previous (or better than previous) condition.

Project No. 2: M.C. Stiles Outfall Modification

As discussed previously, the proposed M.C. Stiles Outfall Modification project is located in a remote area of Northwest Memphis. The City anticipates that growth in the project area will be primarily industrial. The topography of the project area varies from generally flat, and the area is drained by the Mississippi River system. The soils in the project area are generally deep, consisting of sand, silt, clay, and gravel.

The City of Memphis anticipates no adverse impacts to historical or archeological features as a result of the proposed project. The State of Tennessee Department of Environment and Conservation Division of Archaeology and the Tennessee Historical Commission both required a review of the proposed project.

The City of Memphis anticipates no adverse impacts to threatened, endangered, or otherwise protected flora or fauna species as a result of the proposed project. According to information

obtained from the website of the State of Tennessee Department of Environment and Conservation Division of Natural Areas (www.state.tn.us/environment/na), There are a few flora/fauna species listed with a state status of Endangered (E), Threatened (T), Special Concern (S), or Deemed in need of management (D) including the following (common names are used herein) within the Loosahatchie/ Mississippi River Water Shed.:

Mississippi Kite (D), Interior Least Tern (E), Lark Sparrow (T), Blue Sucker (T), and Bald Eagle (D)

Locations of specific habitats of the above-mentioned flora and fauna species within the proposed project area, if any, are not known. The proposed project will disturb only areas immediate to the effluent outfall modifications; such disturbance will be temporary (only for the duration of the construction itself), and the disturbed areas will be returned as close to their pre-construction states as possible. However, should information be revealed during the design or construction of the proposed project regarding disturbance of habitats of any threatened or endangered species, all necessary procedures required by federal or state law will be taken to reduce or eliminate such disturbances.

The City of Memphis anticipates no adverse impacts to the community's water supply as a result of the proposed project. The City of Memphis does not obtain drinking water from any surface lakes or rivers. Rather, the water is obtained from the Memphis aquifer, which sits beneath Shelby County and contains more than 100 trillion gallons of water. This water is drawn via wells, filtered and treated, and distributed to an estimated 265,000 customers. The proposed project should not threaten the City's water supply. Furthermore, this project promotes cleaner surface waters and ground water by improving the effluent quality of the M.C. Stiles WWTP.

SECTION 9 – ENVIRONMENTAL IMPACTS

The City of Memphis anticipates no adverse impacts to Wild or Scenic Rivers or wetlands as there are no National or State Scenic or Wild Rivers in Shelby County and no jurisdictional wetlands in the project area. Also, the City of Memphis anticipates no long-term adverse impacts to ambient air quality or fish and wildlife in the project area. While there may be temporary disturbances to air quality and fish and wildlife associated with normal construction activities, such as noise, dust, odor, and erosion, these impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, and restoring disturbed areas to their previous (or better than previous) condition.

Because the proposed project occurs in a remote area, the City of Memphis anticipates few adverse impacts to residential areas. No displacement of the population or alteration of the character of existing residential neighborhoods is expected. As stated previously, the only anticipated adverse environmental impacts are minor and temporary and include those associated with normal construction activities, such as noise, dust, odor, erosion, and inconvenience to nearby residents. These impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, limiting construction hours to avoid disturbing residents, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, maintaining access to residences and businesses, and restoring disturbed areas to their previous (or better than previous) condition.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

As discussed previously, the proposed Mary's Creek Sewer Interceptor project is located in currently undeveloped areas that are in or adjacent to the floodplains of Mary's Creek. The City anticipates that growth in the project area will be primarily residential. The topography of the Mary's Creek project area varies from generally flat (near the floodplain) to gently rolling hills (north and south of the floodplain), and the area is drained by the Wolf River system, which consists of small creeks scattered throughout the area that drain into Mary's Creek or Gray's Creek. Mary's Creek empties into Gray's Creek north of where Gray's Creek empties into the Wolf River, which empties into the Mississippi River. The soils in the project area are generally deep, consisting of sand, silt, clay, and gravel.

The City of Memphis anticipates no adverse impacts to historical or archeological features as a result of the proposed project. The State of Tennessee Department of Environment and Conservation Division of Archaeology and the Tennessee Historical Commission both required a review of the proposed project (specifically the proposed sewer line routes outside existing road right-of-ways).

The City of Memphis anticipates no adverse impacts to threatened, endangered, or otherwise protected flora or fauna species as a result of the proposed project. According to information obtained from the website of the State of Tennessee Department of Environment and Conservation Division of Natural Areas (www.state.tn.us/environment/na). There are a few flora/fauna species listed with a state status of Endangered (E), Threatened (T), Special Concern (S), or Deemed in need of management (D) including the following (common names are used herein) within the Mary's Creek/Gray's Creek Water Shed.:

Naked Sand Darter (D), Piebald Madtom (D)

SECTION 9 – ENVIRONMENTAL IMPACTS

Locations of specific habitats of the above-mentioned flora and fauna species within the proposed project area, if any, are not known. The proposed project will disturb only areas immediate to the sewer interceptor installation; such disturbance will be temporary (only for the duration of the construction itself), and the disturbed areas will be returned as close to their pre-construction states as possible. However, should information be revealed during the design or construction of the proposed project regarding disturbance of habitats of any threatened or endangered species, all necessary procedures required by federal or state law will be taken to reduce or eliminate such disturbances.

The City of Memphis anticipates no adverse impacts to the community's water supply as a result of the proposed projects. The City of Memphis does not obtain drinking water from any surface lakes or rivers. Rather, the water is obtained from the Memphis aquifer, which sits beneath Shelby County and contains more than 100 trillion gallons of water. This water is drawn via wells, filtered and treated, and distributed to an estimated 265,000 customers. The proposed project should not threaten the City's water supply. Furthermore, this project promotes cleaner surface waters and ground water by limiting sewer septic systems and drainfields and transporting potential contaminants in sewage to treatment facilities.

The City of Memphis anticipates no adverse impacts to Wild or Scenic Rivers or wetlands as there are no National or State Scenic or Wild Rivers in Shelby County and no jurisdictional wetlands in the project area. Also, the City of Memphis anticipates no long-term adverse impacts to ambient air quality or fish and wildlife in the project area. While there may be temporary disturbances to air quality and fish and wildlife associated with normal construction activities, such as noise, dust, odor, and erosion, these impacts should only last for the duration

of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, and restoring disturbed areas to their previous (or better than previous) condition.

Portions of the proposed project do lie within the 100-year floodplain (as they are near Mary's Creek). Occasionally as design requires, the proposed pipeline route may enter the floodway. However, the City of Memphis anticipates no adverse impacts to the floodplain or floodway as a result of the proposed project. While the construction of the proposed interceptor sewer will disturb the floodplain and, possibly, the floodway, the disturbance will only be for the duration of construction, and the disturbed areas will be restored to their previous condition. The completed project will consist of buried pipe (not visible) and occasional manholes (visible and spaced as required by the design of the sewer interceptor). The manhole or vent pipe elevations will be established to lie above the 100-year flood elevation throughout the project area to avoid storm water infiltration during flood events.

The proposed pipeline route for Phase 2 of the Mary's Creek Interceptor Sewer project lies almost entirely (approximately 95 percent) in the floodplain and requires six (6) stream crossings. Of the Phase 2 stream crossings, three (3) occur near the beginning of the project east of Pisgah Road (unnamed creeks) and three (3) occur near the end of the project west of Reed Hooker Road (unnamed creeks). All necessary permits related to stream crossings (ARAP, TVA, or US Army Corps of Engineers, as applicable) will be obtained prior to construction, and all necessary actions will be taken to prevent potential to prevent adverse impacts at the stream crossings.

Because the proposed project occurs in rural areas, the City of Memphis anticipates few adverse impacts to residential areas. No displacement of the population or alteration of the

character of existing residential neighborhoods is expected. As stated previously, the only anticipated adverse environmental impacts are minor and temporary and include those associated with normal construction activities, such as noise, dust, odor, erosion, and inconvenience to nearby residents. These impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, limiting construction hours to avoid disturbing residents, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, maintaining access to residences and businesses, and restoring disturbed areas to their previous (or better than previous) condition.

Project No. 4: Sewer Assessment and Rehabilitation

As discussed previously, the proposed sewer assessment and rehabilitation project is the City of Memphis and adjacent unincorporated areas of Shelby County that are slated for annexation into the City of Memphis. The City anticipates that growth in the project area will be primarily residential. The topography of the project areas varies from generally flat (near the floodplain) to gently rolling hills, and the area is drained by the Wolf River, Loosahtchie River, and the Nonconnah Creek systems. The soils in the project area are generally deep, consisting of sand, silt, clay, and gravel.

The City of Memphis anticipates no adverse impacts to historical or archeological features as a result of the proposed project. The State of Tennessee Department of Environment and Conservation Division of Archaeology and the Tennessee Historical Commission both required a review of the proposed project (specifically the proposed sewer line routes outside existing road right-of-ways). The review did not indicate any archaeologically of historically significant sites in the Project Area.

SECTION 9 – ENVIRONMENTAL IMPACTS

The City of Memphis anticipates no adverse impacts to threatened, endangered, or otherwise protected flora or fauna species as a result of the proposed project. According to information obtained from the website of the State of Tennessee Department of Environment and Conservation Division of Natural Areas (www.state.tn.us/environment/na There are a few flora/fauna species listed with a state status of Endangered (E), Threatened (T), Special Concern (S), or Deemed in need of management (D) including the following (common names are used herein) within the Northeast, Northwest, Southwest, and Southeast Memphis Water Sheds.:

Ovate Catchfly (E),Willow Aster (E), Swainson's Warbler (D), Barn Owl (D), Mississippi Kite (D), Blue Sucker (T), Bulbous Adder's Tongue (S), Bewick's Wren (E), Lark Sparrow (T)

Locations of specific habitats of the above-mentioned flora and fauna species within the proposed project area, if any, are not known. The proposed project will disturb only areas immediate to the sewer interceptor installation; such disturbance will be temporary (only for the duration of the construction itself), and the disturbed areas will be returned as close to their pre-construction states as possible. However, should information be revealed during the design or construction of the proposed project regarding disturbance of habitats of any threatened or endangered species, all necessary procedures required by federal or state law will be taken to reduce or eliminate such disturbances.

The City of Memphis anticipates no adverse impacts to the community's water supply as a result of the proposed projects. The City of Memphis does not obtain drinking water from any surface lakes or rivers. Rather, the water is obtained from the Memphis aquifer, which sits beneath Shelby County and contains more than 100 trillion gallons of water. This water is

drawn via wells, filtered and treated, and distributed to an estimated 265,000 customers. The proposed project should not threaten the City's water supply. Furthermore, this project promotes cleaner surface waters and ground water by limiting sewer septic systems and drainfields and transporting potential contaminants in sewage to treatment facilities.

The City of Memphis anticipates no adverse impacts to Wild or Scenic Rivers or wetlands as there are no National or State Scenic or Wild Rivers in Shelby County and no jurisdictional wetlands in the project area. Also, the City of Memphis anticipates no long-term adverse impacts to ambient air quality or fish and wildlife in the project area. While there may be temporary disturbances to air quality and fish and wildlife associated with normal construction activities, such as noise, dust, odor, and erosion, these impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, and restoring disturbed areas to their previous (or better than previous) condition.

Portions of the proposed project do lie within the 100-year floodplain of the Wolf River, Loosahatchie River, and Nonconnah Creek. Occasionally as design requires, the proposed pipeline route may enter the floodway. However, the City of Memphis anticipates no adverse impacts to the floodplain or floodway as a result of the proposed project. While the sewer rehabilitation will disturb the floodplain and, possibly, the floodway, the disturbance will only be for the duration of construction, and the disturbed areas will be restored to their previous condition. The completed project will consist of repaired or replaced buried pipe (not visible) and occasional manhole repairs.

SECTION 9 – ENVIRONMENTAL IMPACTS

Even though the proposed project occurs throughout the City, it is not anticipated that the project will adversely impact residential areas. No displacement of the population or alteration of the character of existing residential neighborhoods is expected. As stated previously, the only anticipated adverse environmental impacts are minor and temporary and include those associated with normal construction activities, such as noise, dust, odor, erosion, and inconvenience to nearby residents. These impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, limiting construction hours to avoid disturbing residents, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, maintaining access to residences and businesses, and restoring disturbed areas to their previous (or better than previous) condition.

SECTION 10 – ENVIRONMENTAL JUSTICE CONCERNS

10.1 – IDENTIFICATION OF MINORITY AND LOW-INCOME POPULATIONS IN PROJECT AREA

Project No. 1: T.E. Maxson Lagoon Improvements

The Project Area is located in a remote area of Southwest Memphis. There are no residential areas in the vicinity. There are no minority or low-income populations within the project area.

Project No. 2: M.C. Stiles Outfall Modification

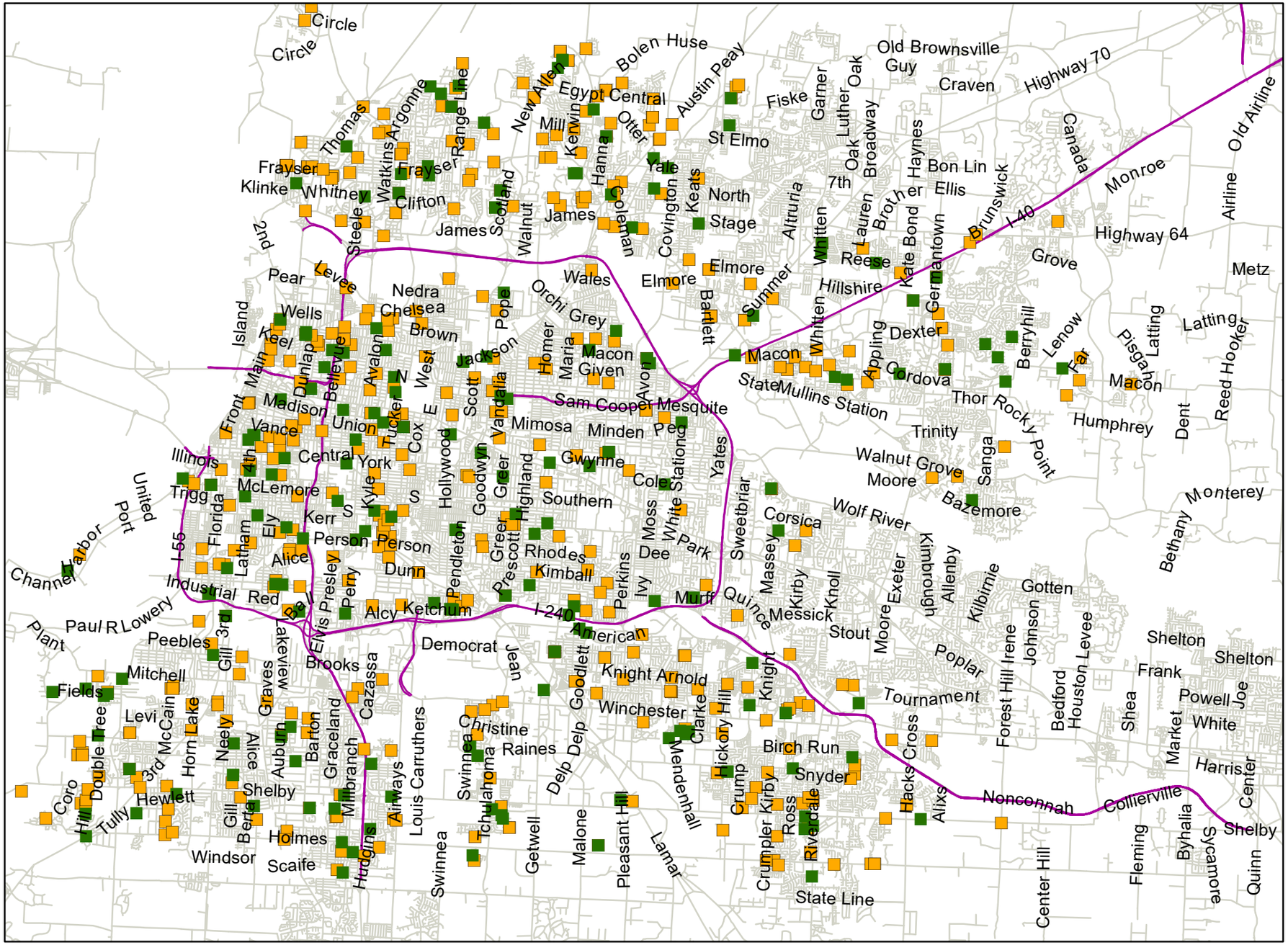
The Project Area is located in a remote area of Northwest Memphis. There are no residential areas in the vicinity. There are no minority or low-income populations within the project area.

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

The immediate project area is in a relatively undeveloped location of a City of Memphis annexation area in Shelby County. As a result of completion of the proposed project, this location should experience swift growth and development. Although minority and low-income populations have not been specifically identified for the project area, the City believes that there are relatively few minority or low-income populations in the Mary's Creek project area, based on population characteristics of the surrounding communities. The anticipated growth in the Mary's Creek project area, again based on population characteristics of surrounding communities, will be predominately average to above-average income populations.

Project No. 4: Sewer Assessment and Rehabilitation

Since this Project Area encompasses the entire City, several areas of minority and low-income population will be included in the sewer assessment and rehabilitation areas. A review of the City Overview Map at the end of this section identifies areas of sewer overflows in the past. The identified areas on this map are indicators of possible sewer rehabilitation projects.



Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 1 2 4 Miles

City Overview

Note: 2012 SSO's thru June

10.2 – EVALUATION OF DISPROPORTIONATE RISKS TO IDENTIFIED EJ POPULATIONS

Project No. 1: T.E. Maxson Lagoon Improvements

Project No. 2: M.C. Stiles Outfall Modification

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Project No. 4: Sewer Assessment and Rehabilitation

There are no anticipated disproportionate risks to EJ populations associated with these projects. The proposed projects should benefit all residents of this City of Memphis and annexation areas in Shelby County by encouraging continued growth and development.

10.3 – IDENTIFICATION OF PUBLIC PARTICIPATION OPPORTUNITIES FOR IDENTIFIED EJ POPULATIONS

Project No. 1: T.E. Maxson Lagoon Improvements

Project No. 2: M.C. Stiles Outfall Modification

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Project No. 4: Sewer Assessment and Rehabilitation

As stated in Section 7.2 – Public Involvement/Public Meetings, a public hearing will be held in which the projects will be identified on a display map for public review and comment during the loan application process. All affected residents of Shelby County, including those in EJ populations, will have opportunity to offer comments, favorable or unfavorable, and ask questions concerning the proposed projects. The City of Memphis anticipates that public comments will be favorable.

10.4 – EVALUATION OF ENVIRONMENTAL/HEALTH RISKS AMONG IDENTIFIED EJ POPULATIONS THAT MAY BE EXACERBATED BY PROPER CONSTRUCTION AND OPERATION OF THE SELECTED ALTERNATIVE

Project No. 1: T.E. Maxson Lagoon Improvements

Project No. 2: M.C. Stiles Outfall Modification

Project No. 3: Mary's Creek Gravity Interceptor Sewer Phase 2

Project No. 4: Sewer Assessment and Rehabilitation

There are no anticipated environmental or health risks among EJ populations that will be exacerbated by proper construction and operation of the selected alternatives. Certain construction practices will be employed to minimize minor adverse impacts associated with normal construction practices (refer to the *Specific Impacts* discussion in Section 9). Again, the proposed projects should benefit all residents of this City of Memphis and annexation areas in Shelby County by encouraging continued growth and development.

APPENDIX A

COPIES OF NPDES PERMITS

1. State of Tennessee NPDES Permit – T.E. Maxson STP *
2. State of Tennessee NPDES Permit – Maynard C. Stiles STP *
3. State of Tennessee NPDES Permit – Memphis-Chapel Hill S.D. STP

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243

DEC 06 2011

Mr. Don Hudgins
Plant Administrator
City of Memphis Environmental Division
2303 N. Second St.
Memphis, TN 38127

Subject: **NPDES Permit No. TN0020729**
Memphis-TE Maxson STP South Plant
Memphis, Shelby County, Tennessee

Dear Mr. Hudgins:

In accordance with the provisions of the Tennessee Water Quality Control Act, Tennessee Code Annotated (T.C.A.), Sections 69-3-101 through 69-3-120, the Division of Water Pollution Control hereby issues the enclosed NPDES Permit. The continuance and/or reissuance of this NPDES Permit is contingent upon your meeting the conditions and requirements as stated therein.

Please be advised that a petition for permit appeal may be filed, pursuant to T.C.A. Section 69-3-105, subsection (i), by the permit applicant or by any aggrieved person who participated in the public comment period or gave testimony at a formal public hearing whose appeal is based upon any of the issues that were provided to the commissioner in writing during the public comment period or in testimony at a formal public hearing on the permit application. Additionally, for those permits for which the department gives public notice of a draft permit, any permit applicant or aggrieved person may base a permit appeal on any material change to conditions in the final permit from those in the draft, unless the material change has been subject to additional opportunity for public comment. Any petition for permit appeal under this subsection (i) shall be filed with the board within thirty (30) days after public notice of the commissioner's decision to issue or deny the permit.

If you have questions, please contact the Memphis Environmental Field Office at 1-888-891-TDEC; or, at this office, please contact Mr. Gary Davis at (615) 532-0649 or by E-mail at *Gary.Davis@tn.gov*.

Sincerely,

[redacted]

Vojin Janjić
Manager, Permit Section
Division of Water Pollution Control

P:WAT-3
Enclosure

cc: Permit Section File
Memphis Environmental Field Office (Eddy.Bouzeid@tn.gov)
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Mr. Gary B. Cohen, Special Counsel for Memphis, Hall & Associates, gcohen@hall-associates.com
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Ms. Katherine Terry, CPESC, ENSAFE, kterry@ensafe.com
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Mr. Thomas W. Kolano, Plant Manager, American Yeast Corporation, tkolano@lallemand.com
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Ms. Rebecca Hoffman, rhoffmann@hornershifrin.com
Ms. Naomi Van Tol, naomi@spiny.com
Ms. Amy Cotter, Engineer II, ADEQ Water Division, cotter@adeq.state.ar.us
Mr. Bill Pretsch, [redacted]
Mr. Tommy Mallard, Survey Servicees Manager, Fisher & Arnold, Inc., tmallard@fisherarnold.com
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Mr. Chris Syrigos, Plant Manager, Fleischmann's Yeast, chrisSyrigos@abmauri.us
Ms. Doris F. Boyd, Environmental Engineering Manager, The Premcor Refining Group, Inc., doris.boyd@valero.com
Mr. Kenneth Roberts, President, Valley Products Company, kroberts@valproco.com
Mr. Christopher Provost, CDM, provostca@cdm.com
Axel Ringe, Vice Conservation Chair, Sierra Club,[redacted]
Ms. Stephanie Matheny, Staff Attorney, Tennessee Clean Water Network, stephanie@tcwn.org
Mr. Dwan L. Gilliom, Director, City of Memphis, Division of Public Works, Dwan.Gilliom@memphistn.gov
Ms. Mary Wilder, , [redacted]
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Mr. Art Newby, Art.Newby@aecom.com
Mr. Geoff Pope, Geoff.Pope@tetratech.com
J. E. Holmes,[redacted]
Mr. James H. Baker, Chickasaw Group-TN Chapter Vice-Chair and TN Water Sentinels Project Leader, Tennesse Chapter-Sierra Club-Chickasaw Group, tn_water_sentinel@yahoo.com
Mr. Brandon W. Neuschafer, Bryan Cave LLP, bwneuschafer@bryancave.com
Mr. Peter Alfonso, Plant Manager, Memphis Utilities, peter.alfonso@memphistn.gov

STATE OF TENNESSEE

NPDES PERMIT

No. TN0020729

Authorization to discharge under the
National Pollutant Discharge Elimination System (NPDES)

Issued By

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
401 Church Street
6th Floor, L & C Annex
Nashville, Tennessee 37243-1534

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger:	**Memphis-T. E. Maxson STP**
Is authorized to discharge:	**treated municipal wastewater from Outfall 001**
From a facility located:	**in Memphis, Shelby County, Tennessee**
To receiving waters named:	**Mississippi River at Mile 725.0**

In accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on:	**January 1, 2012**
This permit shall expire on:	**December 31, 2016**
Issuance date:	**December 6, 2011**

[redacted]

Paul E. Davis, Director
Division of Water Pollution Control

CN-0759
(Template Rev. 1-05)

RDAs 2352 and 2366

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GMDa
TN0020729

1.0. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1.1. NUMERIC AND NARRATIVE EFFLUENT LIMITATIONS

The permittee is authorized to discharge its T.E. Maxson STP treated wastewater from Outfall 001 to the Mississippi River at Mile 725.0 via the local Cooling Water Channel (a wet weather conveyance) pursuant to the permit limitations and monitoring requirements specified in this section. The T.E. Maxson STP has a design capacity of 90 MGD.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
BOD_5	42	31,525	85	63	47,288	84		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	48	36,029	85	72	54,043	96		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Organic-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a)	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits within 36 months from the permit's effective date.
(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
Organic Pesticide Chemicals (b)	Report					Report			Annually	grab	effluent
Total Dioxin	0.000000001					0.000000001			Annually	composite	effluent
Heptachlor Epoxide	0.00019					0.00019			Annually	composite	effluent
Total Polychlorinated Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	composite	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Methyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexachlorobenzene	Report					Report			Annually	grab	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report (Survival for serial effluent dilutions)								Annually	grab	effluent
Outfall Observation, Visual (e)	Report								Daily	visual	(d)
Flow (MGD)	Report			Report		Report			Daily	continuous	influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewer Overflows, Total Occurrences (f)	Report								continuous	visual	NA
Sewer Backups in Buildings Total Occurrences	Report								continuous	visual	NA
Dry Weather Overflows, Total Occurrences (f)	Report								continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I; endosulfan II; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; PCBs, total; chlordane; and toxaphene).
(d) Per Section 3.4.
(e) Permittee shall provide in the DMR comments section or as an attachment a listing of its visual observations including distinctly visible matter and/or objectionable instream color.
(f) Permittee shall provide with its DMRs a listing of sewage overflows that flowed into buildings.

Total residual chlorine (TRC) and oxidants (TRO) monitoring shall be applicable when chlorine, bromine, or any other oxidants are added. The acceptable methods for analysis of TRC are any methods specified in Title 40 CFR, Part 136, as amended.

The permittee may collect more Outfall 001 discharge samples than specified as the monitoring frequency. *E. coli* samples may not be collected at intervals of less than 12 hours. For the purpose of determining the geometric mean, individual samples having an *E. coli* group concentration of less than one (1) cfu per 100 ml shall be considered as having a concentration of one (1) cfu per 100 ml.

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must not cause an objectionable color contrast in the receiving stream.

The wastewater discharge shall not contain pollutants in quantities that will be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner that prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq.

For the purpose of evaluating compliance with the permit limits established herein, where certain limits are below the state of Tennessee published required detection levels (RDLs) for any given effluent characteristics, the results of analyses below the RDL shall be reported as Below Detection Level (BDL), unless in specific cases other detection limits are demonstrated to be the best achievable because of the particular nature of the wastewater being analyzed. The BDL value shall be reported in the DMR "Comments" section.

For BOD_5 and TSS, the treatment facility shall demonstrate a minimum of 85% removal efficiency on a monthly average basis. The minimum removal efficiencies shall be calculated by determining an average of all daily influent concentrations and comparing this to an average of all daily effluent concentrations. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{average of daily effluent concentrations}}{\text{average of daily influent concentrations}} \right] \right] \times 100\% = \%\ \text{removal}$$

The treatment facility will also demonstrate 40% minimum removal of the BOD_5 and TSS based upon each daily composite sample. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{daily effluent concentrations}}{\text{daily influent concentrations}} \right] \right] \times 100\% = \%\ \text{removal}$$

1.2. MONITORING PROCEDURES

1.2.1. Representative Sampling

Appropriate flow measurement devices and/or division-approved methods consistent with accepted scientific practices shall be used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with accepted capability of that type of device. Devices and methods used shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes.

Samples and measurements taken in compliance with the monitoring requirements specified above shall be representative of the volume and nature of the monitored discharge, and shall be taken at the following location(s):

Influent samples must be collected prior to mixing with any other wastewater being returned to the head of the plant, such as return sludge. Those systems with more than one influent line must collect samples from each and proportion the results by the flow from each line. However, as long as the sludge lagoon supernatant is discharged into interceptors ahead of the STP, the influent samples may be collected after the sludge lagoon supernatant return. The permittee must submit an Influent Flow Assessment Report to the division, which relates the quality and quantity of the supernatant stream within sixty (60) days of permit effective date. Otherwise, the influent samples must be collected ahead of the influent's mixing with any other wastestreams being returned to the head of the plant. Additionally, systems with more than one influent line must collect samples from each and proportion the results by the flow from each line.

Effluent samples must be representative of the wastewater being discharged and collected prior to mixing with any other discharge or the receiving stream. This can be a different point for different parameters, but must be after all treatment for that parameter or all expected change:

a. If chlorination is used for disinfection, final effluent BOD_5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD_5 testing procedures approved by the division for its treated effluent analyses.

b. The chlorine residual must be measured after the chlorine contact chamber and any dechlorination. It may be to the advantage of the permittee to measure at the end of any long outfall lines.

c. Samples for *E. coli* can be collected at any point between disinfection and the actual discharge.

d. The dissolved oxygen can drop in the outfall line; therefore, D.O. measurements are required at the discharge end of outfall lines greater than one mile long. Systems with outfall lines less than one mile may measure dissolved oxygen as the wastewater leaves the treatment facility. For systems with dechlorination, dissolved oxygen must be measured after this step and as close to the end of the outfall line as possible.

e. Total suspended solids and settleable solids can be collected at any point after the final clarifier.

f. Biomonitoring tests shall be conducted on final effluent.

1.2.2. Sampling Frequency

Where the permit requires sampling and monitoring of a particular effluent characteristic(s) at a frequency of less than once per day or daily, the permittee is precluded from marking the "No Discharge" block on the Discharge Monitoring Report if there has been any discharge from that particular outfall during the period which coincides with the required monitoring frequency; i.e. if the required monitoring frequency is once per month or 1/month, the monitoring period is one month, and if the discharge occurs during only one day in that period then the permittee must sample on that day and report the results of analyses accordingly.

1.2.3. Test Procedures

a. Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304 (h) of the Clean Water Act (the "Act"), as amended, under which such procedures may be required. The treated effluent total mercury shall be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630. For monitoring PCBs the permittee shall use EPA Method 1668B.

b. Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40 CFR Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act, using sufficiently sensitive testing to demonstrate permit compliance, and/or best achievable methods for permit reporting requirements. The permittee shall obtain written division approval for using analytical procedures not provided in Title 40 CFR Part 136 for permit compliance.

c. Composite samples must be proportioned by flow at time of sampling. Aliquots may be collected manually or automatically. The sample aliquots must be maintained at less than or equal to 6 degrees Celsius during the compositing period.

1.2.4. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date and time of sampling;

b. The exact person(s) collecting samples;

c. The dates and times the analyses were performed;

d. The person(s) or laboratory who performed the analyses;

e. The analytical techniques or methods used, and;

f. The results of all required analyses.

1.2.5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation shall be retained for a minimum of three (3) years, or longer, if requested by the Division of Water Pollution Control.

1.3. REPORTING

1.3.1. Monitoring Results

Monitoring results shall be recorded monthly and submitted monthly using Discharge Monitoring Report (DMR) forms or an electronic program supplied by the Division of Water Pollution Control. Submittals shall be postmarked or sent electronically no later than 15 days after the completion of the reporting period. The top two copies of each report are to be submitted. A copy should be retained for the permittee's files. DMRs and any communication regarding compliance with the conditions of this permit must be sent to:

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
COMPLIANCE REVIEW SECTION
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243-1534

The first DMR is due on the 15th of the month following permit effectiveness.

DMRs and any other report or information submitted to the division must be signed and certified by a responsible corporate officer as defined in 40 CFR 122.22, a general partner or proprietor, or a principal municipal executive officer or ranking

elected official, or his duly authorized representative. Such authorization must be submitted in writing and must explain the duties and responsibilities of the authorized representative.

The electronic submission of DMRs will be accepted only if approved in writing by the division. For purposes of determining compliance with this permit, data submitted in electronic format is legally equivalent to data submitted on signed and certified DMR forms.

1.3.2. Additional Monitoring by Permittee

If the permittee monitors any pollutant specifically limited by this permit more frequently than required at the location(s) designated, using approved analytical methods as specified herein, the results of such monitoring shall be included in the calculation and reporting of the values required in the DMR form. Such increased frequency shall also be indicated on the form.

1.3.3. Falsifying Results and/or Reports

Knowingly making any false statement on any report required by this permit or falsifying any result may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Water Pollution Control Act, as amended, and in Section 69-3-115 of the Tennessee Water Quality Control Act.

1.3.4. Monthly Report of Operation

Monthly operational reports (MORs) shall be submitted on standard forms to the appropriate Division of Water Pollution Control Environmental Field Office in Jackson, Nashville, Chattanooga, Columbia, Cookeville, Memphis, Johnson City, or Knoxville. Reports shall be submitted by the 15th day of the month following data collection.

1.3.5. Bypass and Overflow Reporting

1.3.5.1. Report Requirements

A summary report of known or suspected instances of overflows in the collection system or bypass of wastewater treatment facilities shall accompany the Discharge Monitoring Report. The report must contain the date and duration of the instances of overflow and/or bypassing and the estimated quantity of wastewater released and/or bypassed. The report must separately list which overflows flowed into buildings.

The report must also detail activities undertaken during the reporting period to (1) determine if overflow is occurring in the collection system, (2) correct those known or suspected overflow points and (3) prevent future or possible overflows and any resulting bypassing at the treatment facility.

On the DMR, the permittee must report the number of sanitary sewer overflows, dry-weather overflows and in-plant bypasses separately. Three lines must be used on the DMR form, one for sanitary sewer overflows, one for dry-weather overflows and one for in-plant bypasses.

1.3.5.2. Anticipated Bypass Notification

If, because of unavoidable maintenance or construction activities, the permittee has a need to create an in-plant bypass which would cause an effluent violation, the permittee must notify the division as soon as possible (the division requires 10 days prior to bypass notification, unless it is not possible e.g., pipe break, in which case, as soon as possible notification is warranted).

1.3.6. Reporting Less Than Detection

A permit limit may be less than the accepted detection level. If the samples are below the detection level, then report "BDL" or "NODI =B" on the DMRs. The permittee must use the correct detection levels in all analytical testing required in the permit. The required detection levels are listed in the Rules of the Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3-.05(8).

For example, if the limit is 0.02 mg/l with a detection level of 0.05 mg/l and detection is shown; 0.05 mg/l must be reported. In contrast, if nothing is detected reporting "BDL" or "NODI =B" is acceptable.

1.4. COMPLIANCE WITH SECTION 208

The limits and conditions in this permit shall require compliance with an area-wide waste treatment plan (208 Water Quality Management Plan) where such approved plan is applicable.

1.5. REOPENER CLAUSE

This permit shall be modified, or alternatively revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b)(2)(C) and (D), 307(a)(2) and 405(d)(2)(D) of the Clean Water Act, as amended, if the effluent standard, limitation or sludge disposal requirement so issued or approved:

a. Contains different conditions or is otherwise more stringent than any condition in the permit; or

b. Controls any pollutant or disposal method not addressed in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

The division shall be able to modify this permit to incorporate appropriate changes based on Outfall 001 treated effluent ammonia-nitrogen, chlorinated byproducts, total residual chlorine/oxidants and acute biomonitoring results. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. Pursuant to the permittee's request/justification the division may modify the permit if appropriate to limit the TRO to halogenated oxidants only.

All permit modifications shall be subject to applicable public participation requirements.

2.0 GENERAL PERMIT REQUIREMENTS

2.1. GENERAL PROVISIONS

2.1.1. Duty to Reapply

Permittee is not authorized to discharge after the expiration date of this permit. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information and forms as are required to the Director of Water Pollution Control (the "director") no later than 180 days prior to the expiration date. Such forms shall be properly signed and certified.

2.1.2. Right of Entry

The permittee shall allow the director, the Regional Administrator of the U.S. Environmental Protection Agency, or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or where records are required to be kept under the terms and conditions of this permit, and at reasonable times to copy these records;

b. To inspect at reasonable times any monitoring equipment or method or any collection, treatment, pollution management, or discharge facilities required under this permit; and

c. To sample at reasonable times any discharge of pollutants.

2.1.3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, as amended, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division of Water Pollution Control. As required by the Federal Act, effluent data shall not be considered confidential.

2.1.4. Proper Operation and Maintenance

a. The permittee shall at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory and process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems, which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. Backup continuous pH and flow monitoring equipment are not required.

b. Dilution water shall not be added to comply with effluent requirements to achieve BCT, BPT, BAT and or other technology based effluent limitations such as those in State of Tennessee Rule 1200-4-5-.09.

2.1.5. Treatment Facility Failure (Industrial Sources)

The permittee, in order to maintain compliance with this permit, shall control production, all discharges, or both, upon reduction, loss, or failure of the treatment facility, until the facility is restored or an alternative method of treatment is provided. This requirement applies in such situations as the reduction, loss, or failure of the primary source of power.

2.1.6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations.

2.1.7. Severability

The provisions of this permit are severable. If any provision of this permit due to any circumstance, is held invalid, then the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

2.1.8. Other Information

If the permittee becomes aware of failure to submit any relevant facts in a permit application, or of submission of incorrect information in a permit application or in any

report to the director, then the permittee shall promptly submit such facts or information.

2.2. CHANGES AFFECTING THE PERMIT

2.2.1. Planned Changes

The permittee shall give notice to the director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants, which are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1).

2.2.2. Permit Modification, Revocation, or Termination

a. This permit may be modified, revoked and reissued, or terminated for cause as described in 40 CFR 122.62 and 122.64, Federal Register, Volume 49, No. 188 (Wednesday, September 26, 1984), as amended.

b. The permittee shall furnish to the director, within a reasonable time, any information which the director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the director, upon request, copies of records required to be kept by this permit.

c. If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established for any toxic pollutant under Section 307(a) of the Federal Water Pollution Control Act, as amended, the director shall modify or revoke and reissue the permit to conform to the prohibition or to the effluent standard, providing that the effluent standard is more stringent than the limitation in the permit on the toxic pollutant. The permittee shall comply with these effluent standards or prohibitions within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified or revoked and reissued to incorporate the requirement.

d. The filing of a request by the permittee for a modification, revocation, reissuance, termination, or notification of planned changes or anticipated noncompliance does not halt any permit condition.

2.2.3. Change of Ownership

This permit may be transferred to another party (provided there are neither modifications to the facility or its operations, nor any other changes which might affect the permit limits and conditions contained in the permit) by the permittee if:

a. The permittee notifies the director of the proposed transfer at least 30 days in advance of the proposed transfer date;

b. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and liability between them; and

c. The director, within 30 days, does not notify the current permittee and the new permittee of his intent to modify, revoke or reissue, or terminate the permit and to require that a new application be filed rather than agreeing to the transfer of the permit.

Pursuant to the requirements of 40 CFR 122.61, concerning transfer of ownership, the permittee must provide the following information to the division in their formal notice of intent to transfer ownership: 1) the NPDES permit number of the subject permit; 2) the effective date of the proposed transfer; 3) the name and address of the transferor; 4) the name and address of the transferee; 5) the names of the responsible parties for both the transferor and transferee; 6) a statement that the transferee assumes responsibility for the subject NPDES permit; 7) a statement that the transferor relinquishes responsibility for the subject NPDES permit; 8) the signatures of the responsible parties for both the transferor and transferee pursuant to the requirements of 40 CFR 122.22(a), "Signatories to permit applications"; and, 9) a statement regarding any proposed modifications to the facility, its operations, or any other changes which might affect the permit limits and conditions contained in the permit.

2.2.4. Change of Mailing Address

The permittee shall promptly provide to the director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

2.3. NONCOMPLIANCE

2.3.1. Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable state and federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

2.3.2. Reporting of Noncompliance

a. 24-Hour Reporting

In the case of any noncompliance which could cause a threat to public drinking water supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24-hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response team).

A written submission must be provided within five days of the time the permittee becomes aware of the circumstances unless the director on a case-by-case basis waives this requirement. The permittee shall provide the director with the following information:

i. A description of the discharge and cause of noncompliance;

ii. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and

iii. The steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph 2.3.2.a above, the permittee shall report the noncompliance on the Discharge Monitoring Report. The report shall contain all information concerning the steps taken, or planned, to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

2.3.3. Overflow

a. "**Overflow**" means any discharge of sewage from any portion of the collection, transmission, or treatment system other than through permitted outfalls.

b. Overflows are prohibited.

c. The permittee shall operate the collection system so as to avoid overflows. No new or additional flows shall be added upstream of any point in the collection system, which experiences chronic overflows (greater than 5 events per year) or would otherwise overload any portion of the system.

d. Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after: 1) an authorized representative of the Commissioner of the Department of Environment and Conservation has approved an engineering report and construction plans and

specifications prepared in accordance with accepted engineering practices for correction of the problem; 2) the correction work is underway; and 3) the cumulative, peak-design, flows potentially added from new connections and line extensions upstream of any chronic overflow point are less than or proportional to the amount of inflow and infiltration removal documented upstream of that point. The inflow and infiltration reduction must be measured by the permittee using practices that are customary in the environmental engineering field and reported in an attachment to a Monthly Operating Report submitted to the local TDEC Environmental Field Office. The data measurement period shall be sufficient to account for seasonal rainfall patterns and seasonal groundwater table elevations.

e. In the event that more than 5 overflows have occurred from a single point in the collection system for reasons that may not warrant the self-imposed moratorium or completion of the actions identified in this paragraph, the permittee may request a meeting with the Division of Water Pollution Control EFO staff to petition for a waiver based on mitigating evidence.

2.3.4. Upset

a. "***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. An upset shall constitute an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the permittee demonstrates, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   i. An upset occurred and that the permittee can identify the cause(s) of the upset;

   ii. The permitted facility was at the time being operated in a prudent and workman-like manner and in compliance with proper operation and maintenance procedures;

   iii. The permittee submitted information required under "Reporting of Noncompliance" within 24-hours of becoming aware of the upset (if this information is provided orally, a written submission must be provided within five days); and

   iv. The permittee complied with any remedial measures required under "Adverse Impact."

2.3.5. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2.3.6. Bypass

a. "***Bypass***" is the intentional diversion of wastewater away from any portion of a treatment facility. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypasses are prohibited and the division may take enforcement action, unless all of the following 3 conditions are met:

   i. The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

   ii. There are no feasible alternatives to bypass, such as the construction and use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass, which occurred during normal periods of equipment downtime or preventative maintenance;

   iii. The permittee submits notice of an unanticipated bypass to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours of becoming aware of the bypass (if this information is provided orally, a written submission must be provided within five days). When the need for the bypass is foreseeable, prior notification shall be submitted to the director, if possible, at least 10 days before the date of the bypass.

c. Bypasses not exceeding permit limitations are allowed **only** if the bypass is necessary for essential maintenance to assure efficient operation. All other bypasses are subject to the prohibition in subsection (b) above. Allowable bypasses not exceeding limitations are not subject to the reporting requirements of 2.3.6.b.iii, above.

2.3.7. Washout

a. For domestic wastewater plants only, a "washout" shall be defined as loss of Mixed Liquor Suspended Solids (MLSS) of 30.00% or more. This refers to the MLSS in the aeration basin(s) only. This does not include MLSS decrease due to

solids wasting to the sludge disposal system. A washout can be caused by improper operation or from peak flows due to infiltration and inflow.

b. A washout is prohibited. If a washout occurs the permittee must report the incident to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours by telephone. A written submission must be provided within five days. The washout must be noted on the discharge monitoring report. Each day of a washout is a separate violation.

2.4. LIABILITIES

2.4.1. Civil and Criminal Liability

Except as provided in permit conditions for "***Bypassing***," "***Overflow,***" and "***Upset***," nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

2.4.2. Liability Under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or the Federal Water Pollution Control Act, as amended.

3.0. PERMIT SPECIFIC REQUIREMENTS

3.1. CERTIFIED OPERATOR

The waste treatment facilities shall be operated under the supervision of a certified wastewater treatment operator and the collection system shall be operated under the supervision of a certified collection system operator in accordance with the Water Environmental Health Act of 1984.

3.2. POTW PRETREATMENT PROGRAM

As an update of information previously submitted to the division, the permittee will undertake the following activity.

a. The permittee has been delegated the primary responsibility and therefore becomes the "control authority" for enforcing the 40 CFR 403 General Pretreatment Regulations. Where multiple plants are concerned the permittee is

responsible for the Pretreatment Program for all plants within its jurisdiction. The permittee shall implement and enforce the Industrial Pretreatment Program in accordance with Section 403(b)(8) of the Clean Water Act, the Federal Pretreatment Regulations 40 CFR 403, Tennessee Water Quality Control Act Part 63-3-123 through 63-3-128, and the legal authorities, policies, procedures, and financial provisions contained in its approved Pretreatment Program, except to the extent this permit imposed stricter requirements. Such implementation shall require but not limit the permittee to do the following:

i. Carry out inspection, surveillance, and monitoring procedures, which will determine, independent of information supplied by the industrial user (IU), whether the IU is in compliance with the pretreatment standards;

ii. Require development, as necessary, of compliance schedules for each IU for the installation of control technologies to meet applicable pretreatment standards;

iii. Require all industrial users to comply with all applicable monitoring and reporting requirements outlined in the approved pretreatment program and IU permit;

iv. Maintain and update, as necessary, records identifying the nature and character of industrial user discharges, and retain such records for a minimum of three (3) years;

v. Obtain appropriate remedies for noncompliance by an IU with any pretreatment standard and/or requirement;

vi. Publish annually, pursuant to 40 CFR 403.8 (f)(2)(viii), a list of industrial users that have significantly violated pretreatment requirements and standards during the previous twelve-month period.

vii. Maintain an adequate revenue structure for continued operation of the pretreatment program.

viii. Update its Industrial Waste Survey at least once every five years. Results of this update shall be submitted to the Division of Water Pollution Control, Pretreatment Section within 120 days of the effective date of this permit.

ix. Submit a written technical evaluation of the need to revise local limits within 120 days of the effective date of this permit to the state pretreatment program coordinator. The evaluation should consider the most recent pass-through limits proposed by the division. The technical evaluation shall be based on practical and specialized knowledge of the local program and not be limited by a specified written format.

b. The permittee shall enforce 40 CFR 403.5, "prohibited discharges". Pollutants introduced into the POTW by a non-domestic source shall not cause pass through or interference as defined in 40 CFR Part 403.3. These general

prohibitions and the specific prohibitions in this section apply to all non-domestic sources introducing pollutants into the POTW whether the source is subject to other National Pretreatment Standards or any state or local pretreatment requirements.

Specific Prohibitions. Under no circumstances shall the permittee allow introduction of the following wastes in the waste treatment system:

i. Pollutants which create a fire or explosion hazard in the POTW;

ii. Pollutants which will cause corrosive structural damage to the treatment works, but in no case discharges with pH less than 5.0 unless the system is specifically designed to accept such discharges.

iii. Solid or viscous pollutants in amounts which will cause obstruction to the flow in the treatment system resulting in interference.

iv. Any pollutant, including oxygen-demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the treatment works.

v. Heat in amounts which will inhibit biological activity in the treatment works resulting in interference, but in no case heat in such quantities that the temperature at the treatment works exceeds 40°C (104°F) unless the works are designed to accommodate such heat.

vi. Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal.

vii. Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through;

viii. Pollutants which result in the presence of toxic gases, vapors or fumes within the POTW in a quantity that may cause worker health and safety problems;

ix. Any trucked or hauled pollutants except at discharge points designated by the POTW.

c. The permittee shall notify the Tennessee Division of Water Pollution Control of any of the following changes in user discharge to the system no later than 30 days prior to change of discharge:

i. New introductions into such works of pollutants from any source which would be a new source as defined in Section 306 of the Act if such source were discharging pollutants.

ii. New introductions of pollutants into such works from a source which would be subject to Section 301 of the "Federal Water Pollution Control Act" if it were discharging such pollutants.

iii. A substantial change in volume or character of pollutants being introduced into such works by a source already discharging pollutants into such works at the time the permit is issued.

This notice will include information on the quantity and quality of the wastewater introduced by the new source into the publicly owned treatment works, and on any anticipated impact on the effluent discharged from such works. If this discharge necessitates a revision of the current NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization.

d. Reporting Requirements

The permittee shall provide an annual report briefly describing the permittee's pretreatment program activities over the previous calendar year. The report shall be submitted to the Division of Water Pollution Control, Central Office and a copy to the appropriate Environmental Field Office no later than the 50 days after the end of the reporting period. For control authorities with multiple STPs, one report should be submitted with a separate Form 1 for each STP. Each report shall conform to the format set forth in the state's POTW Pretreatment Semiannual Report Package which contains information regarding (note that the permittee is required to complete and submit an "Annual" rather than a "Semiannual" report):

i. An updated listing of the permittee's industrial users (including information required pursuant to 403.12(i)(1) (e.g., deletions and additions, categorical standards applied, local standards more stringent than categorical standards, and standards applied to each industrial user).

ii. Results of sampling of the influent and effluent of the wastewater treatment plant. At least semiannually during each calendar year, the permittee shall analyze the wastewater treatment plant influent and effluent for the following pollutants, using the prescribed sampling procedures:

Pollutant	**Sample Type**
chromium, trivalent	24-hour composite
chromium, hexavalent	24-hour composite
copper	24-hour composite
lead	24-hour composite
nickel	24-hour composite
zinc	24-hour composite
cadmium	24-hour composite
mercury	24-hour composite
silver	24-hour composite
total phenols	grab
cyanide	grab

If any particular pollutant is analyzed more frequently than is required, the permittee shall report the maximum and average values in its annual report. All upsets, interferences, and pass-through violations must also be reported in the annual report, the actions that were taken to determine the causes of the incidents, and the steps taken to prevent the incidents from recurring.

At least once during the term of the permit, the permittee shall analyze the effluent from the STP (and report the results in the corresponding annual report) for the following pollutants:

chromium, total	silver	phthalates, sum of the following:
copper	benzene	bis (2-ethylhexyl) phthalate
lead	carbon tetrachloride	butyl benzylphthalate
nickel	chloroform	di-n-butylphthalate
zinc	ethylbenzene	diethyl phthalate
cadmium	methylene chloride	tetrachloroethylene
mercury	naphthalene	toluene
phenols, total	1,1,1 trichloroethane	trichloroethylene
cyanide	1,2 trans-dichloroethylene	chromium, hexavalent
		chromium, trivalent

iii. Compliance with categorical and local standards, and review of industrial compliance, which includes a summary of the compliance status for all permitted industries. Also included is information on the number and type of major violations of pretreatment regulations, and the actions taken by the POTW to obtain compliance. The effluent from all significant industrial users must be analyzed for the appropriate pollutants at least once per reporting period.

iv. A list of industries in significant non-compliance as published in local newspapers in accordance with the requirements set forth in 40 CFR 403.8(f)(2)(viii).

v. A description of all substantive changes made to the permittee's pretreatment program. Any such changes shall receive prior approval. Substantive changes include, but are not limited to, any change in any ordinance, major modification in the program's administrative structure, local limits, or a change in the method of funding the program.

vi. Summary of permittee's industrial user inspections, which includes information on the number and type of industry inspected. All significant industrial users must be inspected at least once per year.

3.3. SLUDGE MANAGEMENT PRACTICES

a. The permittee must comply with 40 CFR 503 et seq. Sludge shall be sampled and analyzed at a frequency dependant both on the amount of sludge generated annually and on the disposal practice utilized. Whenever sampling and analysis

are required by 40 CFR 503, the permittee shall report to the division the quantitative data for the following parameters:

1)	Arsenic	7)	Nickel
2)	Cadmium	8)	Selenium
3)	Copper	9)	Zinc
4)	Lead	10)	Nitrite plus Nitrate, NO_2, + NO_3 as N
5)	Mercury	11)	Total Kjeldahl Nitrogen, as N
6)	Molybdenum	12)	Ammonia, NH_3, as N

This sludge analysis must be submitted by February 19th of each calendar year. This information shall be submitted to the Division of Water Pollution Control, Central Office, 401 Church Street, 6th Floor Annex, Nashville TN 37243-1534, Attention: Sludge Coordinator, Municipal Facilities Section.

b. Land application of sludge shall halt immediately if any of the following concentrations are exceeded:

POLLUTANT	CONCENTRATION (mg/kg[1])
Arsenic	75
Cadmium	85
Zinc	7500
Copper	4300
Lead	840

POLLUTANT	CONCENTRATION (mg/kg[1])
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100

1) Concentration on a Dry Weight Basis

Monthly average pollutant concentrations shall not exceed Table 3 of 40 CFR §503.13. If they are exceeded cumulative pollutant loading rates are to be calculated and recorded and shall not exceed Table 2 of 40 CFR §503.13 for the life of the land application site.

c. If land application is the final disposition of the wasted sludge, the permittee shall provide pathogen reduction, sludge stabilization and comply with land and crop usage controls as listed in 40 CFR Part 503, as authorized by the Clean Water Act. Records must be maintained by the permittee that indicate compliance or non-compliance with this rule. If the permittee is required to report to EPA, copies of all reports should be sent to the division, at the address listed in paragraph 1 of this section.

d. Before land applying municipal sludge the permittee must obtain approvals for each site(s) in writing from the division using the latest revision of Guidelines for Land Application or Surface Disposal of Biosolids, unless the sludge being land applied meets the pollutant concentrations of 40 CFR 503.13(b)(3), the Class A pathogen requirements in 40 CFR 503.32(a), and one of the vector attraction reduction requirements in 40 CFR 503.33 (b)(1) through (b)(8).

e. Reopener: If an applicable "acceptable management practice" or numerical limitation for pollutants in sewage sludge promulgated under Section 405(d)(2) of the Clean Water Act, as amended by the Water Quality Act of 1987, is more stringent than the sludge pollutant limit or acceptable management practice in this permit, or controls a pollutant not limited in this permit, this permit shall be promptly modified or revoked and reissued to conform to the requirements promulgated under Section 405(d)(2). The permittee shall comply with the limitations by no later than the compliance deadline specified in the applicable regulations as required by Section 405(d)(2) of the Clean Water Act.

f. Notice of change in sludge disposal practice: The permittee shall give prior notice to the director of any change planned in the permittee's sludge disposal practice. If land application activities are suspended permanently and sludge disposal moves to a municipal solid waste landfill, the permittee shall contact the local Division of Solid Waste Management office address for other permitting and approvals (see table below):

Division of Solid Waste Management			
Office	**Location**	**Zip Code**	**Phone No.**
Chattanooga	540 McCallie Avenue, Suite 550	37402-2013	(423) 634-5745
Jackson	1625 Hollywood Drive	38305	(731) 512-1300
Cookeville	1221 South Willow Avenue	38506	(931) 432-4015
Columbia	1421 Hampshire Pike	38401	(931) 380-3371
Johnson City	2305 Silverdale Road	37601	(423) 854-5400
Knoxville	2700 Middlebrook Pike, Suite 220	37921	(865) 594-6035
Memphis	8383 Wolf Lake Dr., Bartlett	38133	(901) 371-3000
Nashville	711 R.S. Gass Boulevard	37243-1550	(615) 687-7000

3.4. BIOMONITORING REQUIREMENTS

Pursuant to the Outfall 001 treated effluent monitoring presented in this permit, Section 1.1, the permittee shall complete 48-hour LC_{50} (acute toxicity testing annually) per to the requirements shown below within 120 days from the permit's effective date. Additionally, the permittee shall provide the division its permit renewal application at least four IC_{25} (chronic toxicity biomonitoring) scans using the dilution presented in this section. (Based on the permittee's written request and with prior division written approval, Mississippi River dilution water may be used for the acute and chronic whole effluent toxicity testing.)

3.4.1. 48-Hour LC_{50} Acute Biomonitoring Requirements

The permittee shall conduct a 48-hour static acute toxicity test on two test species on samples of final effluent from Outfall 001 within 120 days from the permit's effective date. The test species to be used are Water Fleas (*Ceriodaphnia dubia*) and Fathead Minnows (*Pimephales promelas*). The measured endpoint for toxicity will be the concentration causing 50% lethality (LC_{50}) of the test organisms. The LC_{50} shall be determined based on a 50% lethality as compared to the controls, and as derived from linear interpolation.

Tests shall be conducted and results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for 48-Hour LC50 Acute Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	**50**	**25**	**12.5**	**6.25**	**0**

The dilution/control water used will be hard water as described in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition). An acute standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests shall be conducted using four separate grab samples of final effluent, to be used in four separate tests, and shall be collected at evenly spaced (6-hour) intervals over a 24-hour period. The minimum 48-hr LC_{50} value (maximum acute toxicity) for the four separate tests shall be reported (for each species).

The test control (i.e., dilution water only) results will be considered a failure and its results invalid, if more than 10% of the test organisms die in 48 hours, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition), if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated within 2 weeks. Any test initiated, but terminated before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee must start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices and determination of effluent lethality values will be made in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analysis shall be compiled in a report. The report shall be written in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Two copies of biomonitoring reports (including follow-up reports) shall be submitted to the division. One copy of the report shall be submitted along with the discharge monitoring report (DMR). The second copy shall be submitted to the local Division of Water Pollution Control office address (see table below):

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
MEMPHIS ENVIRONMENTAL FIELD OFFICE
8383 WOLF LAKE DRIVE
BARTLETT TN 38133

3.4.2. Chronic Biomonitoring Requirements (For Permit Renewal Application)

For its permit renewal application, the permittee shall conduct four separate IC_{25} tests. Each test must be based on the 3-Brood Water Fleas (*Ceriodaphnia dubia)* survival and reproduction test) and the 7-Day Fathead Minnows *(Pimephales promelas)* larval survival and growth test using Outfall 001 final effluent samples.

The measured endpoint for toxicity will be the inhibition concentration causing 25% reduction in survival, reproduction and growth (IC_{25}) of the test organisms. The IC_{25} shall be determined based on a 25% reduction as compared to the controls, and as derived from linear interpolation. The average reproduction and growth responses will be determined based on the number of *Ceriodaphnia dubia* or *Pimephales promelas* larvae used to initiate the test.

Test shall be conducted and its results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for Chronic Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	**50**	**25**	**12.5**	**6.25**	**0**

The dilution/control water used will be hard water as described in Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition). A chronic standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests will be conducted using a minimum of three 24-hour flow-proportionate composite samples of final effluent collected on days 1, 3 and 5. If, in any control more than 20% of the test organisms die in 7 days, the test (control and effluent) is considered a test control failure and invalid, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Short-

Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition), or if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated. Any test initiated but terminated before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee shall start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented in the corresponding table above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices, determinations of effluent survival/reproduction and survival/growth values, and report formats will be made in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analyses shall be compiled in a report. The report will be written in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Three copies of biomonitoring reports (including follow-up reports) shall be submitted to the division, included with the permittee's permit renewal application

3.5 VISUAL OUTFALL OBSERVATIONS

On a daily basis, when safety considerations reasonably permit a person to stand of top of the outfall structure, an observation shall be made and noted in an operations log, which would be maintained on site. The operations log should allow the operator to check the following boxes:

- Unsafe to make observation (yes/no)

Only if the answer to the above question is no, answer the following:

- Floatables present (yes/no)
- Scum present (yes/no)
- Foam present (yes/no)
- Oily slick present (yes/no)

3.6. OUTFALL 001 TREATED EFFLUENT *E. coli* COMPLIANCE ELEMENTS AND SCHEDULE

The following schedule provides the treated effluent *E.coli* disinfection work tasks, milestones and schedule:

Disinfection Compliance Schedule

Work Task	Milestone (a)	Submittal/ Completion (b)	Task Duration (c) (Months)	Division Review (Months)	Total (c) Per Task (Months)	Total (c) Overall (Months)
1. Develop disinfection investigation work plan						
	Disinfection Work Plan	No. 1	2	0.5	2.5	2.5
2. Conduct disinfection investigation (non-chlorination based)						
	Disinfection Report (if chlorination not selected)	No. 2A (d)	6	0.5	6.5	9
3. Conduct chlorination disinfection investigation						
	Chlorination Disinfection Report	No. 2B (d)	6	0.5	6.5	15.5
4. Develop Disinfection Report						
	Disinfection Report (if chlorination selected)	No. 2C (d)	3	0.5	3.5	19
5. Design Disinfection System						
	Disinfection System Plans and Specs	No. 3	12	0.5	12.5	31.5
6. Develop Bid Documents/Bid						
	Bidding	No. 4	4	0.5	4.5	36
7. Disinfection System Facilities Construction						
	Construction	No. 6	18	0.5	18.5	54.5
8. Disinfection System Startup/Achieve Permit Limits						
	Functional Disinfection System	No. 7	3	0.5	3.5	58
	Total		**54**	**4**	**58**	

(a) The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved.

(b) The permittee shall provide the division with a written progress status report every 6 months pursuant this disinfection compliance schedule starting with the permit's effective date.

(c) Duration assuming sequential work task processing based on permit's effective date.

(d) As appropriate the Nos. 2A, 2B and 2C submittals must address results from the dechlorination investigations, antidegradation evaluations, and determinations as required pursuant to Section 3.6.1.

As shown in the above schedule, the permittee shall provide the division with a disinfection report that includes antidegradation documentation, including alternatives analyses, for any newly-formed Outfall 001 contaminants expected to be present above a *de minimis* amount.

3.6.1. Additional Permittee Submittals (If Chlorination Disinfection System Selected)

Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly-generated byproducts are related to TRC according to the compliance schedule provided in the table above (section 3.6).

3.7. PLACEMENT OF SIGNS

Within sixty (60) days of the effective date of this permit, the permittee shall place and maintain signs at the Outfall 001 treated effluent discharge point to the Cooling Water Channel, confluence with the Mississippi River, and any bypass/overflow point in the collection system. For the purposes of this requirement, any bypass/overflow point that has discharged five (5) or more times in the last year must be so posted. The sign(s) should be clearly visible to the public from the bank and the receiving stream. The minimum sign size should be two feet by two feet (2' x 2') with one-inch (1") letters. The sign should be made of durable material and have a white background with black letters.

The signs are to provide notice to the public as to the nature of the discharge and, in the case of the permitted outfalls, that the discharge is regulated by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

NPDES Permitted CSO or Unpermitted Bypass/Overflow Point:

UNTREATED SANITARY SEWER OVERFLOW WASTEWATER DISCHARGE POINT
Memphis - T.E. Maxson STP
(901) 576-4300
NPDES Permit NO. TN0020729
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

NPDES Permitted Municipal/Sanitary Outfall 001:

OUTFALL 001 DISCHARGE IS NON-DISINFECTED TREATED INDUSTRIAL/MUNICIPAL WASTEWATER WITH ELEVATED *E. coli*
Memphis-T.E. Maxson STP
(901) 576-4300
NPDES Permit NO. TN0020729
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

No later than sixty (60) days from the permit's effective date, the permittee shall have the above sign(s) on display at locations specified by the division's WPC Memphis Environmental Field Office.

3.8. WASTEWATER TREATMENT FACILITIES INTEGRITY EVALUATION

Within eighteen months from the permit's effective date the permittee shall submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities including any waterborne wastes and sludge storage/disposal units that are constructed of earthen material.

The structural integrity evaluation shall be completed by a professional engineer licensed in the State of Tennessee, an environmental management professional, or other expert who is qualified by education and/or experience to perform and/or oversee such evaluations. The report shall document that the permittee has evaluated the unit's structural integrity and shall include the permittee's planned structural integrity improvements, if warranted. The report shall also address measures implemented and planned by the permittee as appropriate to reduce the chances that said wastewater treatment facilities/units failure would result in an uncontrolled discharge to the receiving stream(s) under normal conditions.

Structural integrity evaluations of earthen basins and/or surface impoundments performed for compliance with other regulatory programs (e.g., Hazardous Waste Management under 1200-1-11, Solid Waste Management under 1200-1-7, or the Safe Dams Act) satisfy the provisions of this permit requirement.

3.9. ANTIDEGRADATION

Tennessee's Antidegradation Statement per Rule 1200-4-3-.06 provides for protecting existing receiving stream uses. The rule states that:

> "Where the quality of Tennessee waters is better than the level necessary to support propagation of fish, shellfish, and wildlife, and recreation in or on the water, that quality will be maintained and protected unless the state finds that, after intergovernmental coordination and public participation, that lowering water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

Evaluation of compliance with this rule shall be made on an individual parameter (pollutant) basis considering such factors as:

- The discharge quantity and/or pollutant loading represents a new condition, an expanded condition, or an existing condition;
- The receiving stream has unavailable conditions (is at or exceeds water quality criteria), available conditions (quality is better than the water quality criteria) or is defined as an Exceptional Tennessee Water or Outstanding Natural Resource Water;
- The discharge impact on the assimilative capacity of the receiving stream is considered *de minimis* or not *de minimis*.

The Mississippi River is considered an Exceptional Tennessee Water due to the presence of the federal endangered Pallid Sturgeon and the state threatened Blue Sucker. The T.E. Maxson STP is an existing discharger and this permit renewal includes no new or expanded flow quantity or pollutant loadings. Therefore, the discharge allowed by this permit is determined not to cause degradation and is not subject to alternatives analysis or socio-economic consideration required under the antidegradation rule. No future increase in design flow or pollutant loading will be allowed without compliance with the above analysis requirements and a determination that such increase is consistent with the above antidegradation rule. However, if the new end-of-pipe disinfection system will result in newly-formed Outfall 001 discharge contaminants above a *de minimis* amount (e.g., chlorinated byproducts if chlorination disinfection system used) the permittee must provide the division with appropriate antidegradation information.

4.0. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

4.1. DEFINITIONS

A "***bypass***" is defined as the intentional diversion of waste streams from any portion of a treatment facility.

A "***calendar day***" is defined as the 24-hour period from midnight to midnight or any other 24-hour period that reasonably approximates the midnight to midnight time period.

A "***composite sample***" is a combination of not less than 4 influent or effluent portions, of at least 100 ml, collected over a 24-hour period. Under certain circumstances a lesser time period may be allowed, but in no case, less than 8 hours.

The "***daily maximum concentration***" is a limitation on the average concentration in units of mass per volume (e.g. milligrams per liter), of the discharge during any calendar day. When a proportional-to-flow composite sampling device is used, the daily concentration is the concentration of that 24-hour composite; when other sampling means are used, the daily concentration is the arithmetic mean of the concentrations of equal volume samples collected during any calendar day or sampling period.

"***Degradation***" means the alteration of the properties of waters by the addition of pollutants or removal of habitat. Alterations not resulting in the condition of pollution that are of a temporary nature or those alterations having de minimis impact (not measurable or less than 5 percent loss of assimilative capacity) will not be considered degradation. Degradation will not be considered de minimis if a substantial loss (more than 50 percent) of assimilative capacity has already occurred.

"***Discharge***" or "discharge of a pollutant" refers to the addition of pollutants to waters from a source.

A "***dry weather overflow***" is a type of sanitary sewer overflow and is defined as one day or any portion of a day in which unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall occurs and is not directly related to a rainfall event. Discharges from more than one point within a 24-hour period shall be counted as separate overflows.

An "***ecoregion***" is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

The "***geometric mean***" of any set of values is the nth root of the product of the individual values where "n" is equal to the number of individual values. The

geometric mean is equivalent to the antilog of the arithmetic mean of the logarithms of the individual values. For the purposes of calculating the geometric mean, values of zero (0) shall be considered to be one (1).

A "***grab sample***" is a single influent or effluent sample collected at a particular time.

The "***instantaneous maximum concentration***" is a limitation on the concentration, in milligrams per liter, of any pollutant contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***instantaneous minimum concentration***" is the minimum allowable concentration, in milligrams per liter, of a pollutant parameter contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***monthly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

The "***monthly average concentration***", other than for *E. coli* bacteria, is the arithmetic mean of all the composite or grab samples collected in a one-calendar month period.

A "***one week period***" (or "***calendar-week***") is defined as the period from Sunday through Saturday. For reporting purposes, a calendar week that contains a change of month shall be considered part of the latter month.

"***Pollutant***" means sewage, industrial wastes, or other wastes.

A "***quarter***" is defined as any one of the following three-month periods: January 1 through March 31, April 1 through June 30, July 1 through September 30, and/or October 1 through December 31.

A "***rainfall event***" is defined as any occurrence of rain, preceded by 10 hours without precipitation that results in an accumulation of 0.01 inches or more. Instances of rainfall occurring within 10 hours of each other will be considered a single rainfall event.

A "***rationale***" (or "fact sheet") is a document that is prepared when drafting a NPDES permit or permit action. It provides the technical, regulatory and administrative basis for an agency's permit decision.

A "***reference site***" means least impacted waters within an ecoregion that have been monitored to establish a baseline to which alterations of other waters can be compared.

A "***reference condition***" is a parameter-specific set of data from regional reference sites that establish the statistical range of values for that particular substance at least-impacted streams.

A "***sanitary sewer overflow (SSO)***" is defined as an unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall.

"***Sewage***" means water-carried waste or discharges from human beings or animals, from residences, public or private buildings, or industrial establishments, or boats, together with such other wastes and ground, surface, storm, or other water as may be present.

"***Severe property damage***" when used to consider the allowance of a bypass or SSO means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass or SSO. Severe property damage does not mean economic loss caused by delays in production.

"***Sewerage system***" means the conduits, sewers, and all devices and appurtenances by means of which sewage and other waste is collected, pumped, treated, or disposed.

A "***subecoregion***" is a smaller, more homogenous area that has been delineated within an ecoregion.

"***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

The term, "***washout***" is applicable to activated sludge plants and is defined as loss of mixed liquor suspended solids (MLSS) of 30.00% or more from the aeration basin(s).

"***Waters***" means any and all water, public or private, on or beneath the surface of the ground, which are contained within, flow through, or border upon Tennessee or any portion thereof except those bodies of water confined to and retained within the limits of private property in single ownership which do not combine or effect a junction with natural surface or underground waters.

The "***weekly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar week when the measurements were made.

The "***weekly average concentration***", is the arithmetic mean of all the composite samples collected in a one-week period. The permittee must report the highest weekly average in the one-month period.

4.2. ACRONYMNS AND ABBREVIATIONS

1Q10 – 1-day minimum, 10-year recurrence interval
30Q5 – 30-day minimum, 5-year recurrence interval
7Q10 – 7-day minimum, 10-year recurrence interval
BAT – best available technology economically achievable
BCT – best conventional pollutant control technology
BDL – below detection level
BOD_5 – five day biochemical oxygen demand
BPT – best practicable control technology currently available
$CBOD_5$ – five day carbonaceous biochemical oxygen demand
CEI – compliance evaluation inspection
CFR – code of federal regulations
CFS – cubic feet per second
CFU – colony forming units
CIU – categorical industrial user
CSO – combined sewer overflow
DMR – discharge monitoring report
D.O. – dissolved oxygen
E. coli – *Escherichia coli*
EFO – environmental field office
LB (lb) - pound
IC_{25} – inhibition concentration causing 25% reduction in survival, reproduction and growth of the test organisms
IU – industrial user
IWS – industrial waste survey
LC_{50} – acute test causing 50% lethality
MDL – method detection level
MGD – million gallons per day
MG/L (mg/l) – milligrams per liter
ML – minimum level of quantification
ml – milliliter
MLSS – mixed liquor suspended solids
MOR – monthly operating report
NODI – no discharge
NOEC – no observed effect concentration
NPDES – national pollutant discharge elimination system
PL – permit limit
POTW – publicly owned treatment works
RDL – required detection limit
SAR – semi-annual [pretreatment program] report
SIU – significant industrial user
SSO – sanitary sewer overflow
STP – sewage treatment plant
TCA – Tennessee code annotated

TDEC – Tennessee Department of Environment and Conservation
TIE/TRE – toxicity identification evaluation/toxicity reduction evaluation
TMDL – total maximum daily load
TRC – total residual chlorine
TSS – total suspended solids
WQBEL – water quality based effluent limit

ADDENDUM TO RATIONALE

Memphis-T.E. Maxson STP
NPDES Permit No. TN0020729
Permit Writer: Gary Davis

This Addendum to Rationale includes the draft permit written comments (provided in the following appendices). To finalize the new permit, the division has abbreviated the comments and provided a response presented in **bold *italics*** font. The Rationale cannot be changed as a result of comments received during the public notice period. This "Addendum to Rationale" provides the basis for augmenting the draft permit's "Rationale" and finalizing the new permit.

A1. Permit Expiration Date should be 5 years from the issuance date – ***the division agrees and the new permit is issued on a 5 year term.***

A2. Section 1.1 – BOD & TSS – monthly and weekly mass limits are not necessary – ***the division agrees with the permittee's request; minimum percent removal of BOD and TSS on a monthly average and daily basis will be retained in the final permit.***

A3. Section 1.1 – E. coli Permit Limits – daily max should not be required since there's no bathing beach downstream of discharge – ***the division considers a daily maximum E. coli discharge limit to be appropriate since the relevant water quality requirements are for all receiving stream recreational usages. As such, the E. coli discharge limits are not subject to the existence of downstream bathing beaches.***

A4. Section 1.1 – Effective Date of E. coli Permit Limits and Monitoring Requirements - per permit footnote, must comply with limits within 36 months which does not say no monitoring required. Memphis wants "During the interim period, there are no E. coli limitations nor monitoring requirements." – ***the division considers its E. coli database to be very limited and E. coli monitoring will be required pursuant the new permit. E. coli discharge limits will be applicable following the permittee's disinfection system installation/startup/stabilization period. The permittee must inform the division in writing that it disinfection system is functional and it treated effluent is subject to the new permit's E. coli discharge limits.***

A5. Section 1.1 – Total Residual Chlorine or Oxidant Limits – premature to include TRC or TRO limits – wants limits removed/reopener for appropriate limit based on selected disinfectant & TRC calculated acute & chronic -> not TDEC's std technology–based TRC of 2.0 mg/L. – ***the division has finalized the permit to provide for its reopening for the inclusion of appropriate discharge parameter(s) limits/monitoring requirements pursuant to the specific disinfection system selected. Reopening the permit is subject to the division's applicable public participation procedures.***

A6. Section 1.1 – Addition of Benzidine and Hexachlorobenzene Monitoring – no basis for including parameters in permit. – ***the division has finalized the new permit to include***

annual monitoring requirements for Outfall 001 treated effluent benzidine and hexachlorobenzene. Benzidine is used in some dyes/pigments manufacturing/usage and the permittee has many relevant industrial users, which may be discharging benzidine. Hexachlorobenzene can be formed as a byproduct during solvents, pesticides and other chemicals manufacturing, and is required to be limited pursuant to OSPSF categorical pretreatment standards for toxic pollutants. The permittee has many industrial dischargers subject to OSPSF categorical pretreatment standards.

A7. Section 1.1- Addition of Visual Outfall Observations – daily observations to include "distinctly visible matter and/or objectionable instream color" standard is vague and subjective. Therefore, if not unsafe and if outfall pipe is not underwater, record yes/no for presence of floatables, scum, foam, oily slick. – ***the division agrees with the permittee request and the monitoring requirements are described in section 3.5 of the final permit.***

A8. Section 1.1 - Addition of Effluent Flow Monitoring – current permit influent only, effluent monitoring considered unnecessary and extremely difficult/expensive. – ***the current permit does include influent monitoring, however, per its Part I.B.1 the current permit also includes the following requirement: "Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements are consistent with accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes." As such, the new permit includes a requirement for the permittee to investigate the correlation between the "actual" influent and effluent flow rates. The permittee must determine options for actually monitoring effluent flow. The division understands that the permittee currently considers its influent flow rate to represent its effluent value. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. The new permit's reopener clause was supplemented with the prior sentence to allow the division to make permit modifications if warranted, based on the permittee's influent/effluent flow report.***

A9. Section 1.1 – TRC Monitoring, p. 3 – would include H_2O_2 as other oxidants – too broad (want when chlorine, bromine or other halogenated oxidants added). – ***the new permit's reopener clause was changed to allow the division to account for the permittee's selected disinfection system and make appropriate permit adjustments.***

A10. Section 1.1 - Narrative standards, p. 3 – color/foam and other visible materials – related to designated uses and cannot omit qualifying language (e.g., "considering the nature and location of the water") – thus, TDEC - incumbent to include numerical color limit(s) and if not feasible then BMPs. – ***the division must apply narrative standard consistent with its rules for all permittees. Certainly, equivalent/more stringent***

permitting requirements can be applicable per the specific situation, e.g., to provide for warranted water quality improvements.

A12. Section 1.2.1.a – BOD5 effluent sampling location p. 5 – permittee wants to be able to collect final effluent BOD5 sample before disinfection for any disinfectant used. – ***Section 1.2.1.(a) of the final permit states: "If chlorination is used for disinfection, final effluent BOD5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD5 testing procedures approved by the division for its treated effluent analyses.***"

A13. Section 1.2.3.a – mercury and methyl mercury analytical methods – requires non-routine techniques and additional expenses – considers it on-going research. – ***The designated uses of the receiving stream are not fully supported due to mercury in fish tissue. For that reason, the new permit simply requires annual monitoring of mercury and methyl-mercury.***

A14. Section 1.2.3.a – PCBs analytical method – low detection method not warranted as PCBs not found in 9 years of annual monitoring/not manufactured/used in US for decades. – ***The designated uses of the receiving stream are not fully supported due to presence of PCBs in the sediment and is subject to TMDL requirements. A more sensitive analytical method is required in order to confirm that facility is not contributing PCBs to the receiving stream.***

A15. Reporting requirements –Section 1.3.5.1 summary report to ID number of sanitary sewer overflows, dry weather overflows and in-plant bypasses and basement backups separately. DMR reporting only provides for sanitary sewer overflows, dry weather overflows and in-plant bypasses. "Suspected" instances should be deleted. – ***The division agrees to include a "Sewer Backups to Buildings" monitoring parameter in the new permit. The "Suspected" permit provision will be retained, since the division considers the requirement to be consistent with its other permits. The overflow permit language will not be based on a single rain event, as proposed by the permittee.***

A16 Section 1.5 – Reopener provisions – unclear why TDEC may want to be able to reopen permit to make changes to E. coli compliance schedule. – ***The language regarding E. Coli compliance schedule has been removed from the reopener provision.***

A17. Section 2.1.4 Proper Operation and Maintenance, p. 10 – the "standard" permit condition regulation does not address the "collection" system and can't be referenced/included since this would amount to a change from "standard". – ***The collection system is considered an integral part of the POTW. This language is consistent with all other municipal permits and will remain in the final permit.***

A18. Section 2.3.2 Reporting of Noncompliance, p. 13 – notification to state with 24 hr for "...threat to drinking water supplies, ... threat to human health or the environment" - permittee wants clarification to note that such notice not required if overflow has been addressed within 24 hr. – ***The permit allows the permittee discretion to determine***

whether or not non-compliance remedied within 24 hours pose a threat to human health and environment.

A19. Section 2.3.3 – Overflow, p. 13 – overflow per rule based on "discharge" not "release" as in draft permit. Other "releases" not addressed by standard permit conditions nor rules. New permit must provide compliance schedule (requesting 20 years) if no feasible alternative to overflow. State has established a new zero discharge technology-based standard for the collection system. – ***The word "release" was replaced with the word "discharge" in the final permit.***

A20. Section 2.3.6.c – Bypasses, p. 16 – "All other bypasses are prohibited" should be changed to "All other bypasses are subject to the prohibition in subsection (b) above." Which permittee notes say they are only prohibited if they do not meet the subsection (b)(i) through (iii) criteria. – ***The proposed language was included in the final permit.***

A21. Section 3.2(a)(ix) – Local Limit Evaluation, p. 18 – division's pass through limits have not been established by regulation/should be deleted – no document explaining the derivation of such limits and why those are appropriate for municipalities. – ***The language in Section 3.2.(a)(ix) of the final permit was changed to state: "The evaluation should consider the most recent pass-through limits proposed by the division."***

A22. Section 3.2(b)(vi) – Pretreatment, p. 18 – prohibit the IU discharge of "any priority pollutant in amounts that will contaminate the treatment works sludge" should be deleted as it is already addressed by the general prohibitions. - ***The language in Section 3.2.(b)(vi) of the final permit was changed to state: "Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal."***

A23. Section 3.2(c) – POTW Pretreatment Program, p. 19 – thirty day notification "If this discharge necessitates a revision of the NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization." - permittee wants quoted sentence deleted because no regulation basis. TDEC has failed to adopt it so-called "pass through guidelines" as a rule instead of using internal TDEC policy, therefore cannot be used to establish industrial user "violations". – ***Permit modification requirements are described in TN Rules, Chapter 1200-4-5-.08(2), which states: "All discharges authorized by the permit shall be consistent with the terms and conditions of the permit; that facility expansions, production increases, or process modifications which result in new or increased discharges of pollutants must be reported by submission of a new application or, if such discharge does not violate effluent limitations specified in the permit, by submission to the commissioner of notice of such new or increased discharges of pollutants; that the discharge of any pollutant more frequently than or at a level in excess of that identified and authorized by the permit shall constitute a violation of the terms and conditions of the permit." Therefore, the language in section 3.2(c) does not have its basis in pretreatment rules, but is derived from the requirement that all pollutant sources must be***

adequately identified and authorized through an NPDES permit prior to commencement of discharge.

A24. Section 3.4.1 and 3.4.2 Frequency of WET testing, pp. 23-27, wants automatic WET testing reduction to 2x/yr if 4 consecutive compliances reported. – ***the new permit includes report-only for WET testing, with 48-hr LC50 acute monitoring on an annual basis. The new permit's IC25 WET chronic testing (scans) is for the permit renewal application. Therefore, the division does not consider WET monitoring frequency reductions to be applicable.***

A26. Section 3.5 (section 3.6 in the final permit)

a) Bacteria compliance schedule – While the permittee agrees that compliance schedule for the treated effluent *E. coli* disinfection is necessary, the timeline should be reasonable so to encourage completion of project consistent with sound engineering practices and reflective of administrative procedures associated with a major financial commitment. – ***The division has accepted permittee's proposed disinfection compliance schedule, albeit with minor modifications, so that the project completion is not outside of mandatory 5 year permit issuance restriction. Pursuant to the permittee's request, the division agrees that a single sign at the Outfall 001 discharge will be required rather than the several signs as described in the draft permit.***

b) Disinfection byproducts research (draft requests Memphis to investigate universe of potential halogenated compounds, rather than a proposed disinfection byproducts list pursuant to known effects regarding designated river usages which are determined before studies are initiated and should be identified in (draft) permit. – ***the division considers newly-generated disinfection byproducts to potentially adversely impact the receiving stream's water quality. Also, the byproducts may increase the amounts of chemicals already identified as needing additional controls (e.g., dioxin, and chloroform) for the receiving stream. The division requires that the permittee identify for its selected E. coli control method, the resulting types/amount of newly-generated disinfection byproducts, and corresponding water quality/antidegradation (pursuant to the division's Chapter 1200-4-3-.06(4)(f)) implications. The list of disinfection byproducts of concern should, at a minimum, consider pollutants with published water quality criteria (TN Rules, Chapter 1200-4-3).***

c) effluent transport/dispersion study (Memphis studies not needed/should be deleted/no rationale, study requirements to vague/broad, any in-stream effluent plume definition should await modifications to existing outfall structure. Study monitoring plan/modeling approach, etc. should be defined and agreed upon and timeframe needed. – ***Considering that end-of-pipe water quality criteria is imposed on E. Coli (following compliance schedule) and other pollutants of concern, the division agrees that effluent transport/dispersion study does not have to be included in this permit. However, such study may be required in the next permit cycle, if deemed necessary.***

d) effluent diffuser (Memphis says that based on discussion w/ACOE diffuser is not feasible – per July 2011 mtg w/TDEC diffuser requirement removed) – ***based on the permittee's effluent diffuser infeasible determination the division agrees not to include the diffuser requirement in the new permit. Thus, "This summary must also address an Outfall 001 diffuser(s)." from the draft permit was not included in the new permit.***

e) antidegradation analysis if newly-formed disinfection contaminants above *de minimis* amounts (antidegradation analysis should not be required/adding treatment. If antidegradation analysis is required, Memphis wants TDEC guidance for what is required to pass *de minimis* test and newly-formed contaminants to be limited to only Rule 1200-4-3 parameters. Memphis says TDEC agreed contaminants based on existing WQ per TN regulations.) – ***the division has finalized the permit to include permittee's antidegradation assessment requirements focused on the newly-formed chemicals which would be discharge pursuant to the permittee's selected disinfection system e.g., total residual chlorine, disinfection byproducts. Certainly the permittee must use the water quality criteria/chemicals included based on narrative criteria (including human health consideration). Also, the division expects that the permittee must use its knowledge regarding its industrial discharger wastestreams in its disinfection byproducts investigations. The permittee must address pollutants included in TN Rules, Chapter 1200-4-3 per the receiving stream's designated usages. The receiving stream is classified as an "Exceptional Tennessee Water" and the division's antidegradation requirements are provided in Rule 1200-4-3-.06, which addresses non-degradation due to de minimis contaminant discharge and social/economic justification requirements pursuant to contaminants resulting in receiving stream degradation. The division may not renew/finalize a discharge permit that results in receiving stream pollution.***

EPA's comments (as summarized by the division) and division's responses:

TDEC should clarify if Allan Steam Plant cooling water channel is "waters of the state." – ***The division does not consider Allan Steam Plant cooling water channel to be "waters of the state."***

Re: Section 1.1 - EPA recommends that composites instead of grabs be used for monitoring organic pesticide chemicals, heptachlor and total chlordane. ***The division agrees with EPA's request.***

Re: Section 1.1 - EPA recommends that the division provide clarification regarding monitoring total mercury using composite sampling and grabs for methyl mercury. ***The division considers composite sampling for total mercury testing to be appropriate since the permittee's wastewater treatment system has a relatively short hydraulic detention time and expects significant raw wastewater variability (due to the numerous/diverse industrial user wastewater inputs). Since methyl mercury is volatile, grab sampling is required. However, the new permit's reopener clause has been revised to include the following provision: "The permit may also be reopened if the total mercury results appear much***

lower than expected in comparison with the methyl mercury grab data. If so, the division may require the permittee to determine the total mercury based on grab samples."

Re: Section 1.1 – Total Mercury should be monitored on semi-annual basis to coincide with pretreatment monitoring frequency in section 3.2.d.ii. ***Monitoring frequencies for the pretreatment program and the NPDES point source discharges do not have to coincide. Annual frequency for total mercury, as proposed in the draft permit, is adequate to characterize the discharge.***

Re: Section 1.1 – EPA noted that the total chlordane footnoted as "technical" chlordane. ***The division agrees with EPA and has changed the footnote to by deleting "technical" to be consistent with EPA's "Persistent Chlorinated Hydrocarbon Pesticides" classification.***

Re: Section 1.2.3.a - EPA noted the transposition "PBCs" for "PCBs". ***The division agrees and has made the correction.***

Re: Section 3.5 – EPA notes that any compliance schedule must be justified pursuant to 40 CFR 122.47(a), require the permittee to provide the division written progress notifications within 14 days of each interim milestone or final compliance with a written statement as to whether compliance dates achieved. ***The division agrees with EPA's comment and has supplemented the schedule with the statement "The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved." (See disinfection compliance schedule table, note (a))***

Re: Section 3.5.1 – EPA recommends that specific dates for each report be included. ***The division does not agree that dates must be included and has included a enhanced disinfection compliance schedule that incorporates specific work tasks, milestones, timing elements and the supplementary requirement (permittee must provide the division with progress status reports every 6 months, starting with the permit's effective date and continuing until the permittee's disinfection treatment system is functional.***

Re: Section 6.3.4 – EPA recommends that the division specify if chronic toxicity (IC25) monitoring and/or limits are appropriate based on a reasonable potential evaluation. ***The dilution factor (DF) outfall 001 is outside of a range of dilution factors for which WET testing is required per EPA's guidance. However, the final permit does require annual acute testing and one chronic test to be submitted with the permit application.***

Re: Rationale 8.10 – EPA recommends that the new permit include a date for the permittee to submit the chlorinated byproducts information to the division. ***See response (above) to comment number A26.***

Re: Rationale 9.1 - EPA recommends that the new permit include a date for the permittee to submit the treated effluent transport/dispersion within the receiving stream information to the division. ***The division removed the requirement for the treated effluent transport/dispersion study from the final permit.***

Re: Rationale 10 – EPA recommends that the division discuss how the TMDL wasteload allocations for chlordane, dioxins and PCBs are consistent with the new permit's requirements and deleting/clarifications for the 3rd paragraph's last sentence. ***The TMDL for chlordane, dioxins and PCBs states, in Part 9 (Implementation Plan):***

"9.1 Point Sources
There are currently no NPDES permitted facilities in the Mississippi River Watershed with an existing allocation to discharge chlordane, dioxins, or PCBs to the Mississippi River."

Therefore, there are no wasteload allocations for chlordane, dioxins, or PCBs in the final permit, but annual monitoring is required to evaluate consistency with the TMDL.

Re: Appendix 2e (treated effluent biomonitoring), Appendix 2f (landfill groundwater monitoring results – mercury) and Appendix 2g (sludge mercury content) EPA recommends that the division obtain more recent data (effluent data limit is 4.5 years). ***The effluent data was timely submitted when the division started this multiple-year complex permit renewal process and plans to finalize the permit using the best information available. The new permit requires that the treated effluent mercury must be analyzed using more sensitive analytical methods.***

TCWN/Sierra Club's draft permit comments (as summarized by the division) and division's responses:

1. Foam and color
   Request division specifically address foam – proposes "There shall be no distinctly visible floating scum, oil, foam, or other matter contained in the wastewater discharge." TDEC & EPA have noted the discharge of foam from plants, therefore a WQBEL limit warranted due to reasonable potential to violate instream water quality criteria. ***The final permit addresses these discharge parameters using a narrative WQBEL approach.***
2. Imposing E. coli limits long overdue – final permits should be issued w/o compliance schedules. If schedule included, ASAP compliance w/3 yrs max. for WQBEL compliance. ***The division concluded that a compliance is appropriate. The final permit requires the permittee to complete parallel work tasks and simplifications such that E. coli compliance must be achieved within the new permit's duration.***
3. TN & TP – drafts fail per WQ for nutrients (per … Ecoregion 68a at the 75th percentile for nitrite + nitrate). Memphis watershed significant contributor to Gulf of Mexico hypoxic zone. ***The division does not consider the Ecoregion 68a reference stream values to be applicable to the Mississippi River (Ecoregion 73a). Therefore, the new permit retains Outfall 001 discharge total nitrogen and total phosphorus monitoring requirements from the draft permit.***
4. Mercury – numeric WQBELs should be included in the final permit - ***The receiving stream is identified as impaired for mercury (atmospheric deposition). The city has monitored its effluent for mercury, and the results have been below detection levels. However, the division is requiring the city to monitor mercury concentrations using the more sensitive method to better quantify their contribution, if any.***

5. Overflows – permits Part 2.3.3(d) unclear what "this requirement" means – ***The first sentence in paragraph d was changed to read: "Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after [...]"***
6. Dieldrin and DDT – Stiles, WQ reasonable potential is insufficient basis for limits elimination – specific exception of antibacksliding trigger needs to be presented. ***The current permit includes the following rationale for dieldrin and DDT limits "...since the ambient river concentrations of DDT and Dieldrin have been calculated to currently exceed the state water quality criteria, effluent limitations for these two pesticides are required in the permit." As such, water quality reasonable potential was the basis for including discharge limits for these treated effluent parameters, and rationale for continuing the limits does not apply. This permitting action is consistent with the division's antidegradation policy and these parameters no longer require additional controls pursuant to the division's 2008 and 2010 EPA-approved 303d lists.***

RATIONALE

Memphis-T.E. Maxson STP
NPDES Permit No. TN0020729
Permit Writer: Gary Davis

R1.0 FACILITY INFORMATION

Memphis-T.E. Maxson STP
Memphis, Shelby County, Tennessee
Treatment Plant Average Design Flow: 90 MGD
2010 Percentage Industrial Flow: 23.9 % (based on design flow)
Treatment Description: Activated Biological Filter Towers/Activated Sludge

R2.0 RECEIVING STREAM INFORMATION

Mississippi River at Mile 725.0 (Watershed Group: Mississippi)

Hydrocode (Mississippi River): 8010100
Low- Flow: 7Q10 = 70,500 MGD (109,000 CFS)
30Q5 = 89,900 MGD (139,000 CFS)

USGS Water-Resource Investigation Report 95-4293
Station #03532200

Receiving Waters: Outfall 001 Discharges to the Mississippi River via the Cooling Water Channel (A Wet Weather Conveyance)
The Mississippi River is classified as an Exceptional Tennessee Waters, (Due to the Federal Endangered Pallid Sturgeon and Tennessee Threatened Blue Sucker Fish Species)

Mississippi River Usage Designations:

Domestic Wtr Supply	Industrial	Fish & Aquatic	Recreation
--	X	X	X
Livestock Wtr & Wlife	Irrigation	Navigation	
X	X	X	

R3.0 CURRENT PERMIT STATUS

Permit Type:	Municipal
Classification:	Major
Issuance Date:	3/31/2000
Expiration Date:	3/31/2005
Effective Date:	4/1/2000

R4.0 DIVISION'S PROPOSED NEW PERMIT AND REFERENCES FOR PREVIOUSLY SUBMITTED WRITTEN COMMENTS REGARDING THE PRIOR DRAFT PERMIT

For developing the T.E. Maxson STP's (TN0020729) new proposed permit, the division received/evaluated numerous written comments for the following previously-issued draft permit:

- Draft Permit (August 30, 2010) – Initially Public Noticed (April 6, 2009) and Re-Public Noticed (October 11, 2010)

This draft permit and comments are in division's Water Pollution Control (WPC) permit file.

R5.0 T.E. MAXSON STP TREATMENT COMPONENTS AND RECEIVING WATER

The T.E. Maxson STP wastewater treatment components include preliminary treatment units, roughing trickling filter towers, an extended aeration activated sludge system, and sludge handling/disposal components. The plant includes effluent disinfection chlorine contact chambers which have been converted to clarifiers. Pursuant to its current and prior NPDES permit requirements, no treated effluent disinfection is occurring. The permittee indicated that if necessary, its chlorine contact chambers might be used for treated effluent disinfection.

Prior to flowing to the Mississippi River the permittee's Outfall 001 treated effluent is discharged to a wet weather conveyance which is called the "Cooling Water Channel". The Cooling Water Channel includes the continuous non-contact cooling water discharge from TVA's Allen Fossil Plant Outfall 003 pursuant to NPDES TN0005355. Normally, TVA only discharges from Outfall 003, however TVA also can discharge from its Outfall 002 to the Cooling Water Channel. TVA's discharges occur upstream of the permittee's Outfall 001 discharge point. Effectively, TVA's Outfall 003 discharge water serves as flow augmentation, since TVA pumps its non-cooling water directly from McKellar Lake. The division does not consider wet weather conveyances to be waters of the United States or state of Tennessee. The Cooling Water Channel is subject to a posted fishing advisory.

R6.0 PERMITTEE'S PERMIT MODIFICATIONS REQUESTED IN NPDES PERMIT RENEWAL APPLICATION

The permittee's current NPDES permit limitations/monitoring requirements and the influent monitoring schematic diagram for the permittee wastewater treatment facility are presented in Appendix R-1.

In its NPDES permit renewal application submittal the permittee requested that the division consider the following items:

- Increased treated effluent BOD_5 and TSS limits beyond federal POTW secondary treatment requirements, due to its relatively large industrial contribution. Based on the permittee's supplemental permit renewal

information, the division has included a variance from federal secondary treatment standards for the permittee's treated effluent.

- Allow higher-than-design monthly flow rates to be used for calculating treated effluent weekly effluent mass loadings. No change in the new permit is appropriate. For municipal wastewater treatment facilities renewed permits, the division determines treated effluent limitations, including maximum weekly concentrations, and uses the permittee's design not an actual flow to establish corresponding weekly mass loadings discharge requirements.

- Pesticide monitoring requirements be eliminated or frequency reduced to once per permit term. Based on the continued input from a pesticides manufacturer, several pesticides formulating and packaging industrial users, wastewater from several large grain processing manufacturing plants that may have pesticides/herbicides present in their wastestreams, the permittee's pesticides DMR monitoring results, and the July 25, 2008 Total Maximum Daily Loads (TMDLs) for chlordane, dioxins, and polychlorinated biphenyls in the Mississippi River, the division considers the permittee's treated effluent to contain pesticides that may possibly violate water quality standards and/or contribute to the receiving stream impairments. Thus, no reduction in monitoring frequency is included in the new permit.

R7.0 EVALUATION OF CURRENT NPDES PERMIT COMPLIANCE, INCLUDING RESULTS PROVIDED IN DISCHARGE MONITORING REPORTS AND NPDES PERMIT RENEWAL APPLICATION

Treated effluent monitoring results are provided in Appendix R-2. TDEC personnel completed several compliance evaluation inspections since the current permit's effective date. The following types of treated effluent monitoring results were evaluated during this permit renewal process:

- Discharge Monitoring Reports (DMRs)
- Fecal Coliform (provided in NPDES permit renewal application)
- Organic Pesticides and PCBs (DMR)
- Total Dioxin (DMR)
- Whole Effluent Toxicity – LC_{50} and NOEC (DMR) and IC_{25} (data provided in NPDES permit renewal application)
- Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus (data provided in NPDES permit renewal application)
- Other Parameters (data provided in NPDES permit renewal application)

R7.1 COMPLIANCE EVALUATION INSPECTION (CEI) RESULTS

Mr. Eddy Bouzeid (TDEC Memphis Environmental Field Office) completed CEIs on October 23, 2001, October 30, 2003, November 7, 2005, April 10, 2006, September 30, 2007, March 31, 2008, and June 4, 2010. The permittee received a satisfactory rating for each CEI evaluation. During the June 4, 2010 inspection foam was visible

at the discharge pipe, however the foam was dissipating before reaching the Mississippi River.

R7.2 DISCHARGE MONITORING REPORT (DMR) RESULTS

The DMR results for the months of April 2000 through March 2011 are provided in Appendix R-2A. As shown in the Appendix R-2A, the permittee has had consistent sanitary sewer overflows, and some effluent BOD_5 and TSS permit exceedances.

R7.3 ADDITIONAL TREATED EFFLUENT MONITORING RESULTS

This section includes monitoring results submitted pursuant to the permittee's current permit and data included in its NPDES permit renewal application, as supplemented.

R7.3.1. Fecal Coliform

The permittee's current permit does not require fecal coliform monitoring. However, in the permittee's NPDES permit renewal application fecal coliform results were provided for three treated effluent samples. The maximum fecal coliform result was 700,000 cfu/100 ml, with an average of 520,000 cfu/100 ml. These are high values because effluent disinfection is not being used. Also, as illustrated by the recent *E. coli* results presented in Appendix R-2B, it appears that elevated *E. coli* levels exist in the Mississippi River upstream of the permittee's Outfall 001 discharge point.

R7.3.2. Organic Pesticides Chemicals and PCBs

The permittee's treated effluent organic pesticide chemicals, and PCBs monitoring results summary is presented in Appendix R-2C. These results show that measurable amounts of heptachlor epoxide and 4, 4'-DDE are present in the Outfall 001 treated effluent.

R7.3.3. Total Dioxin

The permittee's total dioxin results for its Outfall 001 treated effluent are provided in Appendix R-2D. From these results it is apparent that the permittee's treated effluent contains total dioxin.

R7.3.4. Biomonitoring – LC_{50}, NOEC and IC_{25} Results

As shown in Appendix R-2E, the permittee submitted its biomonitoring LC_{50} and NOEC results for its treated effluent consistent with its current permit. Some acute aquatic toxicity was demonstrated, with 96-hour LC_{50} values of 70.7% for water fleas, and 54.4% for fathead minnows. Due to large amounts of diverse industrial wastewaters treated by the permittee, some acute toxicity was expected.

For its permit renewal the permittee submitted results for the four treated effluent IC_{25} tests, also presented in Appendix R-2E. The IC_{25} results ranged from 18.5 to 35.7% for the water fleas and 26.7 to 56.7% for the fathead minnows.

R7.3.5. Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus Results

For the three values reported with its permit renewal application, the permittee reported a daily maximum ammonia-nitrogen value of 34.0 mg/l (27.1 mg/l average) and total Kjeldahl nitrogen of 39.9 mg/l (34.9 mg/l average) in its treated effluent. When compared to domestic sewage, the ammonia nitrogen results are relatively high and due to the facility's large industrial input.

The permittee reported a maximum total phosphorus result of 7.56 mg/l (5.2 mg/l average) for three treated effluent samples. This total phosphorus is relatively high compared to domestic sewage, and similar to the ammonia nitrogen, due the facilities' industrial input.

R7.3.6. Other Parameters and Toxics and Metals Results

In its permit renewal application the permittee reported its Outfall 001 treated effluent mercury to be less than 0.2 ug/L,for three samples. From these results, the actual mercury mass discharge rates can not be determined. The permittee reported 2009 influent and effluent mercury values of <0.2 ug/L, with the exception of two influent results (0.30 ug/L for 4/6-7/2009 and 0.20 ug/L for 11/12-13/2009). The permittee's cake solids mercury content is shown Appendix R-2F, which demonstrates that mercury is present in the sludge. The wastewater treatment system is not designed nor operated for mercury removal. Due to the permittee's T.E. Maxson STP facility large/diverse industrial wastewater input and measured mercury in the plant's wastewater and sludge, the division considers that additional mercury monitoring data needs to be collected for the Outfall 001 treated effluent, using more sensitive analytical testing methods, so that the mercury Outfall 001 treated effluent mercury mass loadings can be established.

R8.0. DIVISION'S DETERMINATIONS AND MAJOR CHANGES INCLUDED IN THE NEW NPDES PERMIT

The following major changes from the current permit have been incorporated into the new permit:

a. The permittee requested a variance from the minimum BOD_5 and TSS wastewater federal secondary treatment standards for POTWs (technology-based) as defined in 40 CFR 133.102. The federal secondary treatment standards are technology-based, variance changes for the proposed new permit are not subject to antibacksliding.

The permittee requested a variance from the minimum BOD_5 and TSS wastewater secondary treatment standards for POTWs as defined in 40 CFR 133.102. As shown in Appendix R-3, the division has determined that the provisions of 40 CFR 133.103(b) have been met by the permittee, and the calculated limits for treated effluent BOD_5 and TSS concentration limits have been determined. As such, the BOD_5 concentration limits per variance follows:

BOD_5 Limits (mg/L)

	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	**42**	**63**	**84**
Per Variance	47.0	70.5	114.1

TSS Limits (mg/L)

	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	**48**	**72**	**96**
Per Variance	52.0	77.9	129.0

Since the Mississippi River designation is an "Exceptional Tennessee Waters" and the permittee has not provided the division with antidegradation documentation (including alternative analyses with social/economic evaluations for the above increased Outfall 001 BOD and TSS concentrations per the variance), the new permit includes the most stringent discharge limits (current permit versus per variance values). The values included in the new permit are shown in bold font.

b. For the permittee's M.C. Stiles STP (TN0020711) facility, the division has received/evaluated numerous draft permit written comments. Because the permittee's M.C. Stiles STP new permit addresses issues that apply to the permit proposed by the division for the T.E. Maxson STP (TN0020729), relevant considerations were used by the division in developing the proposed permit for the T.E. Maxson STP.

c. Pursuant to the elements/timing presented in the permit's Section 3.5, the permittee must install/operate an end-of-pipe treated effluent disinfection system to demonstrate that its T.E. Maxson STP Outfall 001 discharge does not cause nor contribute to any non-attainment of the state of Tennessee's recreation *E. coli* requirements (maximum monthly geometrically mean of 126 cfu/100 ml with a maximum sample of 487 cfu/100 ml required by Tennessee's recreation water quality standards, Rule 1200-4-3.03(4)(f)).

d. Since contaminants (e.g., newly-generated chlorinated byproducts, if chlorination is used for Outfall 001 disinfection) in the permittee's treated effluent discharge mixing zones within the Mississippi River must not exceed the division's human health criteria or adversely impact reasonable uses of the area, per Rule 1200-4-3-.05(2), the new permit's Section 3.5 defines an *E. coli* compliance schedule with associated requirements. Also, the permittee must post signs noting the potential human health hazards associated with Outfall 001's discharge, including those related to the discharges' immediate instream mixing zone, for the release to the Cooling Water Channel and the Mississippi River.

R9.0 REPORT SUBMITTAL REFERENCES

The following summary provides references for selected reports that the permittee must submit to the division:

Selected Reports	Section in Permit
Influent Flow Assessment Report	1.2.1.
Discharge Monitoring Reports (DMR)	1.3.1.
Monthly Operational Reports (MOR)	1.3.4.
Bypass and Overflow Summary Reports	1.3.5.
Industrial Pretreatment Reports	3.2.
Sludge Reports	3.3.
Biomonitoring Reports	3.5.
Influent Flow Assessment Report	1.2.1
E. coli Compliance Elements/Timing Reports	3.5

R10.0. REGULATORY BASIS FOR NEW NPDES PERMIT'S MONITORING/LIMITATIONS REQUIREMENTS

Parameter	Regulatory Basis/Rationale Reference
BOD_5	Refer to Section R10.1. T.C.A. 1200-4-5-.09 (for BOD_5) and 40 CFR 133.103(b)
Total Suspended Solids (TSS)	T.C.A. 1200-4-5-.09 Refer to Section R10.2. and 40 CFR 133.103(b)
Ammonia and Organic Nitrogen	Refer to Section R10.4.
Total Nitrogen	Refer to Section R10.5.
Total Phosphorus	Refer to Section R10.5.
E. coli	T.C.A. 1200-4-3-.03, Refer to Section R10.3.
Total Chlorine Residual	Refer to Section R10.4.
Chlorinated Byproducts	Refer to Section R10.10.
Settleable Solids	T.C.A. 1200-4-5-.09 Refer to Section R10.12.
Dissolved Oxygen	D.O. protection, Refer to Section R10.1.
pH	Refer to Section R10.13.
Organic Chemicals Pesticides	Refer to Section R10.8.
Total Dioxin	Refer to Section R10.9.
Total Mercury and Methyl Mercury	Refer to Section R10.11.
Visual Observations	Refer to Section R10.14
Whole Effluent Toxicity:	
Acute Toxicity - LC_{50}	Refer to Section R10.6.
Chronic Toxicity - IC_{25}	Refer to Section R10.6. (Permit Renewal Scans)
Flow (MGD): Influent and Effluent	Used to quantify pollutant load and percentage removals
Sanitary Sewer Overflows, Total Occurrences	Refer to Section R10.15.
Dry Weather Overflows, Total Occurrences	Refer to Section R10.15.
Bypass of Treatment, Total Occurrences	Refer to Section R10.15.

Additional Permit Criteria:

Weekly limitations on BOD_5 and TSS concentrations are given as required per 40 CFR 133.102(a)(2) or 133.102(a)(4)(2) & 133.102 (b)(2) respectively; daily BOD_5 and TSS limitations are authorized by T.C.A. 1200-4-5-.09; monthly and weekly mass loads are limited per 40 CFR 122.45(f) and based on the design flow as per 40 CFR 122.45(b); monthly average percent removal rates for BOD_5 and TSS are required per 40 CFR 133.102(a)(3) or 133.102(a)(4)(iii) and 133.102 (b)(3) respectively. A minimum 40% daily removal rate is required as equivalent to a daily mass load limitation. Additionally, the permittee must also use the following provisions in achieving its new permit monitoring/limitations requirements:

(a) Since the permittee's treatment facility has multiple input streams the influent flow and resulting characteristics must be estimated. The estimated values must be used for calculating loadings and percentage removals.

(b) All sampling shall be representative.

(c) Pursuant to its current permit requirements, the permittee provided the schematic diagram included in Appendix R-1 along with a narrative in its May 26, 2000 letter submitted to the division. Within 60 days from the new permit's effective date the

permittee must submit to the division's Memphis Environment Field and Nashville Central Offices, an updated Influent Flow Assessment Report which relates the quality and quantity of contributory wastestreams (e.g., sludge handling facility supernatants) to its influent monitoring station, including a revised (if applicable) Appendix R-1 diagram. Based on the updated submittal, the division will notify the permittee in writing if additional influent monitoring requirements are necessary.

R10.1. CONTROL REQUIREMENTS FOR BOD_5, DISSOLVED OXYGEN, AND BOD_5 REMOVAL

a. Biochemical Oxygen Demand (BOD) is a measure of dissolved oxygen used when biological processes breakdown wastewater organic pollutants. The five-day biochemical oxygen demand (BOD_5) is typically used for monitoring both the wastewater's strength and treatment facility's performance.

   Limits on the treated wastewater BOD_5 (oxygen demand) is often necessary to prevent pollutants in the discharge from decreasing the oxygen in the receiving stream below levels necessary to support fish and aquatic life. Additionally, the biological oxidation of ammonia requires dissolved oxygen and therefore, exerts an oxygen demand on receiving stream. Due to the large dilution provided by the Mississippi River, estimated at 784:1 (for 7Q10 flow: STP design flow), no adverse dissolved oxygen impacts are anticipated.

   For this facility, a monthly average BOD_5 limit of 30 mg/l is the federal secondary treatment standard technology-based effluent limitation pursuant to Rule 1200-4-5-.09. However, due to the permittee's large input from major industries, the permittee has requested a federal secondary standards variance pursuant to 40 CFR 133.103(b). The results of the division's variance determination are presented in Appendix R-3 and summarized in Section R8.0.(a). As noted in Section 8.0.(a), antidegradation considerations, the BOD_5 concentrations in the permittee's current permit were included in the new permit. Sample type will be composite.

   The dissolved oxygen (D.O.) effluent limitation of 1.0 mg/l (daily minimum on an instantaneous basis) from the current NPDES permit is retained in the new permit. The new permit requires that grab samples be taken to check for D.O. compliance.

b. The current and new permits include BOD_5 and TSS percent removal requirements, based on the facility influent characteristics. This is part of the minimum requirements for all municipal treatment facilities as referenced at 40 CFR Part 133.102. The reasons stated by the U.S.E.P.A. for these requirements are to achieve these two basic objectives:

   (1) To encourage municipalities to correct excessive inflow and infiltration (I/I) problems in their sanitary sewer systems, and
   (2) To help prevent intentional dilution of the influent wastewater as a means of meeting permit limits.

   The treatment facility is required to achieve its permitted BOD_5 and TSS percentage removals. The number of excursions (days when BOD_5 and/or TSS

removal is less than 40%) must be reported on the Discharge Monitoring Report.

R10.2. TOTAL SUSPENDED SOLIDS (TSS) AND TSS REMOVAL REQUIREMENTS

The rationale for defining new permit TSS limitations is similar to that presented in Section R8.1. for BOD_5. The TSS technology-based effluent limit is also 30 mg/l, pursuant to federal secondary standards (Rule 1200-4-5-.09). As shown in Appendix R-3 and Section 8.0.(a), alternative TSS limitations were calculated based on secondary TSS variance due to the permittee's inputs from its major industries, per 40 CFR Part 133.102. However, as shown in Section 8.0.(a) due to antibacksliding provisions (40 CFR 122.44(l)) the TSS concentrations in the permittee's current permit will be included in the new permit.

R10.3. *E. coli* CONTROL REQUIREMENTS

Due to the known recreational activities occurring within the Cooling Water Channel and Mississippi River, the new permit requires that the permittee disinfect its treated wastewater pursuant to the permit's Section 3.5, to achieve the *E. coli* to protect human health (per Rule 1200-4-3-.05(2)). As of September 30, 2004, the criterion for fecal coliform was removed from the state of Tennessee's Water Quality Standards. The division now imposes an *E. coli* limit on discharges of treated sewage for the protection of recreational use of the stream in lieu of the fecal coliform limit. For example, the *E. coli* daily maximum limit of 487 cfu per 100 ml applies to Tennessee Exceptional Waters.

In anticipation of treated effluent disinfection requirements, the permittee had installed a chlorine contact chamber when its extended aeration activated sludge plant was built. The permittee has indicated to the division that its chlorine contact chambers have been not been used for end-of-pipe disinfection, and the facilities instead were modified for suspended solids settling/thickening. Additionally, the facility has no provisions for disinfection chemicals storage/feed and controls. Since the division recognizes that chlorine usage for disinfection may generate deleterious chlorinated byproducts with adverse water quality potential, additional investigations are warranted as presented in R8.10.

As noted in the proposed permit's Section 3.5, the permittee must post signs which warn recreational users of potential human health hazards associated with the Outfall 001 discharge.

For the T.E. Maxson STP TN0020729 draft permit *E. coli* requirements as presented in Section 3.5, the division used the *E. coli* control elements and timing as proposed by the permittee for its M.C. Stiles STP TN0020711 permit. As such, some elements/timing changes may occur for finalizing the T.E. Maxson STP TN0020729 permit.

R10.4. AQUATIC TOXICITY POTENTIAL DUE TO AMMONIA NITROGEN/ORGANIC NITROGEN, AND TOTAL RESIDUAL CHLORINE/OXIDANTS (TRC)/TRO

The potential for aquatic toxicity within the Mississippi River due to the permittee's treated effluent ammonia-nitrogen and residual oxidants (e.g., total residual chlorine) from treated effluent disinfection is discussed subsequently and in Appendix R-4. The results from the *E. coli* control evaluations (as shown in the permit's Section 3.5) will be used to identify applicable permit limits and modifications are warranted.

Ammonia-Nitrogen Aquatic Toxicity Considerations

Based on the evaluation results shown in Appendix R-4 the new permit includes monthly Outfall 001 discharge monitoring with report-only requirements for the treated effluent ammonia nitrogen and organic nitrogen. Organic nitrogen monitoring requirements are included in the new permit since it may be converted in ammonia nitrogen instream via biooxidation and hydrolysis processes. This conversion frequently occurs within activated sludge wastewater treatment plants if the facility is operated at organic loading rates which result in low treated effluent BOD5, e.g., <10 mg/l; however, as shown in Appendix R-2A, the permittee's Outfall 001 monthly average BOD5 is 30 mg/l. Based on permittee's DMR data and results from the proposed permit's Section 3.5 Outfall 001 discharge transport/dispersion within the Mississippi River, the permit may be reopened to include ammonia toxicity limits.

Total Residual Chlorine (TRC) and Total Residual Oxidant (TRO) Aquatic Toxicity Considerations

Since total residual chlorine (TRC) from a chlorination disinfection process can be toxic to aquatic life, the new permit includes a treated effluent TRC limit based on acute toxicity. TRC limits are derived using the mass balance formula and the EPA instream protection for fish and aquatic life values of 0.011 and 0.019 mg/l for chronic and acute exposure, respectively.

The treated effluent is discharged to the Mississippi River, and as shown in Appendix R-4 the new permit includes a daily maximum TRC limit of 2.0 mg/l. To achieve this TRC level, dechlorination will probably be required. The new permit includes total residual oxidant (TRO) monitoring requirements, as applicable. As such, TRC and/or TRO limits are presented in the permit's Section 1.1. Depending on the specific TRO to be used, the division may reopen the permit to include the relevant aquatic toxicity limitations and change the monitoring frequency. The results from the proposed permit's Section 3.5 will be used to make permit modifications, if warranted for Outfall 001 TRC or TRO.

R10.5. TOTAL NITROGEN AND PHOSPHORUS MONITORING REQUIREMENTS

The permittee's Outfall 001 treated effluent monitoring required in the new permit for total nitrogen and total phosphorus is imposed pursuant to the joint State/Federal Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico. The monitoring results from major municipal and industrial facilities discharging within the Mississippi River Basin will help assess current point source loadings to the Gulf and enable the task force to track changes in loadings across the basin with time. EPA believes that Section 308(a) of the Clean Water Act provides broad authority to require nutrient monitoring. No ecoregion reference streams exist for the Mississippi

River. Thus, references for the application of the state's narrative nutrients criteria are not available. Even where there is no reasonable potential for a particular facility to cause or contribute to excursions of criteria within the immediate receiving waterbody, nutrient monitoring is being included in permits. Additionally, the corresponding influent monitoring is incorporated by the state for use in evaluating the ability of existing technologies to remove nutrients. As such, treated effluent nutrient monitoring data is needed and included in the new permit.

R10.6. WHOLE EFFLUENT TESTING – LC50 AND IC25 MONITORING REQUIREMENTS

The acute and chronic biomonitoring requirements for the new permit are addressed in Appendix R-5. Assuming treated effluent complete dispersion under the low-flow 7Q10 conditions, the Mississippi River provides for a large dilution ratio (784:1), an instream waste concentration of 0.13 %. Therefore, under full effluent dispersion, the reasonable potential for the permittee's discharge to exceed the narrative water quality criterion, "no toxics in toxic amounts" is dramatically decreased. However, as discussed subsequently in Section 10.2, the actual transport/dispersion characteristics within the receiving stream is not well defined and pursuant to Section 3.5 investigation results, further mixing information should be available. As such, the new permit includes acute (48-hour LC_{50}) monitoring requirements, with chronic (IC_{25}) biomonitoring being required pursuant to the permittee's permit renewal application process.

The permittee monitored IC_{25} for its treated effluent once during 2003 and three times in 2004. These results are provided in Appendix R-2E. Some aquatic toxicity/inhibition was demonstrated, with IC_{25} values ranging from 18.5 to 35.7 % for water fleas, and 26.7 to 56.7 % for fathead minnows. Some effluent aquatic toxicity/inhibition was anticipated due to the large amount of industrial discharges to the treatment facility.

Based on the aquatic toxicity results variability, receiving stream characteristics, and the need for permit renewal data the 48-hour LC50 monitoring requirements in the new permit has been increased from once during the permit term to annual.

R10.7. WATER-QUALITY BASED EFFLUENT CALCULATIONS – OTHER PARAMETERS/ANTIDEGRATION CONSIDERATIONS

As shown in Appendix R-6, pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit reissuance process and/or due to changes in industrial waste contribution. The new permit requires the permittee to maintain its pretreatment program.

Based on the water quality reasonable potential calculations shown in Appendix R-6, the new permit includes annual monitoring requirements for Outfall 001 benzidine and hexachlorobenzene. For its permit renewal application the pemittee did not use sufficiently sensitive analytical procedures to demonstrate that no reasonable potential to violate water quality exists. The permittee treats industrial wastewaters from numerous dischargers that manufacture or use organic chemicals, therefore Outfall 001 monitoring for these contaminants is included in the new permit. The

permit reopener clause provides for modification based on the permittee's Outfall 001 benzidine and hexachlorobenzene DMR results.

R10.8. ORGANIC PESTICIDE CHEMICALS, (INCLUDING HEPTACHLOR EPOXIDE, AND PCB) CONTROL REQUIREMENTS

The permittee's organic pesticide chemicals, and PCBs monitoring results are presented in Appendix R-2C. The current permit includes monitoring requirements for the specific list of pesticides. Since the permittee continues to accept wastewater from several pesticides manufacturers, elevated fish tissue pesticides concentrations exist, the Mississippi River is now classified as Tennessee Exceptional Waters, and some treated effluent pesticide values were reported, the new permit requires the once/6 months Outfall 001 discharge monitoring for the organic pesticide chemicals scan and numerical limitations, based on water quality compliance for heptachlor epoxide (as shown in Appendix R-2C). Due to the water quality criteria/calculations shown in Appendix R-6, and the division's concern that some industrial users discharge wastewater containing hexachlorobenzene to the permittee's treatment system, limits are included in the new permit. As noted in the 2008 Mississippi River TMDL for PCBs and chlordane, dischargers having these chemicals in their treated wastewater must be limited to the water quality criterion. As such, the new permit includes the water quality criterion as monthly average and daily maximum values, for the Outfall 001 treated effluent PCBs and chlordane. The permittee must demonstrate compliance with the new permit PCBs using EPA Method 1668B.

The division has the ability to reopen and modify the permit for parameters presented in this section.

R10.9. TOTAL DIOXIN DISCHARGE REQUIREMENTS

"Total dioxin" is defined by the Tennessee Water Quality Criteria as the sum of the concentrations of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs) specified in the criteria. "Total dioxin" is defined by the Tennessee Water Quality Criteria as the sum of the concentrations of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs) specified in the criteria.

The current permit requires that treated effluent total dioxin be monitored annually to determine if the discharge contributes to further Mississippi River degradation. As shown in Appendix R2D the Outfall 001 treated effluent total dioxin ranged from 0.1140 to 16.9407 picograms/liter (pg/L). These results demonstrate that total dioxin is present in the discharged Outfall 001 treated effluent. Based on the 2008 Mississippi River TMDL for PCBs, chlordane and total dioxin, the new permit includes the total dioxin water quality criteria as monthly average and daily maximum limits for the Outfall 001 treated effluent.

For the new permit the total dioxin monitoring frequency will be retained at an annually frequency.

R10.10. CHLORINATED BYPRODUCTS

The division considers the permittee's Maynard C. Stiles STP and T. E. Maxson STP treatment facilities to be unique within the state of Tennessee, since these facilities

treat a higher proportion of industrial wastewater flows/contaminant loadings from numerous/diverse sources. As such, the division is concerned that chlorination of the treated effluent for disinfection, could result in high effluent concentrations of chlorinated byproducts (both inorganic and organic) which may pose a human health risk. The identification/characterization (including types and amounts) of chlorinated organics generated via chlorination-based treated effluent disinfection system is addressed in the proposed permit's Section 3.5.

Based on information to be provided by the permittee relative to chlorinated organics generated (via the proposed permit's Section 3.5 requirements), the new permit includes reopener provisions to modifying the permit to include Outfall 001 numerical limits (e.g., monthly average and daily maximum for identified harmful organic chlorinated byproducts, which may/will be generated due to chlorination for disinfection). The permittee had initially indicated to the division that if disinfection is required, chlorination would be used. However, recently, the permittee indicated that non-chlorination processes are being evaluated for Outfall 001 treated effluent disinfection also.

R10.11. TOTAL MERCURY AND METHYL MERCURY

The division added mercury as a fish-consumption advisory for the Mississippi and Wolf Rivers and McKellar Lake on April 26, 2007. The division's fish tissue trigger point for the mercury advisory is 0.3 ppm. As such, the division is including discharge limitations and/or monitoring requirements for permitted potential sources.

As noted in this Rationale's Section R6.3.6., measureable mercury was reported for the permittee's raw wastewater for two months in 2009. The permittee's permit renewal application included three treated effluent mercury results each < 0.2 ug/L. As shown in Appendix R-2F, mercury is present in the permittee's waste activated sludge (secondary cake) at concentrations ranging from 0.161 to 0.48 mg/Kg. Therefore, since mercury is present in the permittee's wastewater and sludge, the Outfall 001 discharge mercury mass loading needs to be determined. As such, the new permit includes discharge monitoring requirements for both total and methyl mercury on twice per year frequency. The treated effluent total mercury must be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630.

The permittee started using covered lagoons in May 2004 for sludge handling/stabilization. As such, under the anaerobic conditions within the lagoons, the division considers an increased potential exists for the generation of methyl mercury. The supernatant from the sludge lagoons is returned to the wastewater treatment system and some methyl mercury would be discharged via Outfall 001. Methyl mercury is the form that is bioaccumulated in fish tissue. As such, methyl mercury monitoring is included in the new permit.

R10.12. SETTLEABLE SOLIDS

Settleable solids results provide an indication of the treatment system performance. The treated effluent settleable solids limitation (1.0 ml/L) included in the permittee current permit will be used for the new permit.

R10.13. pH

The permittee's must comply with secondary treatment technology pH limitations (6.0 to 9.0 s.u.) for its treated effluent. Major variations in effluent pH can provide the permittee with an indication of industrial user spills.

R10.14. VISUAL OBSERVATIONS

As noted in the proposed permit Section 1.1 the permittee must make observations regarding the Outfall 001 discharge the presence of distinctly visual matter or an objectionable color contrast within the receiving stream. Certainly Outfall 001 discharge foam is "visual matter" and is not allowed pursuant to the permittee's current and proposed new permit. Additionally, discharged foam that results in an objectionable color contrast within the receiving stream is prohibited. The proposed permit requires the permittee to monitor/document/report the character of the Outfall 001 discharge and resulting impact, e.g., objectionable color contrast, on the Mississippi River.

R10.15. OVERFLOW AND BYPASS REPORTING

For the purposes of demonstrating proper operation of the collection, transmission, and treatment system, the new permit defines overflow as any release of sewage other than through permitted outfalls. This definition includes, but is not necessarily limited to, sanitary sewer overflows and dry weather overflows. For example, a collection system blockage or hydraulic overload that causes backup and sewage release into a building during a wet weather event may not clearly fit either the definition of a sanitary sewer overflow or a dry weather overflow. The permittee must also account for overflows that result in sewage flow into buildings. Any unpermitted release potentially warrants permittee mitigation for human health protection and/or water quality impacts via direct or indirect contact and demonstrates a hydraulic problem in the system that warrants permittee consideration as part of proper system operation and maintenance.

For the more typical, unpermitted, releases into the environment, the new permit uses interchangeablely the terms, "overflow" and "sanitary sewer overflow" for compliance reporting purposes. Sanitary sewer overflows can have an adverse impact on the permittee's overall *E. coli* control program. The permittee routinely has had sanitary sewer overflows. The permittee provides a summary of its sanitary sewer overflow sources, amounts, causes and mitigation measures taken, are submitted monthly to the division with its DMRs.

R10.16. ADDITIONAL NPDES PERMIT REQUIREMENTS AND CONDITIONS

This section presents several additional requirements and conditions incorporated into the new permit.

R10.17. CHLORINATED BYPRODUCTS

The division considers the permittee's Maynard C. Stiles STP and T. E. Maxson STP treatment facilities to be unique within the state of Tennessee, since these facilities

treat a higher proportion of industrial wastewater flows/contaminant loadings from numerous/diverse sources. As such, the division is concerned that disinfection of the wastewater using chlorination based system could result in high effluent concentrations of chlorinated byproducts (both inorganic and organic), which may pose a human health risk. The identification/characterization (including types and amounts) of chlorinated organics generated via a chlorination-based disinfection system must be addressed, per the proposed permit's Section 3.5. The permittee must provide the division with sufficient treated effluent chlorinated byproducts characterization (including a list of specific chemicals) and the discharge's instream transport/dispersion information, such that the division may define applicable treated effluent limits for obtaining receiving stream water quality standards. The permit may be reopened to include applicable chlorinated byproducts limits.

Based on information to be provided by the permittee relative to chlorinated organics generated (via the proposed permit's Section 3.5 requirements), the new permit includes reopener provisions to modifying the permit to include Outfall 001 numerical limits (e.g., monthly average and daily maximum for identified harmful organic chlorinated byproducts, which may/will be generated due to chlorination for disinfection). The permittee had initially indicated to the division that if disinfection is required, chlorination would be used. However, recently, the permittee indicated that non-chlorination processes are being evaluated for Outfall 001 treated effluent disinfection also.

R10.18. TREATED EFFLUENT TRANSPORT/DISPERSION WITHIN RECEIVING WATER

Should chlorination be selected by the permittee for Outfall 001 disinfection, as presented in the proposed permit's Section 3.5 *E. coli* compliance program, the permittee must provide the following information to the division:

a. Define the lateral, vertical, and longitudinal extent of the Outfall 001 treated effluent plume within the Cooling Water Channel and Mississippi River. The assessment must be completed for varying conditions of stage, flow, and velocities within the Mississippi River.
b. Develop, or utilize an existing, mathematical model to predict the Outfall 001 treated effluent transport/dispersion characteristics within the Cooling Water Channel and Mississippi River.

The permittee's treated effluent transport/dispersion summary shall also include the evaluation objectives, investigation procedures/protocols, data (monitoring and calculated results), mitigation measures, implementation plans, schedules, conclusions, and recommendations. The permittee must also address the applicability of an effluent diffuser(s). Based on this information the division may determine that the permit must be reopened to make changes to its permit limitations and monitoring conditions and/or other adjustments.

R10.19. WASTEWATER TREATMENT AND COLLECTION SYSTEM OPERATORS

The wastewater treatment facilities shall be operated under the supervision of a certified wastewater treatment operator. Also, the permittee's wastewater collection system shall be operated under the supervision of a certified collection system

operator. These certifications must be in accordance with the Water Environmental Health Act of 1984.

R10.20. PRETREATMENT PROGRAM

The T.E. Maxson STP has an approved pretreatment program. An updated Industrial Waste Survey must be completed within 120 days from the effective date of the new permit.

All permittees with approved pretreatment programs are required to analyze the STP influent and effluent for the following pollutant parameters: chromium, copper, lead, nickel, zinc, silver, cadmium, mercury, total phenols, and cyanide. These pollutants were selected because, historically, they are the ones that tend to be predominant in industrial wastewaters. Other pollutants may be added to the list, as required.

During preparation of this permit, data previous annual reports, as well as data from previous Toxics Release Inventory (TRI) lists, were analyzed. If any particular value of a pollutant equals or exceeds 85% of the pass-through limit, or if the TRI list indicates what may be a significant amount of other pollutants being discharged to the sewer system, the pollutant was added to the list of those that are required to be sampled. Based on our review of the annual reports and other documents, sampling for additional pollutants is not required at this time.

Pretreatment Compliance Inspections (PCIs) were completed by TDEC personnel during June, 2003, April, 2006, and July 2008, and the permittee received a satisfactory rating for its pretreatment program.

R10.21. WASTEWATER TREATMENT SYSTEM INTEGRITY EVALUATION

The permittee must within eighteen months from the permit's effective date submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management) and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities and any waterborne waste and sludge storage/disposal units that are constructed of earthen fill.

Upon submittal of the structural integrity assessment and based on recommendations and/or qualifiers provided in the report, TDEC and the permittee will determine what, if any, improvements will be required. Based on the potential for harm to human health as described, additional site specific evaluations may be required.

Requirements to include permit provisions deemed necessary to protect waters of the state, are based on T.C.A. § 69-3-108. It is expected that the permittee's structural integrity submittals will be reviewed by the division's Water Pollution Control and Solid Waste Management personnel. Although it has not been determined at this time, the division may request additional evaluation input from its outside consultants and/or the U.S. EPA.

R11.0. PERMIT TERM

Because the permittee's treated effluents from its M.C. Stiles STP (TN0020711) and T.E. Maxson STP (TN0020729) are the only significant discharges within the Mississippi Watershed, these permits will expire in 2015.

R12.0 RECEIVING STREAM WATER QUALITY STATUS/ANTIDEGRADATION CONSIDERATIONS

Tennessee's Antidegradation Statement is found in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06. It is the purpose of Tennessee's standards to fully protect existing uses of all surface waters as established under the Act.

Stream determinations for this permit action are associated with the waterbody segment identified by the division as segment ID# TN080100000_1000.

The division has made a determination of the receiving stream for the permittee's discharge and has found the river to be a high quality water. No permanent degradation of water quality will be allowed unless the applicant demonstrates to the Water Quality Control Board that the degradation is for necessary economic or social development and will not interfere with or become injurious to any existing uses. The specific requirements for this demonstration are described in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06(4).

This water does not fully support its fish/aquatic life and recreation designated uses due to mercury, dioxin, chlordane, physical substrate habitat alterations, polychlorinated biphenyls (PCBs). The proposed new permit specifically addresses the relevant contaminants (mercury via more sensitive monitoring, dioxin/chlordane/PCBs discharge limits at water quality standards pursuant to the following referenced TMDL. The division has noted sources causing this not fully supporting status as being due to dredging, contaminated sediments, grazing in riparian or shoreline zones and atmospheric deposition (toxics).

The Mississippi River is classified as Exceptional Tennessee Waters (since it provides habitat for the Pallid Sturgeon (federally endangered) and the Blue Sucker (state of Tennessee threatened) and no increase in water quality degradation will be authorized unless the permittee demonstrates to the Water Quality Control Board such degradation is economically and socially justifiable. The specific requirements for this demonstration are described in Rule 1200-4-3-.06(4).

The following TMDL has been developed and approved for the Mississippi River:

Parameters	TMDL Approval Date
Chlordane, Dioxins and Polychlorinated Biphenyls (PCBs)	July 25, 2008

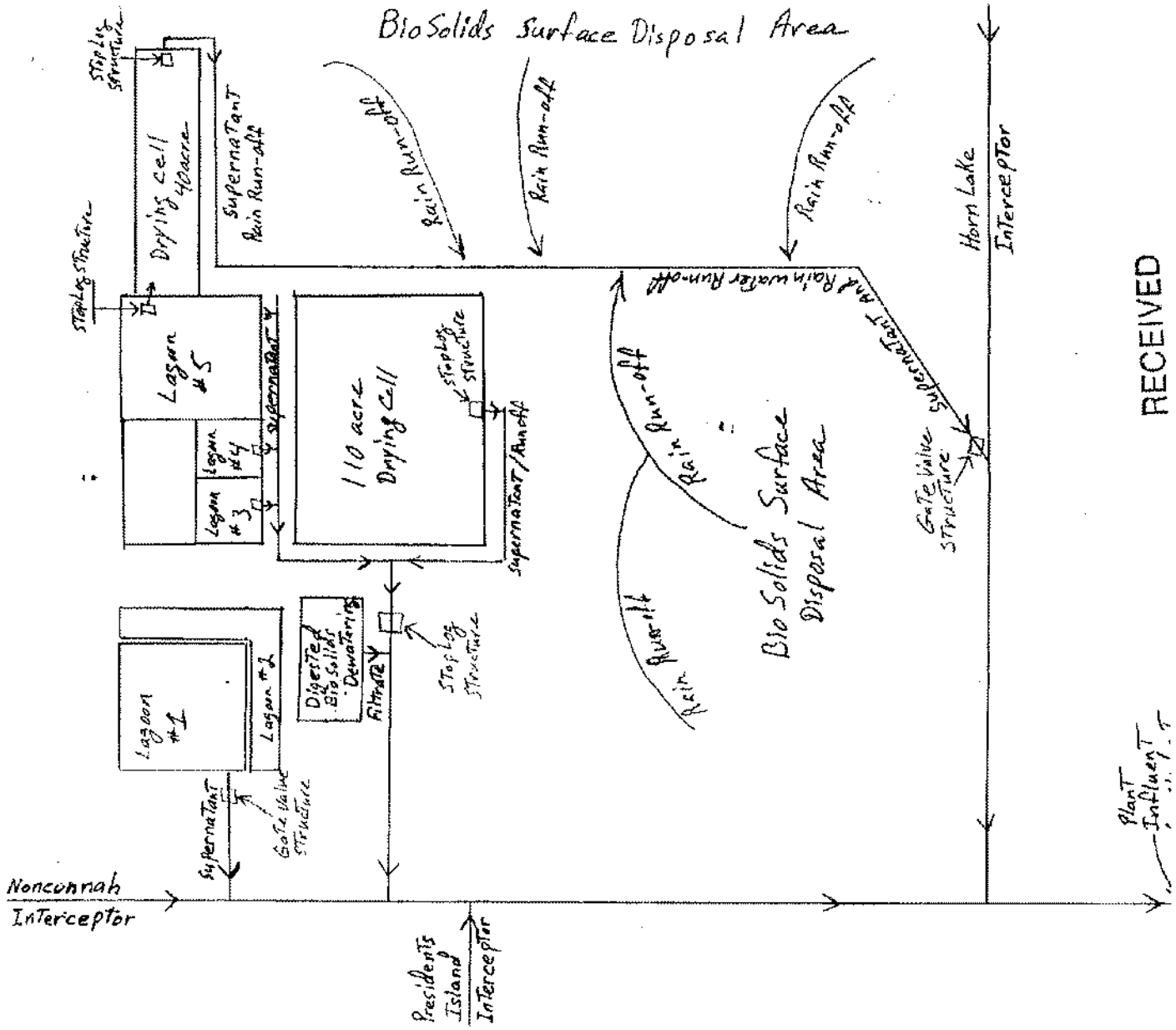
The proposed terms and conditions of this permit comply with the wasteload allocations of this TMDL.

Appendix R-1
Current NPDES Permit Requirements

T.E. Maxson STP (TN0020729) - Permit Effluent Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations									Monitoring Requirements		
	Monthly			Weekly		Daily				Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Maximum (lb/day)	Minimum	Removal (%)			
BOD_5	42	31,525	85	63	47,288	84			40	7/week	composite	effluent
	Report					Report				7/week	composite	influent
Total Suspended Solids	48	36,029	85	72	54,043	96			40	7/week	composite	effluent
	Report					Report				7/week	composite	influent
Settleable Solids (ml/l)						1.0				7/week	composite	effluent
Dissolved Oxygen						1.0 instantaneous				7/week	grab	effluent
pH (standard units)						9.0		6.0		7/week	grab	effluent
Flow (MGD)	Report					Report				7/week	continuous	influent
Organic Pesticide Chemicals (a)						Report				1/year	grab	effluent
Total Dioxin (b)						Report				1/year	composite	effluent
96-hr LC_{50} and 7-day NOEL	Report (Survival, reproduction and growth for serial effluent dilutions)									(c)	composite	effluent
Sanitary Sewer Overflows, Total Occurrences	Report									continuous	visual	NA
Dry Weather Overflows, Total Occurrences	Report									continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report									continuous	visual	NA

(a) "Pesticidies" except for PCBs that are listed in 40 CFR Part 122 (Table II of Appendix D).
(b) Summation of all dioxin and dibenzofuran isomers in Tennessee Water Quality Rule 1200-4-3-.03(4)(h).
(c) Toxicity tests shall be conducted no later than 180 days from permit effective date.


BioSolids Surface Disposal Area
Stop Log Structure
Drying cell 40 acre
Supernatant Rain Run-off
Rain Run-off
Rain Run-off
Rain Run-off
Rain Run-off
Rain Run-off
Horn Lake Interceptor
Stop Log Structure
Lagoon #5
Lagoon #4
Lagoon #3
Supernatant
110 acre Drying cell
Stop Log Structure
Supernatant/Runoff
Supernatant and Rain water Run-off
BioSolids Surface Disposal Area
Gate Valve Structure
Lagoon #1
Lagoon #2
Digested BioSolids Dewatering
Filtrate
Stop Log Structure
Supernatant
Gate Valve Structure
Noncannah Interceptor
Presidents Island Interceptor
Plant Influent

RECEIVED

Appendix R-2A

Discharge Monitoring Report (DMR) Summary

T.E. MAXSON STP - DMR SUMMARY (TN0020729)

Month Ending	Flow		D.O.	INF BOD5		EFF BOD 5					EFF pH		INF TSS		EFF TSS					Settleable	BOD5 Removal		TSS Removal		Overflows
	(MGD)	(MGD)	Min. (mg/L)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	DMin (s.u.)	DMax (s.u.)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	Solids (ml/L)	MAvg (%)	Wk Avg (%)	MAvg (%)	Wk Avg (%)	(No./Month)
4/30/2000	76.1		5.7	708	1,006	39	41	32	20,899	30,525	6.87	7.45	839	1,190	55	86	49	25,098	37,275	0.5	95	90	95	86	
5/31/2000	73.1	94.7	3.8	858	907	38	46	31	19,657	32,067	6.77	7.36	725	1,291	91	170	70	24,966	49,873	6	95	79	95	79	34
6/30/2000	72.5	93.6	5.2	8	1,140	29	37	30	18,173	19,469	6.66	7.43	706	1,063	64	64	39	17,718	24,545	0.5	96	93	96	94	24
7/31/2000	70.5	81.4	5.1	722	876	25	37	31	18,187	21,211	6.94	7.55	659	795	44	31	27	14,433	15,374	0.5	96	94	96	95	17
8/31/2000	71.4	79.2	4.3	767	1,199	28	36	30	17,783	21,288	6.79	7.55	708	913	56	50	31	16,712	19,494	0.5	96	94	96	94	
9/30/2000	71.2	76	5.1	727	990	28	30	28	16,758	17,760	7.05	7.75	675	913	52	46	30	16,752	17,768	0.5	96	93	96	94	23
10/31/2000	70.2	81.1	4.9	770	1,029	31	42	33	19,634	24,807	6.33	7.44	799	1,128	79	54	33	18,083	19,729	0.5	96	88	96	94	27
11/30/2000	75.2	113.2	5.1	691	1,035	31	35	30	19,429	22,442	6.71	7.7	716	1,300	52	64	38	20,245	24,532	0.5	95	86	95	90	24
12/31/2000	73.1	97.6	6.4	772	1,043	34	35	32	19,541	21,830	6.96	7.78	840	1,758	48	56	36	20,767	23,755	0.5	96	94	96	92	30
1/31/2001		72.7	6.0	710	883	45	47	41	25,397	27,734	5.7	7.54	864	1,281	72	132	72	27,893	42,800	0.5	94	87	95	85	49
2/28/2001	79.6	131.7	4.9	684	877	44	4	38	25,394	31,555	6.67	7.63		1,129	65	103	53	31,377	48,126	0.5	94	87	92	77	41
3/31/2001	72.3	92.3	4.4	707	844	35	38	28	16,765	24,231	7.05	7.66	668	984	43	49	50	20,916	31,899	0.5	90	93	94	91	37
4/30/2001	70.1	103.4	5.5	633	872	35	38	31	18,568	21,711	6.74	7.89	837	1,464	77	91	38	26,935	25,147	0.5	95	87	95	84	31
5/31/2001	70.4	97.2	6.1	597	787	36	30	24	14,009	19,557	6.54	7.57	830	1,236	40	59	40	21,318	25,486	0.5	95	93	95	93	28
6/30/2001	74.2	82.9	5.1	623	871	30	28	24	14,916	17,558	6.99	8.54	604	842	36	49	34	18,847	20,122	0.5	96	93	95	91	22
7/31/2001	71.5	86.3	5.1	614	847	23	31	23	13,670	18,524	6.82	7.53	555	904	58	62	30	13,324	16,927	0.5	96	90	96	92	16
8/31/2001	70.9	80.7	4.8	627	763	22	31	27	16,191	18,561	7.06	7.71	555	715	47	40	22	12,748	13,221	0.5	94	91	96	90	28
9/30/2001	69.3	68.8	5.1	675	1,060	25	30	25	14,351	17,735	6.93	7.55	549	1,011	51	51	30	14,459	16,759	0.5	96	92	95	88	26
10/31/2001	72.4	105.9	5.5	610	863	22	29	23	14,292	17,203	6.49	7.66	524	847	53	36	30	13,727	16,001	0.5	96	90	96	93	42
11/30/2001	75.1	155.1	4.0	728	1,109	28	27	27	18,225	14,957	6.56	8.94	027	985	63	71	30	19,247	16,533	0.5	95	75	95	88	45
12/31/2001	65.1	144.8	2.2	578	820	39	55	44	33,340	47,258	6.4	7.89	540	905	79	103	54	30,362	45,968	0.5	91	79	92	75	46
1/31/2002	72.6	102.4	5.6	649	801	33	47	39	23,780	30,498	6.85	8.65	639	934	82	84	47	20,299	31,229	0.5	94	85	95	86	35
2/28/2002	71.8	95.1	6.0	610	891	26	29	29	17,552	24,089	6.41	8.7	652	1,051	58	41	29	15,859	18,136	0.5	95	88	96	94	38
3/31/2002	85.3	144.2	4.1	594	913	48	60	42	31,312	54,059	6.67	7.73	563	842	79	91	67	36,053	02,434	0.5	92	81	91	66	37
4/30/2002	71.7	92.8	5.8	656	900	47	54	45	27,382	38,314	6.99	8.12	554	832	75	78	60	28,446	43,541	0.5	93	87	91	86	22
5/31/2002	75.1	93.8	5.5	589	1,036	29	33	29	18,219	22,119	6.59	8.4	683	1,014	48	48	33	18,219	22,119	0.5	95	91	95	90	22
6/30/2002	70.5	118.1	5.1	645	912	25	35	29	17,290	20,941	6.85	7.38	692	909	45	35	27	14,536	16,332	0.5	95	92	96	93	23
7/31/2002	70.4	118.9	5.3	704	897	29	35	31	18,193	20,589	6.42	7.57	701	1,180	53	59	30	16,851	17,780	0.5	96	93	96	91	19
8/31/2002	70.4	115.3	4.9	677	870	25	33	25	14,699	18,885	6.77	7.52	521	968	40	44	31	14,832	18,540	0.5	96	94	95	90	22
9/30/2002	75.8	168.5	3.1	677	904	31	45	31	20,672	33,663	6.78	7.32	468	590	76	91	47	21,017	35,517	0.05	95	92	93	84	23
10/31/2002	71.8	143.7	1.5	707	865	31	39	33	20,407	29,906	6.24	7.29	552	798	52	56	35	19,088	28,068	0.5	95	84	94	87	23
11/30/2002	67.5	95.7	4.9	691	838	35	37	34	19,268	21,104	6.99	7.39	576	904	49	48	40	19,822	22,221	0.5	95	92	94	90	31
12/31/2002	75.4	122.3	3.7	521	918	42	52	40	27,015	39,478	6.48	7.39	483	745	79	85	52	27,976	39,526	0.5	93	80	91	77	34
1/31/2003	66.3	75.1	5.7	722	920	34	40	33	18,531	22,282	6.74	7.34	539	919	61	48	36	18,583	20,181	0.5	95	90	94	90	48
2/28/2003	82	127.4	4.0	611	818	47	50	49	35,870	40,042	6.73	7.18	528	714	92	89	51	33,676	40,175	0.5	91	76	91	82	42
3/31/2003	69.7	87.8	5.6	688	872	72	114	46	24,215	48,030	6.84	7.23	568	709	55	66	45	26,106	37,530	< 0.5	93	81	92	88	25
4/30/2003	67.3	84.2	5.6	903	7,001	41	38	32	17,824	21,548	6.93	7.37	531	740	49	65	50	23,140	27,657	0	96	90	92	87	29
5/31/2003	79.6	143.6	2.3	636	935	50	46	36	25,118	38,195	6.72	7.73	546	903	64	80	62	34,144	50,898	0	94	83	91	83	33
6/30/2003	68.1	84.4	4.2	532	870	28	27	22	12,606	16,024	6.84	7.62	499	1,191	41	57	33	15,762	18,507	0	96	94	94	88	21
7/31/2003	63.5	74.2	4.4	669	888	39	45	37	19,597	24,067	6.62	7.2	535	716	61	66	51	20,714	27,666	0.5	94	92	93	86	15
8/31/2003	64.0	77.6	2.7	684	1,100	37	40	32	17,260	21,356	6.95	7.45	468	611	52	50	40	19,914	21,525	0	95	93	92	88	13
9/30/2003	61.5	83.6	4.2	695	998	39	36	30	15,676	19,147	6.89	7.31	453	711	49	59	44	19,987	22,887	0	96	89	91	84	20
10/31/2003	59.9	84.3	5.0	706	960	41	40	36	18,137	19,913	6.89	7.34	472	691	72	71	44	20,309	21,120	0	95	89	91	82	28
11/30/2003	63.0	88.3	4.8	760	1,406	44	48	40	21,153	25,001	6.38	7.33	543	912	78	73	50	23,332	26,599	0	95	82	92	83	25
12/31/2003	62.7	88.5	5.0	675	938	41	43	36	19,072	22,303	6.88	7.31	649	1,157	59	56	47	21,413	24,531	0	95	92	94	87	22
1/31/2004	62.6	100.6	4.6	718	966	39	43	36	19,081	23,956	6.54	7.33	654	1,208	57	79	43	20,915	25,478	0	95	90	94	85	42
2/30/2004	72.2	119.4	4.8	650	891	47	59	44	27,076	35,289	6.61	7.28	473	633	93	105	55	28,945	35,233	0	93	77	90	78	37
3/31/2004	77.7	112.6	5.6	643	858	35	38	33	21,416	24,376	6.71	7.51	826	1,389	67	68	37	22,918	23,497	0	95	88	96	86	54
4/30/2004	64.1	145.3	4.5	624	1,078	48	45	39	28,105	38,700	6.58	7.32	732	1,370	58	77	53	34,478	46,352	0	94	83	93	81	42
5/31/2004	66.4	117.4	4.2	628	862	35	37	26	19,052	27,827	6.81	7.7	551	907	49	62	51	25,382	38,421	0	96	90	94	86	25
6/30/2004	84.3	93.4	4.7	675	1,040	46	39	37	26,045	26,934	6.88	7.29	556	1,116	64	78	50	32,608	35,708	0	95	90	92	85	20
7/31/2004	74.4	85	3.1	743	974	46	62	38	23,795	40,845	6.81	7.25	579	855	83	80	66	28,490	43,602	0	95	88	92	81	20
8/31/2004	73.9	80.8	1.7	760	994	45	52	37	22,875	32,055	6.91	7.4	578	1,279	73	67	53	27,684	32,012	0	95	91	92	87	19
9/30/2004	73.0	80.4	4.0	837	1,109	43	38	34	20,380	23,280	6.92	7.8	540	740	52	57	47	26,266	28,961	0	96	94	92	89	23
10/31/2004	75.3	109.9	4.4	802	1,460	34	32	26	16,216	18,915	7.06	7.5	593	1,345	53	63	43	21,249	25,100	0	97	94	94	90	26
11/30/2004	84.6	143.3	1.9	702	1,130	44	36	30	21,983	27,781	6.96	7.9	545	806	50	85	47	31,760	35,747	0	96	90	92	84	18
12/31/2004	80.4	117.3	0.5	732	1,368	39	33	31	21,281	25,844	7.14	8	542	857	57	60	42	26,910	32,827	0	96	92	93	85	24
1/31/2005	85.5	109.8	3.8	762	1,216	39	35	30	21,518	30,037	7.02	7.72	570	884	69	69	44	27,057	37,756	0	96	89	93	84	33
2/28/2005	75.0	91.8	5.6	770	1,419	37	28	27	16,608	18,243	7.1	7.45	570	945	42	58	40	23,387	24,865	0	97	94	93	88	19
3/31/2005	77.0	116.8	5.2	694	1,095	34	29	27	17,671	19,690	6.93	7.44	671	1,471	79	88	36	22,332	24,580	0	96	90	95	88	31
4/30/2005	84.4	126	4.9	723	1,230	40	44	31	22,341	35,402	6.72	7.35	663	1,033	77	78	53	28,611	42,261	0	96	90	94	88	22

Month Ending	Flow (MGD)	Flow (MGD)	D.O. Min. (mg/L)	INF BOD5 MAvg (mg/L)	INF BOD5 DMax (mg/L)	EFF BOD 5 Wk Avg (mg/L)	EFF BOD 5 DMax (mg/L)	EFF BOD 5 MAvg (mg/L)	EFF BOD 5 MAvg (lb/day)	EFF BOD 5 Wk Avg (lb/day)	EFF pH DMin (s.u.)	EFF pH DMax (s.u.)	INF TSS MAvg (mg/L)	INF TSS DMax (mg/L)	EFF TSS Wk Avg (mg/L)	EFF TSS DMax (mg/L)	EFF TSS MAvg (mg/L)	EFF TSS MAvg (lb/day)	EFF TSS Wk Avg (lb/day)	Settleable Solids (ml/L)	BOD5 Removal MAvg (%)	BOD5 Removal Wk Avg (%)	TSS Removal MAvg (%)	TSS Removal Wk Avg (%)	Overflows (No./Month)
5/31/2005	72.6	79.3	3.5	720	1,190	37	31	27	16,256	19,436	7.05	7.55	658	1,160	63	86	46	22,750	28,758	0	96	91	94	87	26
6/30/2005	75.2	82.8	5.1	602	909	31	24	25	15,461	15,421	7.14	7.65	513	1,160	43	46	37	19,743	23,470	0	96	94	94	88	16
7/31/2005	77.9	111.7	4.8	588	819	37	39	32	20,965	27,627	6.79	7.56	529	938	61	59	43	24,121	30,427	0	95	87	93	83	20
8/31/2005	79.3	146.5	3.5	704	989	29	54	40	26,474	32,151	6.56	7.55	498	762	86	59	30	19,444	21,622	0	94	83	94	86	10
9/30/2005	79.7	94.3	3.9	787	1,222	32	35	31	20,516	27,738	7.04	7.5	508	835	51	49	33	21,129	21,836	0	96	93	94	90	10
10/31/2005	82.5	90.7	4.7	883	1,300	37	35	30	20,909	23,342	7.04	7.48	773	1,102	53	61	45	25,744	32,065	0	97	91	95	92	18
11/30/2005	84.2	98.6	5.0	857	1,147	37	38	28	19,961	28,676	7.14	7.45	680	1,044	65	73	42	25,878	31,473	0	97	92	95	89	39
12/31/2005	62.6	101.6	4.8	827	1,458	42	40	30	20,815	27,913	6.9	7.52	684	1,387	55	64	52	29,183	37,024	0	96	93	94	87	25
1/31/2006	88.6	129.9	4.9	829	1,430	42	46	35	27,318	37,707	6.72	7.41	952	1,445	113	91	51	32,096	39,644	0	96	85	96	82	32
2/28/2006	86.5	103.9	4.2	759	1,232	33	33	28	20,090	26,015	6.94	7.39	1,090	1,508	42	51	41	23,919	34,163	0	96	93	97	93	24
3/31/2006	80.9	114.3	4.4	775	1,252	48	51	44	30,306	36,303	7.07	7.48	1,353	2,126	86	113	63	32,879	45,299	0	94	88	96	91	26
4/30/2006	75.1	98.4	5.5	657	800	35	35	29	18,321	21,965	6.99	7.55	1,305	1,584	43	52	42	22,168	26,162	0	96	94	97	96	21
5/31/2006	74.1	108.3	4.5	674	1,115	39	37	31	19,350	24,840	7.09	7.5	863	1,499	57	65	44	24,283	30,376	0	95	90	96	79	25
6/30/2006	73.0	93.5	4.2	676	981	31	31	23	14,434	17,978	6.73	7.52	852	1,340	43	52	38	19,065	22,626	0	97	92	96	91	13
7/31/2006	69.6	77.1	3.0	729	1,001	33	32	25	14,362	19,238	7.11	7.54	661	1,212	35	50	45	19,303	27,190	0	97	93	95	91	
8/31/2006	69.1	79.4	3.7	682	990	19	15	14	7,797	9,086	6.85	7.47	526	691	21	28	23	10,956	12,323	0	98	97	96	93	14
9/30/2006	63.2	90.5	5.2	717	1,028	16	14	13	6,612	7,299	7.09	7.9	495	799	22	26	20	8,194	10,820	0	98	97	97	95	24
10/31/2006	63.6	79.1	1.2	711	980	24	23	20	10,456	13,135	6.77	7.4	476	713	42	41	29	12,744	15,076	0	97	94	95	87	17
11/30/2006	62.1	90.2	5.3	807	1,216	31	51	29	15,291	28,182	6.87	7.36	521	784	65	62	49	16,266	26,985	0	96	90	94	85	24
12/31/2006	69.5	108.9	2.7	684	940	30	41	29	16,846	23,776	6.63	7.3	512	766	54	49	38	17,587	21,925	0	96	90	94	90	37
1/31/2007	73.7	117.4	4.6	652	1,225	34	46	33	20,767	30,288	6.3	7.38	507	1,048	58	55	46	20,929	30,666	0	95	89	93	87	32
2/28/2007	68.9	94.9	4.0	786	1,087	41	43	42	24,462	24,738	6.79	7.3	755	954	96	74	45	23,948	25,608	0	95	82	95	88	31
3/31/2007	66.2	73.2	3.8	891	1,326	39	62	38	21,332	38,617	6.62	7.39	733	1,283	91	71	55	21,621	34,156	0	96	90	95	91	49
4/30/2007	69.3	95.7	4.9	758	1,272	27	25	20	11,661	15,863	6.68	7.54	603	976	42	50	31	15,913	19,761	0	97	94	95	90	33
5/31/2007	67.1	82.7	5.6	682	969	21	23	18	9,939	12,880	6.95	7.89	518	855	30	31	27	11,983	15,501	0	97	96	96	93	21
6/30/2007	66.0	72.7	4.5	791	1,364	29	32	24	13,386	18,338	6.91	7.6	653	3,242	51	72	40	16,627	22,446	0	97	93	96	86	16
7/31/2007	69.3	82.5	4.5	716	982	21	19	16	8,977	10,407	6.83	7.6	557	1,091	33	35	24	11,839	13,715	0	98	94	96	93	7
8/31/2007	67.8	73.5	4.6	676	1,212	18	13	12	7,071	7,859	6.61	7.37	515	874	18	27	20	10,117	11,053	0	98	97	97	94	20
9/30/2007	64.6	70.2	4.3	787	1,181	30	31	25	13,557	16,633	7.12	7.7	615	1,078	49	49	37	16,138	19,928	0	97	94	95	91	17
10/31/2007	66.9	83.6	3.6	853	1,507	37	37	29	15,951	19,217	6.99	7.54	580	919	46	57	48	20,343	25,007	0	97	94	94	88	13
11/30/2007	66.5	81.6	4.2	839	1,043	36	37	29	15,995	20,178	6.9	7.4	555	963	67	66	45	20,091	24,434	0	97	94	93	88	20
12/31/2007	69.4	90.1	5.1	754	1,124	35	47	31	18,854	30,025	6.64	7.48	606	1,122	77	65	47	20,661	30,030	0	96	87	94	87	28
1/31/2008	70.5	96.2	5.2	770	1,343	43	40	38	23,221	26,262	7.02	7.59	630	1,037	93	70	45	25,639	29,009	0	95	88	93	87	29
2/29/2008	66.5	81.2	4.0	840	1,165	66	112	56	32,107	38,316	6.54	7.42	574	895	58	81	50	26,537	37,497	<0.1	93	76	91	80	23
3/31/2008	75.8	113.2	3.8	598	1,016	44	67	42	26,469	35,987	6.34	7.61	438	681	58	61	57	27,941	30,185	0	94	91	90	85	34
4/30/2008	86.7	144.1	2.3	656	1,077	42	49	36	27,487	46,927	6.55	7.62	508	945	63	67	56	31,982	53,760	0	94	84	92	78	35
5/31/2008	74.6	116.3	4.0	712	1,359	34	45	33	21,273	28,816	6.43	7.52	563	878	79	53	38	21,381	24,370	0.1	95	89	94	90	19
6/30/2008	59.4	86.9	4.8	790	947	29	36	25	14,206	21,731	6.41	7.52	589	815	58	63	40	17,019	23,208	0	97	90	95	89	18
7/31/2008	68.1	75.9	4.9	814	1,235	24	24	22	12,596	13,716	6.68	7.81	688	1,638	35	38	27	13,883	14,778	0	97	96	96	93	13
8/31/2008	73.1	106.5	4.1	805	1,139	22	33	24	14,716	20,889	7.02	7.65	752	1,328	51	62	33	13,289	21,022	0.1	97	94	97	95	18
9/30/2008	69.3	101.6	4.4	803	1,148	21	21	20	11,307	11,830	7.15	7.53	784	1,390	35	40	23	11,983	12,994	0.1	97	94	97	94	19
10/31/2008	68.2	93.3	3.6	832	1,205	36	38	32	18,261	23,322	6.96	7.54	831	1,365	57	79	50	20,662	31,180	0.1	96	91	95	83	10
11/30/2008	64.7	82.4	4.0	783	1,262	33	40	27	14,306	21,603	6.54	7.48	739	1,971	61	53	40	17,025	21,831	0.1	96	92	95	91	16
12/31/2008	72.7	136.3	2.6	715	1,052	77	147	52	31484	40314	6.60	7.56	573	1,016	69	107	55	33007	36917	<0.1	92	79	90	82	16
1/31/2009	69.8	119.2	5.3	793	1,373	38	54	28	16,819	27,378	6.25	7.56	758	3,439	38	64	31	18,597	27,337	<0.1	96	87	95	84	20
2/28/2009		123.9	5.0	626	1,013	22	38	18	8,864	11,461	6.68	7.49	531	867	28	34	24	11,349	14,712	0.1	97	93	95	92	17
3/31/2009	75.8	119.4	2.8	598	995	57	177	39	26,296	37,880	6.24	7.42	403	62	42	62	34	22,589	33,767	0.1	93	75	91	83	21
4/30/2009	69.2	106.4	2.2	653	1,007	35	84	34	19,046	22,419	6.74	7.46	494	761	40	63	38	21,502	25,367	0.1	94	87	91	75	21
5/31/2009	78.1	124.6	2.1	595	903	42	70	32	21,363	33,166	6.31	7.26	468	1,041	52	63	39	25,802	38,231	0.1	94	87	91	84	15
6/30/2009	67.3	92.7	4.1	621	829	36	53	28	15,636	20,995	7.03	7.49	450	939	44	62	38	21,245	25,845	0.1	96	91	91	86	12
7/31/2009	70.3	110.3	2.8	583	1,002	29	44	22	12,119	15,477	6.75	7.36	421	719	40	58	31	18,662	21,588	0.1	96	92	92	81	22
8/31/2009	65.9	84.9	1.4	696	1,610	28	36	24	13,313	18,772	6.65	7.58	455	697	35	49	30	16,347	25,199	0.1	96	94	93	87	17
9/30/2009	70.7	104.2	3.0	586	1,698	21	30	14	7,865	11,659	6.98	7.63	494	921	25	43	19	11,118	16,737	0.1	96	94	96	89	11
10/31/2009	80.4	129.1	4.6	560	900	22	38	17	11,765	15,510	6.55	7.44	496	914	27	43	24	16,965	21,824	0.1	96	86	94	86	11
11/30/2009	67.1	87.7	5.5	641	906	22	54	18	9,686	381,716	7.03	8.13	647	1,042	32	41	24	13,068	18,199	0.1	97	91	96	92	18
12/31/2009	74.4	114.4	5.5	551	981	20	29	18	11,452	14,310	6.30	7.42	613	981	29	45	26	16,142	20,233	0.1	96	90	95	89	21
1/31/2010	77.4	117.3	3.1	602	792	37	56	31	20,323	25,712	6.69	7.38	526	1,020	43	66	36	23,694	33,492	0.1	95	91	93	87	27
2/28/2010	81.5	123.0	4.0	583	926	43	54	34	21,249	32,134	6.64	7.98	511	906	48	56	38	23,992	36,088	0.1	94	88	92	82	25
3/31/2010	72.4	99.2	2.2	616	789	36	50	29	17,441	23,245	6.87	7.95	653	1,266	42	54	33	20,397	27,038	0.1	95	92	95	91	31
4/30/2010	73.6	110.8	1.5	633	876	18	40	15	9,011	10,493	6.70	7.91	730	1,087	25	70	23	13,839	14,393	0	96	95	97	91	23
5/31/2010	80.1	133.8	1.8	542	764	24	47	16	11,782	17,565	6.84	7.75	657	1,047	38	56	27	19,180	27,559	0.7	97	89	96	86	16
6/30/2009	72.1	80.3	4	680	929	15	27	13	7,693	8,827	6.4	7.75	648	1,121	24	43	19	11,182	14,225	0.2	98	96	97	92	16
7/31/2009	77	115.5	2.9	620	786	26	37	17	11,156	19,172		8.34	568	1,104	37	56	27	17,508	27,762	0	97	90	95	90	17
8/31/2009	83.1	95.7	3.1	672	1,038	23	31	13	9,248	15,840	6.03	8.54	566	1,028	30	39	19	12,844	20,751	0.2	98	96	97	92	11
9/30/2009	74.9	87.5	4.1	679	992	21	27	15	8,865	13,407	7.11	7.72	574	945	17	26	14	8,314	11,191	0.5	98	96	97	96	16
10/31/2009	68.5	80.7	5	691	952	21	33	15	8,867	12,812	6.95	8.06	710	1,174	25	37	17	9,968	15,393	0	98	94	97	94	14
11/30/2009	78	110.2	2.1	705	1,040	23	57	17	10,781	14,667	7.42	8.13	928	1,665	29	63	23	14,240	18,122	0.1	97	91	97	93	26
12/31/2009	66.7	77.1	3	750	1,118	31	52	25	13,000	17,927	7.26	8.24	712	1,331	34	53	29	16,241	20,057	0.1	07	94	96	92	30
1/31/2010	63.7	98	3.2	754	913	40	56	32	18,443	23,357	7.2	8.04	689	1,108	48	65	39	22,261	27,986	0.2	96	91	94	88	26
2/28/2010	56.6	89.3	2.1	712	970	42	63	38	18,953	23,141	6.1	8	593	1,249	57	89	48	24,231	32,290	0.2	95	89	91	79	16
3/31/2010	77.9	104.9	4.9	618	1,020	33	41	29	18,764	21,257	6.29	8.3	580	968	49	59	40	25,739	31,596	0.3	95	90	93	80	35
DMR Results (Months Ending 4/2000 Through 5/2010)																									
Average	73.0	102.1	4.2	695	1,086	34	42	30	18,293	26,832	6.77	7.62	626	1,067	54	63	40	20,874	27,074	0.2	96	90	94	88	25
Median	72.4	96.2	4.4	692	997	35	38	30	18,243	22,406	6.79	7.54	578	983	52	61	39	20,661	25,283	0.0	96	91	95	88	23
Maximum	88.6	168.5	6.4	903	7,001	77	177	56	35,870	381,716	7.42	8.94	1,353	3,439	113	176	72	36,653	62,434	6.0	98	97	97	96	54
Minimum	59.9	70.2	0.5	8	763	15	4	12	6,612	7,299	6.03	7.18	403	62	17	26	14	8,194	10,820	0.0	91	75	90	66	7
Count	130	121	132	132	132	132	132	132	132	132	131	132	131	132	132	132	132	132	132	128	132	132	132	132	129
Permit Limits	Report	Report	1.0	Report	Report	63	84	42	31,525	47,288	6.0	9.0	Report	Report	72	96	48	36,029	54,043	1.0	85	40	85	40	0
Exceedances	NA	NA	1	NA	NA	3	4	8	3	3	0	0	NA	NA	24	7	31	1	1	1	0	0	0	0	129

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Appendix R-2B
E. coli Monitoring Data

MISSISSIPPI RIVER *E. coli* DATA

4-23-07 Draft

Sampling Location	Approx. River Mile	Station ID	*E. coli* (cfu/100 mL)								
			3/24/05		5/24/05		8/25/05		11/17/05		3/29/06
River Stage (ft)			7.9		10.5		-5.7		-5.2		12.0
Approx. 1.5 miles upstream of Loosahatchie River's mouth											
About 500 ft from AR bank	742	1	15		500		32,800		73		73 (a)
About 500 ft from TN bank	742	2	100		400		36		117		-
Nos. 13 & 14 N. Plant sludge lagoons (approx. 1 mile upstream of N. Plant discharge)											
About 100 ft from AR bank	740	3	74		720		18		36		-
About mid-channel	740	4	33		200		36		91		36
About 100 ft from TN bank	740	5	86		364		18		255		109
North bank of Wolf River's mouth (approx. 1,600 ft downstream of N. Plant discharge)											
About 100 ft from AR bank	738.5	6	40		400		73		91		-
About mid-channel	738.5	7	48		327		18		109		73
About 100 ft from TN bank	738.5	8	2,200		3,260		8,600		2,800		5,000
South end of Mud Island											
About 100 ft from AR bank	736	9	70		255		36		73		-
About mid-channel	736	10	68		218		36		73		145
About 100 ft from TN bank	736	11	840		2,280		11,000		436		700
Wolf River Harbor											
Underneath Mud Island Monorail, mid-channel	-	12	256		73		1,120		600		-
Parallel Gayoso pumping station discharge, mid-channel	-	13	356		36		1,040		1,000		73
Parallel Marble pumping station discharge, mid-channel	-	14	124		36		460		418		182

(a) Mid-channel

Note - grab samples; see "Source" for sampling notes, including climatological information

Source - www.sierraclub.org/watersentinels/tennessee/

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Appendix R-2C

Treated Effluent – Listed Organic Pesticide Chemicals and PCB Results

Listed Organic Pesticide Chemicals and PCBs - T.E. Maxson Treatment Plant Effluent

Pesticide	Aug. 7, 2000 (ug/l)	Dec. 20, 2001 (ug/l)	Aug. 30, 2002 (ug/l)	Dec. 17, 2003 (ug/l)	Jun. 23, 2004 (ug/l)	Oct. 13, 2005 (ug/l)	Dec. 6, 2006 (ug/l)	Dec. 3, 2007 (ug/l)	Nov. 5, 2008 (ug/l)	Nov. 10, 2009 (ug/l)	Nov. 15, 2010 (ug/l)
Alpha-BHC	<0.042										
Lindane (gamma-BHC)	<0.042	<0.500	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor	<0.042	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Aldrin	<0.042	<0.500	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor Epoxide	<0.042	<0.080	<0.050	<0.050	<0.050	<0.05	0.73	<0.05	<0.05	<0.05	<0.004
Endosulfan I (alpha)	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Endosulfan II (beta)	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDD	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDE	<0.042	<0.100	<0.050	<0.050	0.07	0.07	<0.05	<0.05	<0.05	<0.05	<0.004
Methoxychlor	<0.042										
Endrin Aldehyde	<0.042										
Hexachlorobenzene	<0.042										
Hexachloro-1,3,Butadiene	<0.103										
Hexachlorocyclopentadiene	<0.042										
Hexachloronorbornadiene	<0.042										
Octachlorocyclopentene	<0.042										
Heptachloronorbornene	<0.042										
Chlordane	<0.042	<0.100	<1.00	<1.0	<1.00	<1.0	<1.0	<1.0	<1.0	<1.0	<0.004
Endrin Ketone	<0.042										
Endrin	<0.048	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
PCBs-Total		<5.0	<5.0	<1.5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Toxaphene		<5.0	<10.0	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.03

Note: Results for grab samples, unless otherwise noted.

Permittee indicated that as a result of 2000 NPDES permit the following pesticides were removed as analytical requirements: Alpha BHC, Methoxychlor, Endrin Aldehyde, Hexachlorobenzene, Hexachloro-1-3 Butadiene, hexachlorocyclopentadiene, Hexachloronorbornadiene, Octachlorocyclopentene, Heptachloronorbornene, and Endrin Ketone.

HPP/HP2199004033 001234

Appendix R-2D

Treated Effluent - Total Dioxin Results

Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans
Method 1613B (9/97)

PARAMETERS	TEF	Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.	Plt. Eff.
Sample Date		10/8/1999		06/18/2000		12/19-20/2001		8/22/2002		10/22-23/2003		3/9-10/2004		8/2-3/2005		11/29-30 /2006		12/12-13/2007		1/24-25/2008		10/21-22/2009		12/6-7/2010	
		ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD
2,3,7,8 TCDD	1	1	0.0000	0.9	0.8700	6.5	6.5000	7.8	0.0000	5.9	0.0000	3.3	0.0000	2.1	0.0000	1.0	0.0000	0.49	0.0000	0.6	0.0000	2.3	0.0000	0.87	0.0000
1,2,3,7,8-PeCDD	0.5	1.4	0.0000	0.70	0.0000	6.7	3.3500	9.8	0.0000	5.0	0.0000	2.7	0.0000	3.6	0.0000	1.8	0.0000	1.10	0.55	0.8	0.0000	3.9	0.0000	0.87	0.0000
1,2,3,4,7,8-HxCDD	0.1	1.1	0.0000	1	0.0000	5.4	0.0000	9.2	0.0000	5.2	0.0000	2.6	0.0000	2.8	0.0000	1.1	0.0000	1.10	0.0000	0.5	0.0000	4.2	0.0000	0.88	0.0000
1,2,3,6,7,8-HxCDD	0.1	1.1	0.0000	0.90	0.0000	6.2	0.6200	8.8	0.0000	5.5	0.0000	2.2	0.0000	2.9	0.0000	1.8	0.18	0.91	0.091	0.6	0.0550	5.2	0.0000	0.64	0.0000
1,2,3,7,8,9-HxCDD	0.1	1.1	0.0000	0.9	0.0000	12	1.1700	8.5	0.0000	5.6	0.0000	2.4	0.0000	2.8	0.0000	1.1	0.0000	0.57	0.057	0.5	0.0000	4.2	0.0000	0.60	0.0000
1,2,3,4,6,7,8-HpCDD	0.01	5.9	0.0590	4.4	0.0440	12	0.1150	12	0.0000	12	0.1150	3.5	0.0000	6.3	0.0000	11.8	0.118	3.70	0.037	3.60	0.0360	9.8	0.0000	1.6	0.016
1,2,3,4,6,7,8,9-OCDD	0	39	0.0391	56	0.0559	86	0.0857	114	0.1140	76	0.0758	29.1	0.0291	65	0.0653	148	0.148	22.0	0.022	30.0	0.0300	29	0.029	13.0	0.013
2,3,7,8 TCDF	0.1	0.8	0.0000	0.4	0.0000	5.8	0.5800	6.7	0.0000	5.1	0.0000	2.3	0.0000	1.2	0.0000	0.7	0.0000	0.39	0.039	0.5	0.0000	2.0	0.0000	0.63	0.0000
1,2,3,7,8-PeCDF	0.05	0.8	0.0000	0.4	0.0000	7.8	0.3900	6.3	0.0000	3.3	0.0000	6.3	0.0000	2.1	0.0000	1.1	0.0000	0.77	0.0385	0.4	0.0190	1.6	0.0000	0.63	0.0000
2,3,4,7,8-PeCDF	0.5	0.8	0.0000	0.5	0.0000	4.6	2.3000	5.8	0.0000	3.3	0.0000	1.9	0.0000	6.5	0.0000	1.1	0.0000	0.92	0.46	0.4	0.1750	1.2	0.0000	0.55	0.0000
1,2,3,4,7,8-HxCDF	0.1	2.6	0.2600	0.8	0.0000	6.1	0.6100	5.6	0.0000	3.5	0.0000	1.4	0.0000	6.4	0.0000	0.7	0.0000	1.10	0.11	0.5	0.0510	1.6	0.0000	0.67	0.0000
1,2,3,6,7,8-HxCDF	0.1	0.8	0.0000	0.7	0.0000	6.3	0.6300	5.5	0.0000	3.9	0.0000	4.5	0.4500	1.6	0.0000	0.7	0.0000	0.90	0.09	0.4	0.0000	1.9	0.0000	0.62	0.0000
2,3,4,6,7,8-HxCDF	0.1	0.9	0.0000	0.8	0.0000	5.9	0.5900	6.4	0.0000	3.8	0.0000	5.2	0.5200	1.5	0.0000	0.7	0.0000	0.99	0.099	0.45	0.0000	1.6	0.0000	0.78	0.0000
1,2,3,7,8,9-HxCDF	0.1	0.9	0.0000	1	0.0000	1	0.0000	8.4	0.0000	4.8	0.0000	2.0	0.0000	2.2	0.0000	0.9	0.0000	0.48	0.0000	2.10	0.0210	1.9	0.0000	0.78	0.0000
1,2,3,4,6,7,8-HpCDF	0.01	1	0.0000	1	0.0000	1	0.0000	7.8	0.0000	4.2	0.0000	1.8	0.0000	2.4	0.0000	0.9	0.0000	2.10	0.021	1	0.0000	2.5	0.0000	1.70	0.0000
1,2,3,4,7,8,9-HpCDF	0.01	1.3	0.0000	1.4	0.0000	1.4	0.0000	12	0.0000	5.3	0.0000	3.1	0.0000	3.9	0.0000	1.2	0.0000	1.30	0.000	3.9	0.0000	6.6	0.0000	2.30	0.0000
1,2,3,4,6,7,8,9-OCDF	0	11	0.0112	5	0.0000	5	0.0000	16	0.0000	27	0.0271	5.3	0.0000	25	0.0246	11.2	0.0112	3.40	0.0034	4.1	0.0041	6.7	0.0000	1.50	0.0000
TOTAL			0.3693		0.9699		16.9407		0.1140		0.2179		0.9991		0.0899		0.4572		1.6179		0.3911		0.029		0.029

Note: TEF = Toxicity Equivalency Factor; Eq/TCDD = Concentration in terms of 2,3,7,8, TCDD ppq(parts per quadrilion)
1pg/L=1/1000000ug/L or 1000000pg/L=1ug/L or 1pg/L=1/1000000000 mg/L

Appendix R-2E

Treated Effluent - Biomonitoring Results

LC_{50} and NOEC Results:

LC_{50} (96 hour): (Jun. 13-14, 2000, and Jun. 18, 2000)

Ceriodaphnia dubia (water flea) = 70.7%
Pimephales promelas (fathead minnow) = 54.4%

NOEC (7 day): (Jun. 13-14, 2000, Jun. 15-16, 2000, and Jun. 18, 2000)

Ceriodaphnia dubia (water flea): Survival = 50% and Reproduction = 50%
Pimephales promelas (fathead minnow): Survival < 6.25% and Reproduction < 6.25%

IC_{25} Results:

T. E. Maxson STP IC_{25} WET Testing Results

Sample Date	*Ceriodaphnia dubia* (water flea)	*Pimephales promelas* (fathead minnow)
Dec. 9 -11, 2003	18.5%	32.9%
Feb. 9 -13, 2004	32.4%	56.7%
Apr. 26 - 30, 2004	35.7%	33.1%
Jul. 19 - 23, 2004	27.6%	26.7%

(a) Submitted with Sept. 24, 2004 Permit Renewal Application.

Appendix R-2F

Cake Solids Mercury Results

T. E. Maxson STP Sludge Mercury Content

Date	Sludge	Hg (mg/kg)
10/12/2005	Secondary Cake	0.48
9/11/2002	Secondary Cake	0.161
12/5/2001	Primary Cake	0.161

Note: 2010 biosolids/sludges Hg = 0.74 mg/kg.
2009 biosolids/sludges Hg = 0.66 mg/kg.

Appendix R-3
Calculations – Federal Secondary Treatment Standards Effluent BOD_5 and TSS Variances

T.E. MAXSON STP - SECONDARY TREATMENT STANDARDS VARIANCE. PER 40 CFR PART 133.103(b)

A. Variance possible since selected industries contributions are >10 % of flow and/or BOD5 or TSS loadings.

		Flow (mgd)	BOD5 (lb/day)	TSS (lb/day)
T.E. Maxson STP - Design Capacity		90	500,000	300,000
Grain Mills Industries (a)	40CFR Part 406			
	Subpart			
Cargill	A	4.50	97,578	46,678
Kellogg	I	1.28	20,683	5,671
Solae	(b)	5.20	205,174	123,555
Total		10.98	118,261	52,349
Grain Mills Industries Input to STP (%)		12.2	23.7	17.4

(a) Values shown based on City of Memphis' Industrial Wastewater Agreements with selected industries.
(b) Non-Categorical Industry - Best Professional Judgment (BPJ) used for BOD5 and TSS allocations.

B. Selected Industrial Contributions (b)

	Actual Production	Flow	BOD5				TSS			
			Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(1,000 bushels/day)	(mgd)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)
Selected Grain Mills Industries (40 CFR Part 406)										
Cargill (c)	260	4.50	20	5,200	60	15,600	25	6,500	75	19,500
Kellogg (c)	590	1.00	0.4	236	1.2	708	0.4	236	1.2	708
Solae (d)	482	3.70	20	9,643	60	28,929	25	12,054	75	36,161
Total		9.20		15,079		45,237		18,790		56,369

(c) Values shown based on Federal Effluent Guidelines Limitations (direct dischargers) and actual production rates for selected industries.
(d) For BPJ, used effluent allocations shown per footnote "c". Converted production from lb/day to lb/1,000 bushels/day based on ratio of shell corn (56 lb/bushel) to soybean (60 lb/bushel). Solae's actual production rate equals 450,000 lb/day.

C. T.E. Maxson STP Effluent Requirements - Without and With Secondary Treatment Standards Variance

T.E. Maxson STP Effluent Requirements	Flow	BOD5				TSS			
		Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(mgd)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)
Without Secondary Variance	90	30	22,518	60	45,036	30	22,518	60	45,036
Corrected for Selected Industrial Flow	9.20	30	2,302	60	4,604	30	2,302	60	4,604
net	80.80		20,216		40,432		20,216		40,432
With Secondary Variance Loading Allocation			35,295		85,669		39,006		96,801
With Secondary Variance Loading Allocation - resulting concentration	90	47.0		114.1		52.0		129.0	
Resulting weekly concentration assuming 1.5 X monthly value		70.5	Weekly Avg.			77.9	Weekly Avg.		

Appendix R-4

Aquatic Toxicity Potential due to Ammonia Nitrogen and Total Residual Chlorine (TRC) - Considerations

Potential aquatic toxicity within the Mississippi River due to the permittee's Outfall 001 discharged treated effluent ammonia-nitrogen and total residual chlorine (TRC) if chlorination is used, is addressed in this section.

AMMONIA- NITROGEN AQUATIC TOXICITY CONSIDERATIONS

To access chronic aquatic toxicity impacts, the state uses the EPA document, 1999 Update to Ambient Water Quality Criteria for Ammonia and assumed stream temperatures of 25°C and 15°C and pH of 7.5 or 8.0 to derive an allowable instream protection values. A mass balance equation with permittee's discharge and stream flows and this allowable value determines the monthly average permit limit. The criteria document states that a 30Q5 flow value is protective in deriving allowable values. Where the division has 30Q5 flow values, the division may use them. Otherwise, the division utilizes the available 7Q10 or 1Q10 values that are generally more conservative. The criteria continuous concentrations (CCC) derived from assumed temperature and pH values are as follows:

CCC values based on temperature and pH, in mg/L:

Temperature (°C)	7.5 pH	8.0 pH
30	1.61	0.90

Temperature (°C)	7.5 pH	8.0 pH
20	3.06	1.71

The mass balance equation is as follows:

$$CCC = \frac{Q_S C_S + Q_{STP} C_{STP}}{Q_S + Q_{STP}} \qquad \text{or,} \qquad C_{STP} = \frac{CCC(Q_S + Q_{STP}) - (Q_S C_S)}{Q_{STP}}$$

where:

CCC =Criteria continuous concentration (mg/l)
Q_S =Mississippi River 7Q10 flow (70,500 MGD) and Cooling Water Channel (TVA's Allen Fossil Plant Outfalls 002 and 003, 507.6 MGD)
Q_{STP} =STP Design flow (90 MGD)
C_S =Assumed/Measured upstream NH_3 – N (0.1 mg/l)
C_{STP} =Allowable STP discharge NH_3 – N (mg/l)

Assuming Complete Treated Effluent Dispersion Within the Receiving Stream:

Within Mississippi River

(summer)

$$C_{STP} = \frac{0.90\ (70{,}500+507.6+90) - (70{,}500 \times 0.1l)}{90} = 633 \text{ mg/l}$$

(winter)

$$C_{STP} = \frac{1.71\ (70{,}500 +507.6+90) - (70{,}500 \times 0.1)}{90} = 1{,}273 \text{ mg/l}$$

Based on the permittee's treated effluent discharge characteristics (as provided in the permit renewal application) and the above evaluation results, Outfall 001 NH_3-N permit limits for discharge to the Mississippi River are not warranted.

TOTAL RESIDUAL CHLORINE (TRC) TOXICITY CONSIDERATIONS

Should the permittee start using chlorination for effluent disinfection, the following approach would be applicable. An acute residual chlorine limit is determined using the following mass balance and the EPA instream protection value of 0.019 mg/l for fish and aquatic life:

Assuming Complete Treated Effluent Dispersion Within the Receiving Stream:

where:

0.019	=	instream acute protection value (mg/l)
90	=	Qd, STP design flow (MGD)
70,500	=	Qs, Mississippi River 7Q10 flow (MGD)

Within - Mississippi River

Limit (mg/l) =

$$\frac{0.019\,(Qd + Qs)}{Qd} = \frac{0.019(90+70{,}500)}{90} = 14.9 \text{ mg/l}$$

New permit TRC limit for Outfall 001 discharge = 2.0 mg/l (from industry practice for breakpoint chlorination where 2.0 mg/l of free residual chlorine is associated with a 30 minute hydraulic retention time).

Appendix R-5

Whole Effluent Toxicity - Biomonitoring (LC_{50} and IC_{25}) Considerations

The division evaluates all dischargers for reasonable potential to exceed the narrative water quality criterion, "no toxics in toxic amounts" and the division has determined that for municipal facilities with stream dilutions of less than 500:1, any of the following conditions may demonstrate reasonable potential to exceed this criterion (the T.E. Maxson STP has all three) :

a. Some toxicity is suspected or demonstrated.
b. A pretreatment program is required.
c. The design capacity of the facility is greater than 1.0 MGD.

Based on the permittee's Outfall 001 treated effluent whole effluent toxicity (WET) results, the division considers potential WET conditions exists within the Mississippi River. The permittee's 90 MGD Outfall 001 discharge translates to a 790:1 dilution for fully dispersion within the Mississippi River.

EPA's **Technical Support Document for Water Quality Based Toxics Control** (TSD) recommends that the evaluation of both acute and chronic toxicity be based on the number of observations in the data set, the coefficient of variation and an uncertainty factor. The uncertainty factor value is taken from a chart in the technical support document and the coefficient of variation (C.V.) is based on the following numbers.

Less than ten observations C.V. = 0.6
More than ten observations C.V. = Standard Deviation/Mean

Biomonitoring test results are converted to Toxic Units (TU) as follows:

$TUa = 100/LC_{50}$ (for acute test results)
$TUc = 100/NOEC$ or $100/IC_{25}$ (for chronic test results)

To determine if acute and/or chronic biomonitoring is required in the new permit, the final acute value is compared to the criteria maximum concentration (CMC) for acute toxicity (CMC = 0.3 X TUa). The CMC is defined as the highest instream concentration of an effluent to which organisms can be exposed to for a brief period of time without causing an acute effect. The final chronic value is compared to the criteria continuous concentration (CCC) for chronic toxicity (CCC = 1.0 X TUc). The CCC is defined as the highest instream concentration of an effluent to which organisms can be exposed to indefinitely without causing an unacceptable effect. In the absence of chronic data, an acute to chronic ratio (ACR) of 4.4 is assumed (TSD Appendix A.3).

WET Based on Discharge into Mississippi River

Facility	T.E. Maxson STP							
NPDES No.	TN0020711				7Q10 = 70,500 MGD		TUupstream =	0.0 acute
Q_{design} =	90 MGD				1Q10 = N/A		TUupstream =	0.0 chronic
Sample Dates	LC_{50} (%)	*sp.*	TU_a 100/LC_{50}		Sample Dates	*sp.*	NOEC or IC_{25} (%)	TU_c 100/NOEC or 100/IC_{25}
Jun 13-14 & Jun 18 2000	70.7	CD	1.4					
Jun 27-28 & Jul 2 2000	54.4	PP	1.8		Jun 13-14, Jun 15-16 & Jun 18 2000	CD	50	2.0
					Jun 13-14, Jun 15-16 & Jun 18 2000	PP	6.25	16.0
					Dec 9-11, 2003	CD	18.5	5.4
					Dec 9-11, 2003	PP	32.9	3.0
					Feb 9-13, 2004	CD	32.4	3.1
					Feb 9-13, 2004	PP	56.7	1.8
					Apr 26-30, 2004	CD	35.7	2.8
					Apr 26-30, 2004	PP	33.1	3.0
					Jul 19-23, 2004	CD	27.6	3.6
					Jul 19-23, 2004	PP	26.7	3.7
Count			2					10
Average			N/A					4.4
Maximum			1.8					16.0
Std Dev			N/A					4.2
Coeff. Of Variation (c.v.)			0.6					0.9
Uncertainty Factor (u.f.) (a)			3.8					1.6
TU loading @ Discharge = TU*u.f.*Q_{design}			629					2.592
TU loading @ Upstream = TUupstream * 7Q10			0					0
TU @ Downstream (c)			0.009					0.037
Biomonitoring Requirement (b)			NO					NO

(a) From uncertainty factors table. If standard deviation = 0.0, then use 1.0 for uncertainty factor.
(b) Biomonitoring required if TUa ≥ 0.3 and/or if TUc ≥ 1.0.
(c) TU loading downstream/(Qdesign + 7Q10)
(d) TU loading downstream/(Qdesign + TVA Allen Fossel Plant Flow)
Note: Maximum TUa and TUc values were used for discharge TU loadings. Also, upstream TU values are assumed.

In the current permit, the division used the NOEC as the measure of chronic toxicity and coupled it with the requirement to estimate the 96-hour LC_{50} (acute toxicity) from the NOEC. However, LC_{50} values cannot be accurately calculated from the NOEC, since the test requirements are different. The chronic toxicity IC_{25} test is deemed equal to but statistically preferred to the NOEC because the IC_{25} is not readily affected by variability in the test data and it incorporates both mortality and chronic effects.

As shown in the above biomonitoring summary table for discharge to the Mississippi River, the estimated TUa and TUc values do not exceed the CMC and CCC, respectively. As such, a reasonable potential for instream acute and chronic toxicity are not demonstrated, for the Outfall 001 treated effluent fully dispersed in the Mississippi River under low-flow conditions. However, since the actual Outfall 001 discharge mixing characteristics within the Mississippi River have not been determined at this time, 48-hour LC_{50} biomonitoring testing is also required for the new permit. The division may modify the new permit acute WET requirements if warranted based the actual Outfall 001 biomonitoring results, and the Outfall 001 discharge transport/dispersion characteristics within the Mississippi River, pursuant to the new permit's Section 3.5 requirements.

Appendix R-6

Water-Quality Based Effluent Calculations- Other Parameters/Antidegradation Considerations

The following procedure is used to calculate the allowable instream concentrations within the Mississippi River for pass-through guidelines and permit limitations. Water quality assessments (acute aquatic toxicity and human health considerations) were also completed for the Outfall 001 treated effluent discharge to the Cooling Water Channel.

a. The following general approach was used for water quality calculations related to discharge to the Mississippi River, based on recent data:

   * 7Q10 of receiving stream (70,500 MGD, USGS)
   * Calcium hardness (192 mg/l)
   * Total suspended solids (71 mg/l, default)
   * Background metals concentrations (½ water quality criteria)
   * Other dischargers impacting this segment (as referenced)
   * Downstream water supplies, not applicable

b. The chronic water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel and zinc. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions.

c. The acute water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel, zinc, and silver. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions for the following metals: cadmium, copper, lead, nickel, and silver.

d. The chronic criteria for Chromium (T) is given in the total recoverable form and is not converted to a dissolved lab condition or to the total recoverable ambient condition.

e. A standard mass balance equation determines the total allowable concentration (permit limit) for each pollutant. This equation also includes a percent stream allocation of no more than 90%.

The following formulas are used to evaluate water quality protection:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow
Qs = stream low flow

to protect water quality:

$$Cw \leq \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

where (S_A) is the percent "Stream Allocation".

Calculations for this permit have been done using a standardized spreadsheet, titled "Water Quality Based Effluent Calculations." Division policy dictates the following procedures in establishing these permit limits:

1. The critical low flow values are determined using USGS data:

   Fish and Aquatic Life Protection
   7Q10 - Low flow under natural conditions
   1Q10 - Regulated low flow conditions

   Other than Fish and Aquatic Life Protection
   30Q5 - Low flow under natural conditions

2. Fish & Aquatic Life water quality criteria for certain Metals are developed through application of hardness dependent equations. These criteria are combined with dissolved fraction methodologies in order to formulate the final effluent concentrations.

3. For criteria that are hardness dependent, chronic and acute concentrations are based on a Hardness of 25 mg/L and Total Suspended Solids (TSS) of 10 mg/L unless STORET or Water Supply intake data substantiate a different value. Minimum and maximum limits on the hardness value used for water quality calculations are 25 mg/L and 400 mg/L respectively. The minimum limit on the TSS value used for water quality calculations is 10 mg/L.

4. Background concentrations are determined from the division database, results of sampling obtained from the permittee, and/or obtained from nearby stream sampling data. If this background data is not sufficient, one-half of the chronic "In-stream Allowable" water quality criteria for fish and aquatic life is used. If the measured background concentration is greater than the chronic "In-stream Allowable" water quality criteria, then the measured background concentration is used in lieu of the chronic "In-stream Allowable" water quality criteria for the purpose of calculating the appropriate effluent limitation (Cw). Under these circumstances, and in the event the "stream allocation" is less than 100%, the calculated chronic effluent limitation for fish and aquatic life should be equal to the chronic "In-stream Allowable" water quality criteria. These guidelines should be strictly followed where the industrial source water is not the receiving stream. Where the industrial source water is the receiving stream, and the measured background concentration is greater than the chronic "In-stream Allowable" water

quality criteria, consideration may be given as to the degree to which the permittee should be required to meet the requirements of the water quality criteria in view of the nature and characteristics of the receiving stream.

The spreadsheet has fifteen (15) data columns, all of which may not be applicable to any particular characteristic constituent of the discharge. A description of each column is as follows:

Column 1: The "Stream Background" concentrations of the effluent characteristics.

Column 2: The "Chronic" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Continuous Concentration (CCC) is calculated using the equation:

$$CCC = (\exp \{ m_C [\ln (\text{stream hardness})] + b_C \}) (CCF)$$

CCF = Chronic Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained *in The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From* a *Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no chronic criteria exists for silver. Published criteria are used for non-metal parameters.

Column 3: The "Acute" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, Silver, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Maximum Concentration (CMC) is calculated using the equation:

$$CMC = (\exp \{ m_A [\ln (\text{stream hardness})] + b_A \}) (ACF)$$

ACF = Acute Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From* a *Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no acute criteria exists for Total Chromium. Published criteria are used for non-metal parameters.

Column 4: The "Fraction Dissolved" converts the value for dissolved metal at laboratory conditions (columns 2 & 3) to total recoverable metal at in-stream ambient conditions (columns 5 & 6). This factor is calculated using the linear partition coefficients found in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996) and the equation:

$$\frac{C_{diss}}{C_{total}} = \frac{1}{1 + \{ [K_{po}] [ss^{(1+a)}] [10^{-6}] \}}$$

ss = in-stream suspended solids concentration [mg/l]

Linear partition coefficients for streams are used for unregulated (7Q10) receiving waters, and linear partition coefficients for lakes are used for regulated (1Q10) receiving waters. For those parameters not in the dissolved form in columns 2 & 3 (and all non-metal parameters), a Translator of 1 is used.

Column 5: The "Chronic" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 2 by the value in column 4.

Column 6: The "Acute" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 3 by the value in column 4.

Column 7: The "Chronic" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the chronic limit.

Column 8: The "Acute" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the acute limit.

Column 9: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Organism Consumption (Recreation).

Column 10: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Water and Organism Consumption. These criteria are only to be applied when the stream use classification for the receiving stream includes both "Recreation" and "Domestic Water Supply."

Column 11: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Domestic Water Supply.

Column 12: The Calculated Effluent Concentration associated with Organism Consumption.

Column 13: The Calculated Effluent Concentration associated with Water and Organism Consumption.

Column 14: The Calculated Effluent Concentration associated with Domestic Water Supply.

Column 15: The Effluent Limited criteria. This upper level of allowable pollutant loading is established if (a) the calculated water quality value is greater than accepted removal efficiency values, (b) the treatment facility is properly operated, and (c) full compliance with the pretreatment program is demonstrated. This upper level limit is based upon EPA's 40 POTW Survey on levels of metals that should be discharged from a POTW with a properly enforced pretreatment program and considering normal coincidental removals.

The most stringent water quality effluent concentration from Columns 7, 8, 12, 13, 14, and 15 is applied if the receiving stream is designated for domestic water supply. Otherwise, the most stringent effluent concentration is chosen from columns 7, 8, 12, and 15 only.

PASS-THROUGH LIMITATIONS

Pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit issuance process and/or due to changes in industrial waste contribution to the POTW. This POTW is required to implement/maintain a pretreatment program. More frequent monitoring will be required in the permit if (a) the reported concentrations approach or exceed calculated allowable values, (b) significant amounts of particular pollutants are present which may impact the treatment process sludge character or the receiving stream, or (c) minimum information is lacking to accurately calculate water quality protection values, in which case additional stream monitoring may also be required.

Based on the permittee's annually reported data and the Mississippi River flow, the Outfall 001 treated effluent does not indicate that the potential exists for the water quality criteria for any parameter to be exceeded.

VOLATILE ORGANIC, ACID-EXTRACTABLE, AND BASE-NEUTRAL COMPOUNDS

The division evaluated effluent concentrations of volatile organic, acid-extractable, and base-neutral compounds and antimony, arsenic, beryllium, selenium and thallium for potential to violate water quality criteria using the following mass balance equation:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow, (STP design flow)
Qs = stream low flow

to protect water quality:

$$Cw \leq Ca$$

where:

Ca = STP effluent concentration allowable

$$= \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

and (S_A) = the percent "Stream Allocation".

The reasonable potential evaluation uses the following assumptions and procedures:

a. Stream background concentrations, Cs, for all volatile organic, acid-extractable, and base-neutral compounds equal zero unless actual stream data exists to show otherwise. Use of the effluent concentrations of such pollutants contributed by upstream dischargers as background is not justifiable due to the volatility and reactivity of these pollutants.

b. The stream allocation, S_A, is 90% and is used as a factor of safety.

c. A mass balance uses the STP design flow, the receiving stream critical low flow (7Q10 or 1Q10), the state water quality numeric criteria, and the stream allocation safety factor to derive the allowable effluent concentrations.

d. When pollutants have potential to violate standards because the concentrations are below the scan detection levels but could be above the allowable water quality based effluent concentrations, the pollutants are handled one of three (3) ways:

i. Additional testing of detected and non-detected pollutants is required if contributing industrial processes are likely to contain them and the effluent scans have not met the minimum required detection levels (RDL) in the state water quality standards or approximated the method detection limits (MDL) of the approved test methods for the pollutants in 40 CFR Part 136.

ii. If the required RDL has been used and resulted in non-detection, or if an MDL has been used with non-detection and the contributing industrial processes do not reasonably contain that pollutant, the division drops the pollutant from further consideration.

iii. Pollutants detected at levels high enough to violate standards are limited in the permit to the allowable concentration, Cw, based on STP design flow.

Calculations for this permit have been done using a standardized spreadsheet, titled "WQ Based Effluent Calculations- Other Compounds".

The evaluation indicates that volatile organic, acid extractable, and base neutral compounds and antimony, arsenic, beryllium, selenium, and thallium do not exhibit the potential to violate water quality criteria within the Mississippi River, and thus will

not be given effluent limitations and monitoring requirements in the permit from a pass – through standpoint.

2007 WQC

PASS THROUGH LIMITATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

Calculations for nickel, cadmium, zinc, and cyanide

FACILITY:	PERMIT #:	DATE:	CALC BY:
Memphis - TE Maxson STP	TN0020729	6/1/2009	YLM

non-regulated stream worksheet (7Q10)

Stream (7Q10)	Stream (30Q5)	Waste Flow	Tot. Susp. Solids	Hardness	Margin of Safety
[MGD]	[MGD]	[MGD]	[mg/l]	[mg/l as CaCO3]	[%]
70.500	89.900	90	71	192	50

Mississippi River is considered non-wadeable

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Stream Bckgrnd Conc	Fish/Aqua. Life (F & AL) WQC lab conditions		Fraction Dissolved	F & AL instream allowable ambient conditions (Tot)		Calc. Effluent Concentration based on F & AL		Human Health Water Quality Criteria ^ In-Stream Criteria			Calc. Effluent Concentration **			effluent limited case	
PARAMETER	[ug/l]	Chronic [ug/l]	Acute [ug/l]	[Fraction]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Organisms [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Organisms [ug/l]	DWS [ug/l]	ug/l	PARAMETER
Copper (a,b)	5.500	15.638	24.848	0.244	64.153	101.937	23004.65	37822.29	N/A	N/A	N/A	N/A	N/A	N/A	80.0	Copper (a,b)
Chromium III	349.040	126.452	972.116	0.181	968.081	3306.573	137056.55	1967883.53	N/A	N/A	N/A	N/A	N/A	N/A		Chromium III
Chromium VI	5.500	11.000	16.000	1.000	11.000	16.000	2159.67	4120.50	N/A	N/A	N/A	N/A	N/A	N/A		Chromium VI
Chromium, Total	1.000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100.0	N/A	N/A	49495.00	60.0	Chromium, Total
Nickel (a,b)	5.000	90.309	813.088	0.248	364.751	3283.999	141084.83	1285916.78	4600.0	610.0	100.0	2297247.22	302468.88	47497.32	180.0	Nickel (a,b)
Cadmium (a,b)	0.500	0.387	3.795	0.304	1.273	12.492	303.56	4703.25	N/A	N/A	5.0	N/A	N/A	2250.00	5.0	Cadmium (a,b)
Lead (a,b)	2.500	5.080	130.362	0.132	38.444	986.532	14097.19	386905.85	N/A	N/A	5.0	N/A	N/A	1251.11	45.0	Lead (a,b)
Mercury (T) (c,e)	0.720	0.770	1.400	1.000	0.770	1.400	19.97	267.03	0.051	0.05	2.0	334.10	334.60	640.29	0.4	Mercury (T) (c,e)
Silver (a,b,f)	4.000	N/A	9.879	1.000	N/A	9.879	N/A	1939.50	N/A	N/A	N/A	N/A	N/A	N/A	5.0	Silver (a,b,f)
Zinc (a,b)	18.000	205.321	203.656	0.185	1112.463	1103.462	429230.78	425690.98	N/A	N/A	N/A	N/A	N/A	N/A	200.0	Zinc (a,b)
Cyanide (d)	2.000	5.200	22.000	1.000	5.200	22.000	1020.93	7609.33	140.0	140.0	200.0	68693.67	68693.67	98690.33	230.0	Cyanide (d)
Toluene	0.000								15000.0	1300.0	1000.0	7499166.67	649927.78	499944.44	15.0	Toluene
Benzene	0.000								510.0	22.0	5.0	254971.67	10998.78	2499.72	3.0	Benzene
1,1,1 Trichloroethane	0.000								N/A	N/A	200.0	N/A	N/A	99988.89	30.0	1,1,1 Trichloroethane
Ethylbenzene	0.000								2100.0	530.0	700.0	1049883.33	264970.56	349961.11	4.0	Ethylbenzene
Carbon Tetrachloride	0.000								16.0	2.3	5.0	7999.11	1149.67	2499.72	15.0	Carbon Tetrachloride
Chloroform	0.000								4700.0	57.0	N/A	2349738.89	28495.63	N/A	85.0	Chloroform
Tetrachloroethylene	0.000								33.0	6.9	5.0	16498.17	3449.62	2499.72	25.0	Tetrachloroethylene
Trichloroethylene	0.000								300.0	25.0	5.0	149983.33	12498.61	2499.72	10.0	Trichloroethylene
1,2 trans Dichloroethylene	0.000								10000.0	140.0	100.0	N/A	69992.22	49994.44	1.5	1,2 trans Dichloroethylene
Methylene Chloride	0.000								5900.0	46.0	N/A	2949672.22	23037.44	N/A	50.0	Methylene Chloride
Total Phenols	0.000								N/A	N/A	N/A	N/A	N/A	N/A	50.0	Total Phenols
Naphthalene	0.000								N/A	N/A	N/A	N/A	N/A	N/A	1.0	Naphthalene
Total Phthalates	0.000								N/A	N/A	N/A	N/A	N/A	N/A	64.5	Total Phthalates
Chlorine (T. Res.)	5.500	11.000	19.000	1.000	11.000	19.000	4319.33	10594.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Chlorine (T. Res.)

a. Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.
b. The criteria for this metal is in the dissolved form at lab conditions. The calculated effluent concentration is in the total recoverable form.
c. The chronic criteria for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity.
d. The criteria for this parameter is in the total form.
e. Previously, the Division established that 0.006 ug/L would be maximum background default if no sample data available or if all samples were <RDL (<0.2 ug/L), based on reference stream monitoring by DOE.
f. Silver limit is daily max if column 8 is most stringent.
g. When columns 7 or 8 result in a negative number, use results from columns 5 or 6, respectively.
h. When columns 12, 13 or 14 result in a negative number, use results from columns 9, 10 or 11, respectively, as applicable.
i. Domestic supply included in river use so pick from columns 7,8,12,13,14,15 or Domestic supply not included in river use so pick from columns 7, 8, 12 or 15.
^ Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow.

T.E. Maxson	PTL 2/6/1998	85% PTLs	Proposed 6/1/2009	Jan-Dec 09	Jan-Dec 08	Jan-Dec 07	Jan-Dec 06	Jan-Dec 05	Jan-Dec 04	Jan-Dec 03	Jan-Dec 02	Oct-00 AR - Feb 01	Apr-00
COPPER	**0.0800**	0.0680	**0.0800**	0.00438	0.02110		0.00560	0.00698	0.01053	0.07160	0.00800	0.00779	0.00859
CHROMIUM, III	**N/A**	**N/A**	**report**										
CHROMIUM, VI	**N/A**	**N/A**	**report**										
CHROMIUM, TOTAL	**0.0600**	**N/A**	**N/A**	0.00170	0.00821		0.00257	0.00261	0.00320	0.03030	0.00400	0.00180	0.00170
NICKEL	**0.1800**	**0.1530**	**0.1800**	0.01607	0.03830		0.02516	0.01717	0.02070	0.01797	0.02800	0.02135	0.02000
CADMIUM	**0.0050**	**0.0043**	**0.0050**	0.00101	0.00202		0.00101	0.00101	0.00101	0.00005	0.00050	0.00002	0.00002
LEAD	**0.0450**	**0.0383**	**0.0450**	0.00050	0.00146		0.00200	0.00200	0.00200	0.00200	0.00200	0.00052	0.00060
MERCURY	**0.000400**	**0.000043**	**0.000051**									0.00020	0.00020
SILVER	**0.0050**	**0.0043**	**0.0050**									0.00001	0.00008
ZINC	**0.2000**	**0.1700**	**0.2000**	0.01364	0.08200		0.01671	0.01818	0.02627	0.01478	0.02300	0.03425	0.02965
CYANIDE	**0.2300**	**0.1955**	**0.2300**	0.00438	0.01000		0.00001	0.01010	0.01007	0.01010	0.01010	0.00001	0.00001
TOLUENE	**0.0150**	**0.0128**	**0.0150**		0.00163							0.00500	0.00500
BENZENE	**0.0030**	**0.0026**	**0.0030**		0.00100							0.00100	0.00100
1,1,1 TRICHLOROETHANE	**0.0300**	**0.0255**	**0.0300**		0.00100							0.00100	0.00100
ETHYLBENZENE	**0.0040**	**0.0034**	**0.0040**		0.00100							0.00100	0.00100
CARBON TETRACHLORIDE	**0.0150**	**0.0128**	**0.0150**		0.00100							0.00100	0.00100
CHLOROFORM	0.0850	**0.0723**	**0.0850**		0.00069							0.00100	0.00100
TETRACHLOROETHYLENE	**0.0250**	**0.0213**	**0.0250**		0.00100							0.00100	0.00100
TRICHLOROETHYLENE	**0.0100**	**0.0085**	**0.0100**		0.00100							0.00100	0.00100
1,2 TRANSDICHLOROETHYL	**0.0015**	**0.0013**	**0.0015**		0.00100							0.00160	0.00160
METHYLENE CHLORIDE	**0.0500**	**0.0425**	**0.0500**		0.00100							0.00200	0.02000
TOTAL PHENOLS	**0.0500**	**0.1190**	**0.1400**	0.05000	0.05000		0.00556	0.00556	0.00959	0.00808	0.02420	0.02550	**0.06900**
NAPHTHALENE	**0.0010**	**0.0009**	**0.0010**		0.00100							0.00200	0.00200
TOTAL PHTHALATES	**0.0645**	**0.0548**	**0.0645**		0.02545							0.03966	0.03960

Bolded in effluent data exceeds 85% of proposed PTLs
Shaded means detection level

TDEC-TN-2-0000-0883 001251

First Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	90	71	192	50

	1	2	3	5	6	7	8	9	10	11	12	13	14	15
	Stream	Dectection Levels		Fish/Aqua Life		Calculated Effluent		Human Health Water Quality Criteria (30Q5)						Permit Renewal
	Bckgrnd.	Scan	WQC RDL	Water Quality Criteria		Concentration		In-Stream Criteria			Calculated Effluent Concentration			Application (3 Values)
	Conc.	MDL	*EPA MDL	Chronic	Acute	Chronic	Acute	Organisms	Water/Org	DWS	Organisms	Water/Org	DWS	Avg/Max
PARAMETER	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]
HEPTACHLOR EPOXIDE			0.08	0.0038	0.52	1.49	204	0.00039	0.00039	0.2	0.19	0.2	100.0	0.73 (12/6/2006)
4,4'-DDE			0.1					0.0022	0.0022		1.1	1.1		0.07 (6/23/2004 &10/13/2005)
ANTIMONY		5.0	3.0					640.0	5.6	6.0	319984.4	2799.7	2999.7	8.4/9.09
ARSENIC		2.0	1.0	150.0	340.0	58825.0	133336.7	10.0	10.0	10.0	4999.4	4999.4	4999.4	<2.0/<2.0
BERYLLIUM		1.0	1.0							4.0			1999.8	<1.0/<1.0
SELENIUM		3.0	2.0	5.0	20.0	1960.8	7843.3			50.0			24997.2	<3.0/<3.0
THALLIUM		10.0	*					0.47	0.24	2.0	235.0	120.0	999.9	<10/<10
ACROLEIN	0.0	10.0	1.0					290.0	190.0		144983.9	94989.4		<10/<10
ACRYLONITRILE	0.0	10.0	1.0					2.5	0.51		1249.9	255.0		<10/<10
BENZENE	0.0	5.0	1.0					510.0	22.0	5.0	254971.7	10998.8	2499.7	<5/<5
BROMOFORM	0.0	5.0	1.0					1400.0	43.0		699922.2	21497.6		<5/<5
CARBON TETRACHLORIDE	0.0	5.0	1.0					16.0	2.3	5.0	7999.1	1149.9	2499.7	<5/<5
CHLOROBENZENE	0.0	5.0	*					1600.0	130.0	100	799911.1	64992.8	49994.4	<5/<5
CHLORODIBROMO-METHANE	0.0	10.0	*					130.0	4.0		64992.8	1999.8		<10/<10
CHLOROETHANE	0.0	10.0	*											<10/<10
2-CHLORO-ETHYLVINYL ETHER	0.0	10.0	*											<10/<10
CHLOROFORM	0.0	5.0	0.5					4700.0	57.0		2349738.9	28496.8		<5/<5
DICHLOROBROMO-METHANE	0.0	5.0	1.0					170.0	5.5		84990.8	2749.7		<5/<5
1,1-DICHLOROETHANE	0.0	5.0	1.0					NA	NA	NA	NA	NA	NA	<5/<5
1,2-DICHLOROETHANE	0.0	5.0	1.0					370.0	3.8	5.0	184979.4	1899.8	2499.7	<5/<5
TRANS 1,2-DICHLORO-ETHYLENE	0.0	5.0	*					10000	140.0	100.0	4999444.4	69992.2	49994.4	<5/<5
1,1-DICHLOROETHYLENE	0.0	5.0	1.0					7,100	330	7.0	3549605.6	164981.7	3499.6	<5/<5
1,2-DICHLOROPROPANE	0.0	5.0	*					150.0	5.0	5.0	74991.7	2499.7	2499.7	<5/<5
1,3-DICHLORO-PROPYLENE	0.0	5.0	1.0					210.0	3.4		104988.3	1699.8		<5/<5
ETHYLBENZENE	0.0	5.0	1.0					2100	530.0	700.0	1049883.3	264970.6	349961.1	<5/<5
METHYL BROMIDE	0.0	10.0	*					1500.0	47.0		749916.7	23497.4		<10/<10
METHYL CHLORIDE	0.0	10.0	1.0											<10/<10
METHYLENE CHLORIDE	0.0	5.0	1.0					5900.0	46.0		2949672.2	22997.4		<5/<5
1,1,2,2-TETRACHLORO-ETHANE	0.0	5.0	0.5					40.0	1.7		19997.8	849.9		<5/<5
TETRACHLORO-ETHYLENE	0.0	5.0	0.5					33.0	6.9	5.0	16498.2	3449.8	2499.7	<5/<5
TOLUENE	0.0	5.0	1.0					15000	1300.0	1000.0	7499186.7	649927.8	499944.4	<5/<5
1,1,1-TRICHLOROETHANE	0.0	5.0	1.0							200.0			99988.9	<5/<5
1,1,2-TRICHLOROETHANE	0.0	5.0	0.2					160.0	5.9	5.0	79991.1	2949.7	2499.7	<5/<5
TRICHLORETHYLENE	0.0	5.0	1.0					300.0	25.0	5.0	149983.3	12498.6	2499.7	<5/<5
VINYL CHLORIDE	0.0	10.0	2.0					24.0	0.25	2.0	11998.7	125.0	999.9	<10/<10
P-CHLORO-M-CRESOL	0.0	10.0	*											<10/<10
2-CHLOROPHENOL	0.0	10.0	*					150.0	81.0		74991.7	40495.5		<10/<10
2,4-DICHLOROPHENOL	0.0	10.0	*					290.0	77.0		144983.9	38495.7		<10/<10
2,4-DIMETHYLPHENOL	0.0	10.0	*					850.0	380.0		424952.8	189978.9		<10/<10
4,6-DINITRO-O-CRESOL	0.0	10.0	24.0					280.0	13.0		139984.4	6499.3		<20/<20
2,4-DINITROPHENOL	0.0	10.0	42.0					5300.0	69.0		2649705.6	34496.2		<10/<10
2-NITROPHENOL	0.0	10.0	*											<10/<10
4-NITROPHENOL	0.0	10.0	*											<10<10
PENTACHLOROPHENOL	0.0	20.0	5.0	15	19	5882.5	7451.2	30.0	2.7	1.0	14998.3	1349.9	499.9	<20/<20
PHENOL	0.0	20.0	*					1700000	21000.0		849905555.6	10498833.3		<20/<20

Second Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70.500	89.900	90	71	192	50

	1	2	3	5	6	7	8	9	10	11	12	13	14	15
	Stream	Detection Levels		Fish/Aqua. Life		Calculated Effluent		Human Health Water Quality Criteria (30Q5)						Permit Renewal
	Bckgrnd.	Scan	WQC RDL	Water Quality Criteria		Concentration		In-Stream Criteria			Calculated Effluent Concentration			Application (3 Values)
PARAMETER	Conc. [ug/l]	MDL [ug/l]	*EPA MDL [ug/l]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Avg/Max [ug/l]
2,4,6-TRICHLOROPHENOL	0.0	10.0	2.7					24.0	14.0		11998.7	6999.2		<10/<10
ACENAPHTHENE	0.0	10.0	"					990.0	670.0		494945.0	334962.8		<10/<10
ACENAPHTHYLENE	0.0	10.0	2.3											<10/<10
ANTHRACENE	0.0	10.0	0.7					40000	8300.0		19997777.8	4149538.9		<10/<10
BENZIDINE	0.0	50.0	"					0.0020	0.00086		1.000	0.4		<10/<10
BENZO(A)ANTHRACENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BENZO(A)PYRENE	0.0	10.0	0.3					0.18	0.038	0.2	90.0	19.0	100.0	<10/<10
3,4 BENZO-FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BENZO(GHI)PERYLENE	0.0	10.0	"											<10/<10
BENZO(K)FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BIS (2-CHLOROETHOXY) METHANE	0.0	10.0	"											<10/<10
BIS (2-CHLOROETHYL)-ETHER	0.0	10.0	1.0					5.3	0.30		2649.7	150.0		<10/<10
BIS (2-CHLOROISO-PROPYL) ETHER	0.0	10.0	"					65000	1400.0		32496388.9	699922.2		<10/<10
BIS (2-ETHYLHEXYL) PHTHALATE	0.0	10.0	2.5					22.0	12.0	6.0	10998.8	6999.3	2999.7	<10/<10
4-BROMOPHENYL PHENYL ETHER	0.0	10.0	"											<10/<10
BUTYL BENZYL PHTHALATE	0.0	10.0	"					1900.0	1500.0		949894.4	749916.7		<10/<10
2-CHLORONAPHTHALENE	0.0	10.0	"					1600.0	1000.0		799911.1	499944.4		<10/<10
4-CHLORPHENYL PHENYL ETHER	0.0	10.0	"											<10/<10
CHRYSENE	0.0	10.0	2.5					0.18	0.038		90.0	19.0		<10/<10
DI-N-BUTYL PHTHALATE	0.0	10.0	2.5					4500.0	2000.0		2249750.0	999888.9		<10/<10
DI-N-OCTYL PHTHALATE	0.0	10.0	"											<10/<10
DIBENZO(A,H) ANTHRACENE	0.0	10.0	"					0.18	0.038		90.0	19.0		<10/<10
1,2-DICHLOROBENZENE	0.0	5.0	2.0					1300.0	420.0	600	649927.8	209976.7	299966.7	<5/<5
1,3-DICHLOROBENZENE	0.0	5.0	2.0					960.0	320.0		479946.7	159982.2		<5/<5
1,4-DICHLOROBENZENE	0.0	5.0	2.0					190.0	63.0	75	94989.4	31498.5	37495.8	<5/<5
3,3-DICHLOROBENZIDINE	0.0	10.0	"					0.28	0.21		140.0	105.0		<10/<10
DIETHYL PHTHALATE	0.0	10.0	1.9					44000	17000.0		21997555.6	8499055.6		<10/<10
DIMETHYL PHTHALATE	0.0	10.0	1.6					1100000	270000.0		549938888.9	134985000.0		<10/<10
2,4-DINITROTOLUENE	0.0	10.0	1.0					34.0	1.1		16998.1	549.9		<10/<10
2,6-DINITROTOLUENE	0.0	10.0	"											<10/<10
1,2 DIPHENYLHYDRAZINE	0.0	10.0	"					2.0	0.36		999.9	180.0		<10/<10
FLUORANTHENE	0.0	10.0	2.2					140.0	130.0		69992.2	64992.8		<10/<10
FLUORENE	0.0	10.0	0.3					5300.0	1100.0		2649705.6	549938.9		<10/<10
HEXACHLOROBENZENE	0.0	10.0	1.9					0.0029	0.0028	1.0	1.450	1.4	499.9	<10/<10
HEXACHLOROBUTADIENE	0.0	10.0	5.0					180.0	4.4		89990.0	2199.8		<10/<10
HEXACHLOROCYCLO-PENTADIENE	0.0	50.0	"					1100.0	40.0	50.0	549938.9	19997.8	24997.2	<50/<50
HEXACHLOROETHANE	0.0	10.0	0.5					33.0	14.0		16498.2	6999.2		<10/<10
INDENO(1,2,3-CD)PYRENE	0.0	10.0	"					0.18	0.038		90.0	19.0		<10/<10
ISOPHORONE	0.0	10.0	"					9600	350.0		4799468.7	174980.6		<10/<10
NAPHTHALENE	0.0	10.0	"											<10/<10
NITROBENZENE	0.0	10.0	10.0					690.0	17.0		344961.7	8499.1		<10/<10
N-NITROSODI-N-PROPYLAMINE	0.0	10.0	"					5.1	0.050		2549.7	25.0		<10/<10
N-NITROSODI-METHYLAMINE	0.0	10.0	"					30.0	0.0069		14998.3	3.4		<10/<10
N-NITROSODI-PHENYLAMINE	0.0	10.0	"					60.0	33.0		29996.7	16498.2		<10/<10
PHENANTHRENE	0.0	10.0	0.7											<10/<10
PYRENE	0.0	10.0	0.3					4000.0	830.0		1999777.8	414953.9		<10/<10
1,2,4-TRICHLOROBENZENE	0.0	10.0	"					70.0	35.0	70.0	34996.1	17498.1	34996.1	<10/<10

a. Columns 7-8, and 12-14 are the effluent concentrations allowable to prevent exceedence of water quality criteria.
b. Potential to exceed criteria exists if the measured quantity in column 15 exceeds, or could exceed, the calculated allowable concentrations in columns 7-8, and 12-14.
c. Additional testing is required if the detection level used in the scan is higher than the state RDL and/or the MDL of the approved EPA scan method and industry is known to have that pollutant.
d. All background concentrations for these volatile organic, acid-extractable, and base-neutral compounds are assumed zero in the absence of supporting monitoring data.
e. Other metals for which data were provided on the application are evaluated on the Metals & Toxics spreadsheet.
f. Reasonable potential not demonstrated. In some cases, the MDLs are not sufficient to identify potential water quality problems.

WATER QUALITY BASED CALCULATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT #: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Stream Allocation [%]
70.500	89.900	90	71	192	50

EFFLUENT CHARACTERISTIC	1 Stream Bckgmd. Conc. [ug/l]	2 Fish/Aqua. Life Water Quality Criteria Chronic [ug/l]	3 Acute [ug/l]	4 Effluent Fraction Dissolved [Fraction]	5 Fish & Aquatic Life Water Quality Criteria (7Q10) In-Stream Allowable Chronic [ug/l]	6 Acute [ug/l]	7 Calc. Effluent Concentration Chronic [ug/l]	8 Acute [ug/l]	Permit Renewal Application Avg/Max [ug/l]
Cadmium *	0.193	0.387	3.795	0.304	1.273	12.492	**423.6**	**4823.3**	<0.5/<0.5
Copper *	5.500	15.638	24.848	0.244	64.153	101.937	**23004.7**	**37822.3**	7.07/10.1
Lead *	2.500	5.080	130.362	0.132	38.444	986.532	**14097.2**	**385905.9**	<2.0/<2.0
Nickel *	5.000	90.309	813.088	0.248	364.751	3283.999	**141084.8**	**1285916.8**	21.5/27.3
Silver *	4.939	NA	9.879	1.000	NA	9.879	**N/A**	**1939.6**	<1.0/<1.0
Zinc *	18.000	205.321	203.656	0.185	1112.488	1103.462	**429230.8**	**425691.0**	15.8/18.2
Mercury, (T) **	0.006	0.770	1.400	1.000	0.770	1.400	**299.62**	**546.7**	<0.2/<0.2
Chromium III	63.226	126.452	972.116	0.181	698.081	5366.573	**249000.5**	**2079827.4**	(a)
Chromium VI	5.500	11.000	16.000	1.000	11.000	16.000	**2159.7**	**4120.5**	(a)
Cyanide ***	2.600	5.200	22.000	1.000	5.200	22.000	**1020.9**	**7609.3**	<10/<10

EFFLUENT CHARACTERISTIC	9 Human Health Water Quality Criteria (30Q5) In-Stream Criteria Organisms [ug/l]	10 Water/Organisms [ug/l]	11 DWS [ug/l]	12 Calculated Effluent Concentration Organisms [ug/l]	13 Water/Organisms [ug/l]	14 DWS [ug/l]	Permit Renewal Application Avg/Max [ug/l]
Cadmium *	NA	NA	5.0	**NA**	**NA**	**2403.1**	<0.5/<0.5
Copper *	NA	N/A	**NA**	**NA**	**NA**	**NA**	7.07/10.1
Lead *	NA	NA	5.0	**NA**	**NA**	**1251.1**	<2.0/<2.0
Nickel *	4600.0	610.0	100.0	**2297247.2**	**302468.9**	**47497.2**	21.5/27.3
Silver *	NA	NA	**NA**	**NA**	**NA**	**NA**	<1.0/<1.0
Zinc *	NA	NA	NA	**NA**	**NA**	**NA**	15.8/18.2
Mercury, (T) **	0.051	0.05	2.0	**22.5**	**22.0**	**996.9**	<0.2/<0.2
Chromium III	NA	NA	100.0	**NA**	**NA**	**18416.5**	(a)
Chromium VI	NA	NA	100.0	**NA**	**NA**	**47247.5**	(a)
Cyanide ***	140.0	140.0	200.0	**68693.7**	**68693.7**	**98690.3**	<10/<10

(a) Total chromium, avg/max = 3.03/4.04

* Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.The Fish & Aquatic Life criteria for this metal are in the dissolved form at laboratory conditions. The in-stream allowable criteria and calculated effluent concentrations are in the total recoverable form.

** The chronic criterion for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity.

*** The criteria for this parameter are in the total recoverable form.

NOTE: Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow.

Appendix R-7
New NPDES Permit Limitations and Monitoring Requirements

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
BDD_5	42	31,525	85	63	47,288	84		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	48	36,029	85	72	54,043	96		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Organic-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a)	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits within 36 months from the permit's effective date.

(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
Drganic Pesticide Chemicals (b)	Report					Report			Annually	grab	effluent
Total Dioxin	0.000000001					0.000000001			Annually	composite	effluent
Heptachlor Epoxide	0.00019					0.00019			Annually	grab	effluent
Total Polychlorinated Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	grab	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Methyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexachlorobenzene	Report					Report			Annually	grab	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report								Annually	grab	effluent
Outfall Observation, Visual (e)	Report								Daily	visual	(d)
Flow (MGD)	Report			Report		Report			Daily	continuous	influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewer Overflows, Total Occurrences (f)	Report								continuous	visual	NA
Dry Weather Dverflows, Total Occurrences (f)	Report								continuous	visual	NA
Bypass of Treatment, Total Dccurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I, endosulfan II; endrin; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; PCBs, total; technical chlordane; and toxaphene).

(d) Per Section 3.4.

(e) Permittee shall provide in the DMR comments section or as an attachment a listing of its visual observations including distinctly visible matter and/or objectionable instream color.

(f) Permittee shall provide with its DMRs a listing of sewage overflows that flowed into buildings.

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243

NOV 30 2011

Mr. Dwan L. Gilliom
Director
City of Memphis, Division of Public Works
125 North Main Street
Room 608
Memphis, TN 38103

Subject: **NPDES Permit No. TN0020711**
Memphis-Maynard C. Stiles STP North Plant
Memphis, Shelby County, Tennessee

Dear Mr. Gilliom:

In accordance with the provisions of the Tennessee Water Quality Control Act, Tennessee Code Annotated (T.C.A.), Sections 69-3-101 through 69-3-120, the Division of Water Pollution Control hereby issues the enclosed NPDES Permit. The continuance and/or reissuance of this NPDES Permit is contingent upon your meeting the conditions and requirements as stated therein.

Please be advised that a petition for permit appeal may be filed, pursuant to T.C.A. Section 69-3-105, subsection (i), by the permit applicant or by any aggrieved person who participated in the public comment period or gave testimony at a formal public hearing whose appeal is based upon any of the issues that were provided to the commissioner in writing during the public comment period or in testimony at a formal public hearing on the permit application. Additionally, for those permits for which the department gives public notice of a draft permit, any permit applicant or aggrieved person may base a permit appeal on any material change to conditions in the final permit from those in the draft, unless the material change has been subject to additional opportunity for public comment. Any petition for permit appeal under this subsection (i) shall be filed with the board within thirty (30) days after public notice of the commissioner's decision to issue or deny the permit.

If you have questions, please contact the Memphis Environmental Field Office at 1-888-891-TDEC; or, at this office, please contact Mr. Gary Davis at (615) 532-0649 or by E-mail at *Gary.Davis@tn.gov*.

[redacted]
Vojin Janjic
Manager, Permit Section
Division of Water Pollution Control

P/WAT-3
Enclosure

cc: Permit Section File
Memphis Environmental Field Office (Eddy.Bouzeid@tn.gov)
Ms. Connie A. Kagey, NPDES Permit Section, EPA Region IV, Kagey.Connie@epamail.epa.gov
Mr. J. Andrew Goddard, Attorney at Law, Bass, Barry and Sims, PLC, DGoddard@bassberry.com
Mr. Gary B. Cohen, Special Counsel for Memphis, Hall & Associates, gcohen@hall-associates.com
Mr. James H. Baker, Chickasaw Group-TN Chapter Vice-Chair and TN Water Sentinels Project Leader, Tennessee Chapter-Sierra Club-Chickasaw Group, tn_water_sentinel@yahoo.com

STATE OF TENNESSEE

NPDES PERMIT

No. TN0020711

Authorization to discharge under the
National Pollutant Discharge Elimination System (NPDES)

Issued By

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
401 Church Street
6th Floor, L & C Annex
Nashville, Tennessee 37243-1534

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger:	**Memphis - Maynard C. Stiles STP**
is authorized to discharge:	**treated municipal wastewater from Outfall 001**
from a facility located:	**in Memphis, Shelby County, Tennessee**
to receiving waters named:	**Mississippi River at mile 738.8**

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on:	**January 1, 2012**
This permit shall expire on:	**December 31, 2016**
Issuance date:	**November 30, 2011**

[redacted]

Paul E. Davis, Director
Division of Water Pollution Control

CN-0759

RDAs 2352 and 2366

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GMDa
TN0020711PMT.DOC

1 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1.1 EFFLUENT LIMITATIONS

The permittee is authorized to discharge its M.C. Stiles STP treated wastewater from Outfall 001 to the Mississippi River at Mile 738.8 pursuant to the permit limitations and monitoring requirements specified in this section. The M.C. Stiles STP has a design capacity of 135 MGD.

Maynard C. Stiles STP (TN0020711) - Outfall 001 Discharge Effluent Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement	Sample	Sample
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)	Frequency	Type	Point
BOD_5	43.1	Report	65	64.7	Report	66.1		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	52	Report	85	78	Report	104		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a) - during compliance schedule	Report					Report			Daily	grab	effluent
E. coli, cfu/100 ml (a) - following compliance schedule	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits following the compliance schedule presented in section 3.8 of this permit.
(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

Maynard C. Stiles STP (TN0020711) - Outfall 001 Discharge Effluent Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement	Sample	Sample
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)	Frequency	Type	Point
Organic Pesticide Chemicals (c)	Report					Report			Annually	composite	effluent
Total Dioxin	0.000000001					0.000000001			Annually	grab	effluent
Total Polychlorinated Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	composite	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Methyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexachlorobenzene	Report					Report			Annually	grab	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report (Survival for serial effluent dilutions)								Annually	grab	effluent
Outfall Observation, Visual (e)									Daily	visual	effluent
Flow (MGD)	Report			Report		Report			Daily	continuous	Influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewer Overflows, Total Occurrences	Report								continuous	visual	NA
Dry Weather Overflows, Total Occurrences	Report								continuous	visual	NA
Sewer Backups in Buildings, Total Occurrences	Report								continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I, endosulfan II; endrin; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; P total chlordane; toxaphene; DDT; and dieldrin).

(d) Per Section 3.4.

(e) Permittee shall complete its visual observations pursuant to Section 3.5 of this permit

Total residual chlorine (TRC) and oxidants (TRO) monitoring shall be applicable when chlorine, bromine, or any other oxidants are added. The acceptable methods for analysis of TRC are any methods specified in Title 40 CFR, Part 136, as amended.

The permittee may collect more Outfall 001 discharge samples than specified as the monitoring frequency. *E. coli* samples may not be collected at intervals of less than 12 hours. For the purpose of determining the geometric mean, individual samples having an *E. coli* group concentration of less than one (1) cfu per 100 ml shall be considered as having a concentration of one (1) cfu per 100 ml.

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must not cause an objectionable color contrast in the receiving stream.

The wastewater discharge shall not contain pollutants in quantities that will be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner that prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq.

For the purpose of evaluating compliance with the permit limits established herein, where certain limits are below the state of Tennessee published required detection levels (RDLs) for any given effluent characteristics, the results of analyses below the RDL shall be reported as Below Detection Level (BDL), unless in specific cases other detection limits are demonstrated to be the best achievable because of the particular nature of the wastewater being analyzed. The BDL value shall be reported in the DMR "Comments" section.

For BOD_5 and TSS, the treatment facility shall demonstrate a minimum of 85% removal efficiency on a monthly average basis. This is calculated by determining an average of all daily influent concentrations and comparing this to an average of all daily effluent concentrations. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{average of daily effluent concentrations}}{\text{average of daily influent concentrations}} \right] \right] \times 100\% = \%\ \text{removal}$$

The treatment facility will also demonstrate 40% minimum removal of the BOD_5 and TSS based upon each daily composite sample. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{daily effluent concentrations}}{\text{daily influent concentrations}} \right] \right] \times 100\% = \%\ \text{removal}$$

1.2 MONITORING PROCEDURES

1.2.1 Representative Sampling

Appropriate flow measurement devices and/or division-approved methods consistent with accepted scientific practices shall be used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with accepted capability of that type of device. Devices and methods used shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes.

Samples and measurements taken in compliance with the monitoring requirements specified above shall be representative of the volume and nature of the monitored discharge, and shall be taken at the following location(s):

Influent samples must be collected prior to mixing with any other wastewater being returned to the head of the plant, such as return sludge. Those systems with more than one influent line must collect samples from each and proportion the results by the flow from each line. However, as long as the sludge lagoon supernatant is discharged into interceptors ahead of the STP, the influent samples may be collected after the sludge lagoon supernatant return. The permittee must submit an Influent Flow Assessment Report to the division, which relates the quality and quantity of the supernatant stream within sixty (60) days of permit effective date. Otherwise, the influent samples must be collected ahead of the influent's mixing with any other wastestreams being returned to the head of the plant. Additionally, systems with more than one influent line must collect samples from each and proportion the results by the flow from each line.

Effluent samples must be representative of the wastewater being discharged and collected prior to mixing with any other discharge or the receiving stream. This can be a different point for different parameters, but must be after all treatment for that parameter or all expected change:

a. If chlorination is used for disinfection, final effluent BOD_5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD_5 testing procedures approved by the division for its treated effluent analyses.

b. The chlorine residual must be measured after the chlorine contact chamber and any dechlorination. It may be to the advantage of the permittee to measure at the end of any long outfall lines.

c. Samples for *E. coli* can be collected at any point between disinfection and the actual discharge.

d. The dissolved oxygen can drop in the outfall line; therefore, D.O. measurements are required at the discharge end of outfall lines greater than one mile long. Systems with outfall lines less than one mile may measure dissolved oxygen as the wastewater leaves the treatment facility. For systems with dechlorination, dissolved oxygen must be measured after this step and as close to the end of the outfall line as possible.

e. Total suspended solids and settleable solids can be collected at any point after the final clarifier.

f. Biomonitoring tests shall be conducted on final effluent.

1.2.2 Sampling Frequency

Where the permit requires sampling and monitoring of a particular effluent characteristic(s) at a frequency of less than once per day or daily, the permittee is precluded from marking the "No Discharge" block on the Discharge Monitoring Report if there has been any discharge from that particular outfall during the period which coincides with the required monitoring frequency; i.e. if the required monitoring frequency is once per month or 1/month, the monitoring period is one month, and if the discharge occurs during only one day in that period then the permittee must sample on that day and report the results of analyses accordingly.

1.2.3 Test Procedures

a. Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304 (h) of the Clean Water Act (the "Act"), as amended, under which such procedures may be required. The treated effluent total mercury shall be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630. For monitoring PBCs the permittee shall use EPA Method 1668B.

b. Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40 CFR Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act, using sufficiently sensitive testing to demonstrate permit compliance, and/or best achievable methods for permit reporting requirements. The permittee shall obtain written division approval for using analytical procedures not provided in Title 40 CFR Part 136 for permit compliance.

c. Composite samples must be proportioned by flow at time of sampling. Aliquots may be collected manually or automatically. The sample aliquots must be maintained at less than or equal to 6 degrees Celsius during the compositing period.

1.2.4 Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date and time of sampling;

b. The exact person(s) collecting samples;

c. The dates and times the analyses were performed;

d. The person(s) or laboratory who performed the analyses;

e. The analytical techniques or methods used, and;

f. The results of all required analyses.

1.2.5 Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation shall be retained for a minimum of three (3) years, or longer, if requested by the Division of Water Pollution Control.

1.3 REPORTING

1.3.1 Monitoring Results

Monitoring results shall be recorded monthly and submitted monthly using Discharge Monitoring Report (DMR) forms or an electronic program supplied by the Division of Water Pollution Control. Submittals shall be postmarked or sent electronically no later than 15 days after the completion of the reporting period. The top two copies of each report are to be submitted. A copy should be retained for the permittee's files. DMRs and any communication regarding compliance with the conditions of this permit must be sent to:

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
COMPLIANCE REVIEW SECTION
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243-1534

The first DMR is due on the 15th of the month following permit effectiveness.

DMRs and any other report or information submitted to the division must be signed and certified by a responsible corporate officer as defined in 40 CFR 122.22, a general partner or proprietor, or a principal municipal executive officer or ranking

elected official, or his duly authorized representative. Such authorization must be submitted in writing and must explain the duties and responsibilities of the authorized representative.

The electronic submission of DMRs will be accepted only if approved in writing by the division. For purposes of determining compliance with this permit, data submitted in electronic format is legally equivalent to data submitted on signed and certified DMR forms.

1.3.2 Additional Monitoring by Permittee

If the permittee monitors any pollutant specifically limited by this permit more frequently than required at the location(s) designated, using approved analytical methods as specified herein, the results of such monitoring shall be included in the calculation and reporting of the values required in the DMR form. Such increased frequency shall also be indicated on the form.

1.3.3 Falsifying Results and/or Reports

Knowingly making any false statement on any report required by this permit or falsifying any result may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Water Pollution Control Act, as amended, and in Section 69-3-115 of the Tennessee Water Quality Control Act.

1.3.4 Monthly Report of Operation

Monthly operational reports shall be submitted on standard forms to the appropriate Division of Water Pollution Control Environmental Field Office in Jackson, Nashville, Chattanooga, Columbia, Cookeville, Memphis, Johnson City, or Knoxville. Reports shall be submitted by the 15th day of the month following data collection.

1.3.5 Bypass and Overflow Reporting

1.3.5.1 Report Requirements

A summary report of known or suspected instances of overflows in the collection system or bypass of wastewater treatment facilities shall accompany the Discharge Monitoring Report. The report must contain the date and duration of the instances of overflow and/or bypassing and the estimated quantity of wastewater released and/or bypassed. The report must separately list which overflows flowed into buildings.

The report must also detail activities undertaken during the reporting period to (1) determine if overflow is occurring in the collection system, (2) correct those known or suspected overflow points and (3) prevent future or possible overflows and any resulting bypassing at the treatment facility.

On the DMR, the permittee must report the number of sanitary sewer overflows, dry-weather overflows and in-plant bypasses separately. Three lines must be used on

the DMR form, one for sanitary sewer overflows, one for dry-weather overflows and one for in-plant bypasses.

1.3.5.2 Anticipated Bypass Notification

If, because of unavoidable maintenance or construction activities, the permittee has a need to create an in-plant bypass which would cause an effluent violation, the permittee must notify the division as soon as possible (the division requires 10 days prior to bypass notification, unless it is not possible e.g., pipe break, in which case, as soon as possible notification is warranted).

1.3.6 Reporting Less Than Detection

A permit limit may be less than the accepted detection level. If the samples are below the detection level, then report "BDL" or "NODI =B" on the DMRs. The permittee must use the correct detection levels in all analytical testing required in the permit. The required detection levels are listed in the Rules of the Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3-.05(8).

For example, if the limit is 0.02 mg/l with a detection level of 0.05 mg/l and detection is shown; 0.05 mg/l must be reported. In contrast, if nothing is detected reporting "BDL" or "NODI =B" is acceptable.

1.4 COMPLIANCE WITH SECTION 208

The limits and conditions in this permit shall require compliance with an area-wide waste treatment plan (208 Water Quality Management Plan) where such approved plan is applicable.

1.5 REOPENER CLAUSE

This permit shall be modified, or alternatively revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b)(2)(C) and (D), 307(a)(2) and 405(d)(2)(D) of the Clean Water Act, as amended, if the effluent standard, limitation or sludge disposal requirement so issued or approved:

a. Contains different conditions or is otherwise more stringent than any condition in the permit; or

b. Controls any pollutant or disposal method not addressed in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

The division may modify this permit to incorporate appropriate changes based on Outfall 001 treated effluent ammonia-nitrogen, chlorinated byproducts, total residual chlorine, total residual oxidants (TRO), acute biomonitoring results and color

investigation results. The permit may also be reopened if the total mercury results appear much lower than expected in comparison with the methyl mercury grab data. If so, the division may require the permittee to determine the total mercury based on grab samples. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. Pursuant to the permittee's request/justification the division may modify the permit if appropriate to limit the TRO to halogenated oxidants only.

All permit modifications shall be subject to applicable public participation requirements.

2 GENERAL PERMIT REQUIREMENTS

2.1 GENERAL PROVISIONS

2.1.1 Duty to Reapply

Permittee is not authorized to discharge after the expiration date of this permit. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information and forms as are required to the Director of Water Pollution Control (the "director") no later than 180 days prior to the expiration date. Such forms shall be properly signed and certified.

2.1.2 Right of Entry

The permittee shall allow the director, the Regional Administrator of the U.S. Environmental Protection Agency, or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or where records are required to be kept under the terms and conditions of this permit, and at reasonable times to copy these records;

b. To inspect at reasonable times any monitoring equipment or method or any collection, treatment, pollution management, or discharge facilities required under this permit; and

c. To sample at reasonable times any discharge of pollutants.

2.1.3 Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, as amended, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the

Division of Water Pollution Control. As required by the Federal Act, effluent data shall not be considered confidential.

2.1.4 Proper Operation and Maintenance

a. The permittee shall at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory and process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems, which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. Backup continuous pH and flow monitoring equipment are not required.

b. Dilution water shall not be added to comply with effluent requirements to achieve BCT, BPT, BAT and or other technology based effluent limitations such as those in State of Tennessee Rule 1200-4-5-.09.

2.1.5 Treatment Facility Failure (Industrial Sources)

The permittee, in order to maintain compliance with this permit, shall control production, all discharges, or both, upon reduction, loss, or failure of the treatment facility, until the facility is restored or an alternative method of treatment is provided. This requirement applies in such situations as the reduction, loss, or failure of the primary source of power.

2.1.6 Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations.

2.1.7 Severability

The provisions of this permit are severable. If any provision of this permit due to any circumstance, is held invalid, then the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

2.1.8 Other Information

If the permittee becomes aware of failure to submit any relevant facts in a permit application, or of submission of incorrect information in a permit application or in any report to the director, then the permittee shall promptly submit such facts or information.

2.2 CHANGES AFFECTING THE PERMIT

2.2.1 Planned Changes

The permittee shall give notice to the director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants, which are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1).

2.2.2 Permit Modification, Revocation, or Termination

a. This permit may be modified, revoked and reissued, or terminated for cause as described in 40 CFR 122.62 and 122.64, Federal Register, Volume 49, No. 188 (Wednesday, September 26, 1984), as amended.

b. The permittee shall furnish to the director, within a reasonable time, any information which the director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the director, upon request, copies of records required to be kept by this permit.

c. If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established for any toxic pollutant under Section 307(a) of the Federal Water Pollution Control Act, as amended, the director shall modify or revoke and reissue the permit to conform to the prohibition or to the effluent standard, providing that the effluent standard is more stringent than the limitation in the permit on the toxic pollutant. The permittee shall comply with these effluent standards or prohibitions within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified or revoked and reissued to incorporate the requirement.

d. The filing of a request by the permittee for a modification, revocation, reissuance, termination, or notification of planned changes or anticipated noncompliance does not halt any permit condition.

2.2.3 Change of Ownership

This permit may be transferred to another party (provided there are neither modifications to the facility or its operations, nor any other changes which might affect the permit limits and conditions contained in the permit) by the permittee if:

a. The permittee notifies the director of the proposed transfer at least 30 days in advance of the proposed transfer date;

b. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and liability between them; and

c. The director, within 30 days, does not notify the current permittee and the new permittee of his intent to modify, revoke or reissue, or terminate the permit and to require that a new application be filed rather than agreeing to the transfer of the permit.

Pursuant to the requirements of 40 CFR 122.61, concerning transfer of ownership, the permittee must provide the following information to the division in their formal notice of intent to transfer ownership: 1) the NPDES permit number of the subject permit; 2) the effective date of the proposed transfer; 3) the name and address of the transferor; 4) the name and address of the transferee; 5) the names of the responsible parties for both the transferor and transferee; 6) a statement that the transferee assumes responsibility for the subject NPDES permit; 7) a statement that the transferor relinquishes responsibility for the subject NPDES permit; 8) the signatures of the responsible parties for both the transferor and transferee pursuant to the requirements of 40 CFR 122.22(a), "Signatories to permit applications"; and, 9) a statement regarding any proposed modifications to the facility, its operations, or any other changes which might affect the permit limits and conditions contained in the permit.

2.2.4 Change of Mailing Address

The permittee shall promptly provide to the director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

2.3 NONCOMPLIANCE

2.3.1 Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable state and federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

2.3.2 Reporting of Noncompliance

a. 24-Hour Reporting

In the case of any noncompliance which could cause a threat to public drinking water supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Pollution Control in the appropriate

Environmental Field Office within 24-hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response team).

A written submission must be provided within five days of the time the permittee becomes aware of the circumstances unless the director on a case-by-case basis waives this requirement. The permittee shall provide the director with the following information:

i. A description of the discharge and cause of noncompliance;

ii. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and

iii. The steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph 2.3.2.a above, the permittee shall report the noncompliance on the Discharge Monitoring Report. The report shall contain all information concerning the steps taken, or planned, to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

2.3.3 Overflow

a. "**Overflow**" means any discharge of sewage from any portion of the collection, transmission, or treatment system other than through permitted outfalls.

b. Overflows are prohibited.

c. The permittee shall operate the collection system so as to avoid overflows. No new or additional flows shall be added upstream of any point in the collection system, which experiences chronic overflows (greater than 5 events per year) or would otherwise overload any portion of the system.

d. Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after: 1) an authorized representative of the Commissioner of the Department of Environment and Conservation has approved an engineering report and construction plans and specifications prepared in accordance with accepted engineering practices for correction of the problem; 2) the correction work is underway; and 3) the cumulative, peak-design, flows potentially added from new connections and line extensions upstream of any chronic overflow point are less than or proportional to the amount of inflow and infiltration removal documented upstream of that point. The inflow and infiltration reduction must be measured by the permittee using practices that are customary in the environmental engineering field and reported in an attachment to a Monthly Operating Report submitted to the local

TDEC Environmental Field Office. The data measurement period shall be sufficient to account for seasonal rainfall patterns and seasonal groundwater table elevations.

e. In the event that more than 5 overflows have occurred from a single point in the collection system for reasons that may not warrant the self-imposed moratorium or completion of the actions identified in this paragraph, the permittee may request a meeting with the Division of Water Pollution Control EFO staff to petition for a waiver based on mitigating evidence.

2.3.4 Upset

a. "***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. An upset shall constitute an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the permittee demonstrates, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   i. An upset occurred and that the permittee can identify the cause(s) of the upset;

   ii. The permitted facility was at the time being operated in a prudent and workman-like manner and in compliance with proper operation and maintenance procedures;

   iii. The permittee submitted information required under "Reporting of Noncompliance" within 24-hours of becoming aware of the upset (if this information is provided orally, a written submission must be provided within five days); and

   iv. The permittee complied with any remedial measures required under "Adverse Impact."

2.3.5 Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2.3.6 Bypass

a. "***Bypass***" is the intentional diversion of wastewater away from any portion of a treatment facility. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypasses are prohibited and the division may take enforcement action, unless all of the following 3 conditions are met:

   i. The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

   ii. There are no feasible alternatives to bypass, such as the construction and use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass, which occurred during normal periods of equipment downtime or preventative maintenance;

   iii. The permittee submits notice of an unanticipated bypass to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours of becoming aware of the bypass (if this information is provided orally, a written submission must be provided within five days). When the need for the bypass is foreseeable, prior notification shall be submitted to the director, if possible, at least 10 days before the date of the bypass.

c. Bypasses not exceeding permit limitations are allowed **only** if the bypass is necessary for essential maintenance to assure efficient operation. All other bypasses are subject to the prohibition in subsection (b) above. Allowable bypasses not exceeding limitations are not subject to the reporting requirements of 2.3.6.b.iii, above.

2.3.7 Washout

a. For domestic wastewater plants only, a "washout" shall be defined as loss of Mixed Liquor Suspended Solids (MLSS) of 30.00% or more. This refers to the MLSS in the aeration basin(s) only. This does not include MLSS decrease due to solids wasting to the sludge disposal system. A washout can be caused by improper operation or from peak flows due to infiltration and inflow.

b. A washout is prohibited. If a washout occurs the permittee must report the incident to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours by telephone. A written submission must be provided within five days. The washout must be noted on the discharge monitoring report. Each day of a washout is a separate violation.

2.4 LIABILITIES

2.4.1 Civil and Criminal Liability

Except as provided in permit conditions for "***Bypassing***," "***Overflow,***" and "***Upset***," nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

2.4.2 Liability Under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or the Federal Water Pollution Control Act, as amended.

3 PERMIT SPECIFIC REQUIREMENTS

3.1 CERTIFIED OPERATOR

The waste treatment facilities shall be operated under the supervision of a certified wastewater treatment operator and the collection system shall be operated under the supervision of a certified collection system operator in accordance with the Water Environmental Health Act of 1984.

3.2 POTW PRETREATMENT PROGRAM

As an update of information previously submitted to the division, the permittee will undertake the following activity.

a. The permittee has been delegated the primary responsibility and therefore becomes the "control authority" for enforcing the 40 CFR 403 General Pretreatment Regulations. Where multiple plants are concerned the permittee is responsible for the Pretreatment Program for all plants within its jurisdiction. The permittee shall implement and enforce the Industrial Pretreatment Program in accordance with Section 403(b)(8) of the Clean Water Act, the Federal Pretreatment Regulations 40 CFR 403, Tennessee Water Quality Control Act Part 63-3-123 through 63-3-128, and the legal authorities, policies, procedures, and financial provisions contained in its approved Pretreatment Program, except to the extent this permit imposed stricter requirements. Such implementation shall require but not limit the permittee to do the following:

i. Carry out inspection, surveillance, and monitoring procedures, which will determine, independent of information supplied by the industrial user (IU), whether the IU is in compliance with the pretreatment standards;

ii. Require development, as necessary, of compliance schedules for each IU for the installation of control technologies to meet applicable pretreatment standards;

iii. Require all industrial users to comply with all applicable monitoring and reporting requirements outlined in the approved pretreatment program and IU permit;

iv. Maintain and update, as necessary, records identifying the nature and character of industrial user discharges, and retain such records for a minimum of three (3) years;

v. Obtain appropriate remedies for noncompliance by an IU with any pretreatment standard and/or requirement;

vi. Publish annually, pursuant to 40 CFR 403.8 (f)(2)(viii), a list of industrial users that have significantly violated pretreatment requirements and standards during the previous twelve-month period.

vii. Maintain an adequate revenue structure for continued operation of the pretreatment program.

viii. Update its Industrial Waste Survey at least once every five years. Results of this update shall be submitted to the Division of Water Pollution Control, Pretreatment Section within 120 days of the effective date of this permit.

ix. Submit a written technical evaluation of the need to revise local limits within 120 days of the effective date of this permit to the state pretreatment program coordinator. The evaluation should consider the most recent pass-through limits proposed by the division. The technical evaluation shall be based on practical and specialized knowledge of the local program and not be limited by a specified written format.

b. The permittee shall enforce 40 CFR 403.5, "prohibited discharges". Pollutants introduced into the POTW by a non-domestic source shall not cause pass through or interference as defined in 40 CFR Part 403.3. These general prohibitions and the specific prohibitions in this section apply to all non-domestic sources introducing pollutants into the POTW whether the source is subject to other National Pretreatment Standards or any state or local pretreatment requirements.

Specific prohibitions. Under no circumstances shall the permittee allow introduction of the following wastes in the waste treatment system:

i. Pollutants which create a fire or explosion hazard in the POTW;

ii. Pollutants which will cause corrosive structural damage to the treatment works, but in no case discharges with pH less than 5.0 unless the system is specifically designed to accept such discharges.

iii. Solid or viscous pollutants in amounts which will cause obstruction to the flow in the treatment system resulting in interference.

iv. Any pollutant, including oxygen-demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the treatment works.

v. Heat in amounts which will inhibit biological activity in the treatment works resulting in interference, but in no case heat in such quantities that the temperature at the treatment works exceeds 40°C (104°F) unless the works are designed to accommodate such heat.

vi. Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal.

vii. Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through;

viii. Pollutants which result in the presence of toxic gases, vapors or fumes within the POTW in a quantity that may cause worker health and safety problems;

ix. Any trucked or hauled pollutants except at discharge points designated by the POTW.

c. The permittee shall notify the Tennessee Division of Water Pollution Control of any of the following changes in user discharge to the system no later than 30 days prior to change of discharge:

i. New introductions into such works of pollutants from any source which would be a new source as defined in Section 306 of the Act if such source were discharging pollutants.

ii. New introductions of pollutants into such works from a source which would be subject to Section 301 of the "Federal Water Quality Act as Amended" if it were discharging such pollutants.

iii. A substantial change in volume or character of pollutants being introduced into such works by a source already discharging pollutants into such works at the time the permit is issued.

This notice will include information on the quantity and quality of the wastewater introduced by the new source into the publicly owned treatment works, and on any anticipated impact on the effluent discharged from such works. If this discharge necessitates a revision of the current NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization.

d. Reporting Requirements

The permittee shall provide an annual report briefly describing the permittee's pretreatment program activities over the previous calendar year. The report shall be submitted to the Division of Water Pollution Control, Central Office and a copy to the appropriate Environmental Field Office no later than the 50 days after the end of the reporting period. For control authorities with multiple STPs, one report should be submitted with a separate Form 1 for each STP. Each report shall conform to the format set forth in the state's POTW Pretreatment Semiannual Report Package which contains information regarding (note that the permittee is required to complete and submit an "Annual" rather than a "Semiannual" report):

i. An updated listing of the permittee's industrial users (including information required pursuant to 403.12(i)(1) (e.g., deletions and additions, categorical standards applied, local standards more stringent than categorical standards, and standards applied to each industrial user).

ii. Results of sampling of the influent and effluent of the wastewater treatment plant. At least semiannually during each calendar year, the permittee shall analyze the wastewater treatment plant influent and effluent for the following pollutants, using the prescribed sampling procedures:

Pollutant	**Sample Type**
chromium, trivalent	24-hour composite
chromium, hexavalent	24-hour composite
copper	24-hour composite
lead	24-hour composite
nickel	24-hour composite
zinc	24-hour composite
cadmium	24-hour composite
mercury	24-hour composite
silver	24-hour composite
total phenols	grab
cyanide	grab

If any particular pollutant is analyzed more frequently than is required, the permittee shall report the maximum and average values on the semiannual report. All upsets, interferences, and pass-through violations must also be reported on the annual report, the actions that were taken to determine the

causes of the incidents and the steps that have been taken to prevent the incidents from recurring.

At least once during the term of the permit, the permittee shall analyze the effluent from the STP (and report the results in the corresponding annual report) for the following pollutants:

chromium, total	silver	phthalates, sum of the following: bis (2-ethylhexyl) phthalate butyl benzylphthalate di-n-butylphthalate diethyl phthalate
copper	benzene	
lead	carbon tetrachloride	
nickel	chloroform	
zinc	ethylbenzene	
cadmium	methylene chloride	tetrachloroethylene
mercury	naphthalene	toluene
phenols, total	1,1,1 trichloroethane	trichloroethylene
cyanide	1,2 trans-dichloroethylene	chromium, hexavalent
		chromium, trivalent

iii. Compliance with categorical and local standards, and review of industrial compliance, which includes a summary of the compliance status for all permitted industries. Also included is information on the number and type of major violations of pretreatment regulations, and the actions taken by the POTW to obtain compliance. The effluent from all significant industrial users must be analyzed for the appropriate pollutants at least once per reporting period.

iv. A list of industries in significant non-compliance as published in local newspapers in accordance with the requirements set forth in 40 CFR 403.8(f)(2)(viii).

v. A description of all substantive changes made to the permittee's pretreatment program. Any such changes shall receive prior approval. Substantive changes include, but are not limited to, any change in any ordinance, major modification in the program's administrative structure, local limits, or a change in the method of funding the program.

vi. Summary of permittee's industrial user inspections, which includes information on the number and type of industry inspected. All significant industrial users must be inspected at least once per year.

3.3 SLUDGE MANAGEMENT PRACTICES

a. The permittee must comply with 40 CFR 503 et seq. Sludge shall be sampled and analyzed at a frequency dependant both on the amount of sludge generated annually and on the disposal practice utilized. Whenever sampling and analysis are required by 40 CFR 503, the permittee shall report to the division the quantitative data for the following parameters:

1)	Arsenic	7)	Nickel
2)	Cadmium	8)	Selenium
3)	Copper	9)	Zinc
4)	Lead	10)	Nitrite plus Nitrate, NO_2, + NO_3 as N
5)	Mercury	11)	Total Kjeldahl Nitrogen, as N
6)	Molybdenum	12)	Ammonia, NH_3, as N

This sludge analysis must be submitted by February 19th of each calendar year. This information shall be submitted to the Division of Water Pollution Control, Central Office, 401 Church Street, 6th Floor Annex, Nashville TN 37243-1534, Attention: Sludge Coordinator, Municipal Facilities Section.

b. Land application of sludge shall halt immediately if any of the following concentrations are exceeded:

POLLUTANT	CONCENTRATION (mg/kg[1])
Arsenic	75
Cadmium	85
Zinc	7500
Copper	4300
Lead	840

POLLUTANT	CONCENTRATION (mg/kg[1])
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100

1 - Dry Weight Basis

Monthly average pollutant concentrations shall not exceed Table 3 of 40 CFR §503.13. If they are exceeded cumulative pollutant loading rates are to be calculated and recorded and shall not exceed Table 2 of 40 CFR §503.13 for the life of the land application site.

c. If land application is the final disposition of the wasted sludge, the permittee shall provide pathogen reduction, sludge stabilization and comply with land and crop usage controls as listed in 40 CFR Part 503, as authorized by the Clean Water Act. Records must be maintained by the permittee that indicate compliance or non-compliance with this rule. If the permittee is required to report to EPA, copies of all reports should be sent to the division, at the address listed in paragraph 1 of this section.

d. Before land applying municipal sludge the permittee must obtain approvals for each site(s) in writing from the division using the latest revision of Guidelines for Land Application or Surface Disposal of Biosolids, unless the sludge being land applied meets the pollutant concentrations of 40 CFR 503.13(b)(3), the Class A pathogen requirements in 40 CFR 503.32(a), and one of the vector attraction reduction requirements in 40 CFR 503.33 (b)(1) through (b)(8).

e. Reopener: If an applicable "acceptable management practice" or numerical limitation for pollutants in sewage sludge promulgated under Section 405(d)(2) of the Clean Water Act, as amended by the Water Quality Act of 1987, is more

stringent than the sludge pollutant limit or acceptable management practice in this permit, or controls a pollutant not limited in this permit, this permit shall be promptly modified or revoked and reissued to conform to the requirements promulgated under Section 405(d)(2). The permittee shall comply with the limitations by no later than the compliance deadline specified in the applicable regulations as required by Section 405(d)(2) of the Clean Water Act.

f. Notice of change in sludge disposal practice: The permittee shall give prior notice to the director of any change planned in the permittee's sludge disposal practice. If land application activities are suspended permanently and sludge disposal moves to a municipal solid waste landfill, the permittee shall contact the local Division of Solid Waste Management office address for other permitting and approvals (see table below):

Division of Solid Waste Management			
Office	**Location**	**Zip Code**	**Phone No.**
Chattanooga	540 McCallie Avenue, Suite 550	37402-2013	(423) 634-5745
Jackson	1625 Hollywood Drive	38305	(731) 512-1300
Cookeville	1221 South Willow Avenue	38506	(931) 432-4015
Columbia	2484 Park Plus Drive	38401	(931) 380-3371
Johnson City	2305 Silverdale Road	37601	(423) 854-5400
Knoxville	2700 Middlebrook Pike, Suite 220	37921	(865) 594-6035
Memphis	8383 Wolf Lake Drive, Bartlett	38133	(901) 368-7939
Nashville	711 R.S. Gass Boulevard	37243-1550	(615) 687-7000

3.4 BIOMONITORING REQUIREMENTS

Pursuant to the Outfall 001 treated effluent monitoring presented in this permit, Section 1.1, the permittee shall complete 48-hour LC_{50} (acute toxicity testing annually) per to the requirements shown below within 120 days from the permit's effective date. Additionally, the permittee shall provide the division its permit renewal application at least four IC_{25} (chronic toxicity biomonitoring) scans using the dilution presented in this section. (Based on the permittee's written request and with prior division written approval, Mississippi River dilution water may be used for the acute and chronic whole effluent toxicity testing.)

3.4.1 48-Hour LC_{50} Acute Biomonitoring Requirements

The permittee shall conduct a 48-hour static acute toxicity test on two test species on samples of final effluent from Outfall 001 within 120 days from the permit's effective date. The test species to be used are Water Fleas (*Ceriodaphnia dubia*) and Fathead Minnows (*Pimephales promelas*). The measured endpoint for toxicity will be the concentration causing 50% lethality (LC_{50}) of the test organisms. The LC_{50} shall be determined based on 50% lethality as compared to the controls, and as derived from linear interpolation.

Tests shall be conducted and results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for Acute Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	50	25	12.5	6.25	0

The dilution/control water used will be hard water as described in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition). An acute standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests shall be conducted using four separate grab samples of final effluent, to be used in four separate tests, and shall be collected at evenly spaced (6-hour) intervals over a 24-hour period. The minimum 48-hr LC_{50} value (maximum acute toxicity) for the four separate tests shall be reported (for each species).

The test control (i.e., dilution water only) results will be considered a failure and its results invalid, if more than 10% of the test organisms die in 48 hours, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition), if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated within 2 weeks. Any test initiated, but terminated before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee must start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices and determination of effluent lethality values will be made in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analysis shall be compiled in a report. The report shall be written in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Two copies of 48-hour LC_{50} biomonitoring reports (including follow-up reports) shall be submitted to the division. One copy of the report shall be submitted along with the discharge monitoring report (DMR). The second copy shall be submitted to the local Division of Water Pollution Control office address:

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
MEMPHIS ENVIRONMENTAL FIELD OFFICE
8383 WOLF LAKE DRIVE
BARTLETT TN 38133

3.4.2 Chronic Biomonitoring Requirements (For Permit Renewal Application)

For its permit renewal application, the permittee shall conduct four separate IC_{25} tests. Each test must be based on the 3-Brood Water Fleas (*Ceriodaphnia dubia)* survival and reproduction test) and the 7-Day Fathead Minnows *(Pimephales promelas)* larval survival and growth test using Outfall 001 final effluent samples.

The measured endpoint for toxicity will be the inhibition concentration causing 25% reduction in survival, reproduction and growth (IC_{25}) of the test organisms. The IC_{25} shall be determined based on a 25% reduction as compared to the controls, and as derived from linear interpolation. The average reproduction and growth responses will be determined based on the number of *Ceriodaphnia dubia* or *Pimephales promelas* larvae used to initiate the test.

Test shall be conducted and its results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for Chronic Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	**50**	**25**	**12.5**	**6.25**	**0**

The dilution/control water used will be hard water as described in Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition). A chronic standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests will be conducted using a minimum of three 24-hour flow-proportionate composite samples of final effluent collected on days 1, 3 and 5. If, in any control more than 20% of the test organisms die in 7 days, the test (with 100% dilution water) is considered a test control failure and invalid, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition), or if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated, within 2 weeks. Any test initiated but terminated

before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee shall start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented in the corresponding table above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices, determinations of effluent survival/reproduction and survival/growth values, and report formats will be made in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analyses shall be compiled in a report. The report will be written in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Three copies of the IC_{25} biomonitoring reports (including follow-up reports) shall be submitted to the division, included with the permittee's permit renewal application.

3.5 VISUAL OUTFALL OBSERVATIONS

On a daily basis, when safety considerations reasonably permit a person to stand of top of the outfall structure, an observation shall be made and noted in an operations log, which would be maintained on site. The operations log should allow the operator to check the following boxes:

- Unsafe to make observation (yes/no)

Only if the answer to the above question is no, answer the following:

- Floatables present (yes/no)
- Scum present (yes/no)
- Foam present (yes/no)
- Oily slick present (yes/no)

3.6 OUTFALL 001 TREATED EFFLUENT E. COLI COMPLIANCE WORK TASKS, MILESTONES AND SCHEDULE

The following schedule provides the treated effluent *E.coli* disinfection work tasks, milestones and schedule:

Disinfection Complisnce Schedule

Work Task	Milestone (s)	Submittal/ Completion (b)	Task Durstion (c) (Months)	Division Review (Months)	Total (c) Per Task (Months)	Total (c) Overall (Months)
1. Develop disintection investigation work plan						
	Disinfection Work Plan	No. 1	2	0.5	2.5	2.5
2. Conduct disinfection investigation (non-chlorination based)						
	Disinfection Report (if chlorination not selected)	No. 2A (d)	6	0.5	6.5	9
3. Conduct chlorination disinfection investigation						
	Chlorination Disinfection Report	No. 2B (d)	6	0.5	6.5	15.5
4. Develop Disinfection Report						
	Disinfection Report (if chlorination selected)	No. 2C (d)	3	0.5	3.5	19
5. Design Disintection System						
	Disinfection System Plans and Specs	No. 3	12	0.5	12.5	31.5
6. Develop Bid Documents/Bid						
	Bidding	No. 4	4	0.5	4.5	36
7. Disinfection System Facilities Construction						
	Construction	No. 6	18	0.5	18.5	54.5
8. Disinfection System Startup/Achieve Permit Limits						
	Functional Disinfection System	No. 7	3	0.5	3.5	58
	Total		**54**	**4**	**58**	

(a) The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved.

(b) The permittee shall provide the division with a written progress status report every 6 months pursuant this disinfection compliance schedule starting with the permit's effective date.

(c) Duration assuming sequential work task processing based on permit's effective date.

(d) As appropriate the Nos 2A, 2B and 2C submittals must addiess results from the dechlorination investigations, antidegradation evaluations, and determinations as required pursuant to Section 3.5.1.

As shown in the above schedule, the permittee shall provide the division with a disinfection report that includes antidegradation documentation, including alternatives analyses, for any newly-formed Outfall 001 contaminants expected to be present above a *de minimis* amount.

3.6.1 Additional Permittee Submittals (If Chlorination Disinfection System Selected)

Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly-generated byproducts are related to TRC according to the compliance schedule provided in the table above (section 3.6).

3.7 PLACEMENT OF SIGNS

Within sixty (60) days of the effective date of this permit, the permittee shall place and maintain signs at the Outfall 001 treated effluent discharge point the Mississippi River, and any bypass/overflow point in the collection system. For the purposes of this requirement, any bypass/overflow point that has discharged five (5) or more times in the last year must be so posted. The sign(s) should be clearly visible to the public from the bank and the receiving stream. The minimum sign size should be two feet by two feet (2' x 2') with one-inch (1") letters. The sign should be made of durable material and have a white background with black letters.

The sign(s) are to provide notice to the public as to the nature of the discharge and, in the case of the permitted outfalls, that the discharge is regulated by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

NPDES Permitted CSO or Unpermitted Bypass/Overflow Point:

UNTREATED SANITARY SEWER OVERFLOW WASTEWATER DISCHARGE POINT
Memphis - Maynard C. Stiles STP
(901) 576-4300
NPDES Permit NO. TN0020711
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

NPDES Permitted Municipal/Sanitary Outfall 001:

OUTFALL 001 DISCHARGE IS NON-DISINFECTED TREATED INDUSTRIAL/MUNICIPAL WASTEWATER WITH ELEVATED *E. coli*
Memphis - Maynard C. Stiles STP
(901) 576-4300
NPDES Permit NO. TN0020711
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

The above example Outfall 001 signs must be supplemented with signs that also include a warning for recreational users regarding the potential human health hazards associated with the non-disinfected treated wastewater with potentially elevated *E. coli* concentration. The permittee shall coordinate directly with the Memphis Environmental Field Office to define the actual number and locations for these signs. When the permittee has installed/operated the Outfall 001 treated effluent disinfection system and achieves the *E. coli* limits specified in Section 1.1, the hazard signage may be revised/removed as appropriate with the division's Water Pollution Control (WPC) prior approval.

No later than sixty (60) days from the permit's effective date, the permittee shall have the above sign(s) on display at locations specified by the division's WPC Memphis Environmental Field Office.

3.8 WASTEWATER TREATMENT FACILITIES INTEGRITY EVALUATION

Within eighteen months from the permit's effective date the permittee shall submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities including any waterborne wastes and sludge storage/disposal units that are constructed of earthen material.

The structural integrity evaluation shall be completed by a professional engineer licensed in the State of Tennessee, an environmental management professional, or other expert who is qualified by education and/or experience to perform and/or oversee such evaluations. The report shall document that the permittee has evaluated the unit's structural integrity and shall include the permittee's planned structural integrity improvements, if warranted. The report shall also address measures implemented and planned by the permittee as appropriate to reduce the chances that said wastewater treatment facilities/units failure would result in an uncontrolled discharge to the receiving stream(s) under normal conditions.

Structural integrity evaluations of earthen basins and/or surface impoundments performed for compliance with other regulatory programs (e.g., Hazardous Waste Management under 1200-1-11, Solid Waste Management under 1200-1-7, or the Safe Dams Act) satisfy the provisions of this permit requirement.

3.9 ANTIDEGRADATION

Tennessee's Antidegradation Statement per Rule 1200-4-3-.06 provides for protecting existing receiving stream uses and prevents the degradation of high quality waters. The rule states that:

> "Where the quality of Tennessee waters is better than the level necessary to support propagation of fish, shellfish, and wildlife, and recreation in or on the water, that quality will be maintained and protected unless the state finds that, after intergovernmental coordination and public participation, that lowering water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

Evaluation of compliance with this rule shall be made on an individual parameter (pollutant) basis considering such factors as:

- The discharge quantity and/or pollutant loading represents a new condition, an expanded condition, or an existing condition;
- The receiving stream has unavailable conditions (is at or exceeds water quality criteria), available conditions (quality is better than the water quality criteria) or is defined as an Exceptional Tennessee Water or Outstanding Natural Resource Water;
- The discharge impact on the assimilative capacity of the receiving stream is considered *de minimis* or not *de minimis*.

The Mississippi River is considered an Exceptional Tennessee Water due to the presence of the federal endangered Pallid Sturgeon and the state threatened Blue Sucker. The M.C. Stiles STP is an existing discharger and this permit renewal includes no new or expanded flow quantity or pollutant loadings. Therefore, the discharge allowed by this permit is determined not to cause degradation and is not subject to alternatives analysis or socio-economic consideration required under the antidegradation rule. No future increase in design flow or pollutant loading will be allowed without compliance with the above analysis requirements and a determination that such increase is consistent with the above antidegradation rule. However, if the new end-of-pipe disinfection system will result in newly-formed Outfall 001 discharge contaminants above a *de minimis* amount (e.g., chlorinated

byproducts if chlorination disinfection system used) the permittee must provide the division with appropriate antidegradation information..

4 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

4.1 DEFINITIONS

A "***bypass***" is defined as the intentional diversion of waste streams from any portion of a treatment facility.

A "***calendar day***" is defined as the 24-hour period from midnight to midnight or any other 24-hour period that reasonably approximates the midnight to midnight time period.

A "***composite sample***" is a combination of not less than 4 influent or effluent portions, of at least 100 ml, collected over a 24-hour period. Under certain circumstances a lesser time period may be allowed, but in no case, less than 8 hours.

The "***daily maximum concentration***" is a limitation on the average concentration in units of mass per volume (e.g. milligrams per liter), of the discharge during any calendar day. When a proportional-to-flow composite sampling device is used, the daily concentration is the concentration of that 24-hour composite; when other sampling means are used, the daily concentration is the arithmetic mean of the concentrations of equal volume samples collected during any calendar day or sampling period.

"***Degradation***" means the alteration of the properties of waters by the addition of pollutants or removal of habitat. Alterations not resulting in the condition of pollution that are of a temporary nature or those alterations having de minimis impact (not measurable or less than 5 percent loss of assimilative capacity) will not be considered degradation. Degradation will not be considered de minimis if a substantial loss (more than 50 percent) of assimilative capacity has already occurred.

"***Discharge***" or "discharge of a pollutant" refers to the addition of pollutants to waters from a source.

A "***dry weather overflow***" is a type of sanitary sewer overflow and is defined as one day or any portion of a day in which unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall occurs and is not directly related to a rainfall event. Discharges from more than one point within a 24-hour period shall be counted as separate overflows.

An "***ecoregion***" is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

The "***geometric mean***" of any set of values is the nth root of the product of the individual values where "n" is equal to the number of individual values. The geometric mean is equivalent to the antilog of the arithmetic mean of the logarithms of the individual values. For the purposes of calculating the geometric mean, values of zero (0) shall be considered to be one (1).

A "***grab sample***" is a single influent or effluent sample collected at a particular time.

The "***instantaneous maximum concentration***" is a limitation on the concentration, in milligrams per liter, of any pollutant contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***instantaneous minimum concentration***" is the minimum allowable concentration, in milligrams per liter, of a pollutant parameter contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***monthly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

The "***monthly average concentration***", other than for *E. coli* bacteria, is the arithmetic mean of all the composite or grab samples collected in a one-calendar month period.

A "***one week period***" (or "***calendar-week***") is defined as the period from Sunday through Saturday. For reporting purposes, a calendar week that contains a change of month shall be considered part of the latter month.

"***Pollutant***" means sewage, industrial wastes, or other wastes.

A "***quarter***" is defined as any one of the following three-month periods: January 1 through March 31, April 1 through June 30, July 1 through September 30, and/or October 1 through December 31.

A "***rainfall event***" is defined as any occurrence of rain, preceded by 10 hours without precipitation that results in an accumulation of 0.01 inches or more. Instances of rainfall occurring within 10 hours of each other will be considered a single rainfall event.

A "***rationale***" (or "fact sheet") is a document that is prepared when drafting a NPDES permit or permit action. It provides the technical, regulatory and administrative basis for an agency's permit decision.

A "***reference site***" means least impacted waters within an ecoregion that have been monitored to establish a baseline to which alterations of other waters can be compared.

A "***reference condition***" is a parameter-specific set of data from regional reference sites that establish the statistical range of values for that particular substance at least-impacted streams.

A "***sanitary sewer overflow (SSO)***" is defined as an unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall.

"***Sewage***" means water-carried waste or discharges from human beings or animals, from residences, public or private buildings, or industrial establishments, or boats, together with such other wastes and ground, surface, storm, or other water as may be present.

"***Severe property damage***" when used to consider the allowance of a bypass or SSO means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass or SSO. Severe property damage does not mean economic loss caused by delays in production.

"***Sewerage system***" means the conduits, sewers, and all devices and appurtenances by means of which sewage and other waste is collected, pumped, treated, or disposed.

For the purposes of this permit, the following designations apply:
"***Winter months***", the months of December, January, and February
"***Spring months***" the months of March, April, and May
"***Summer months***" the months of June, July, and August
"***Fall months***" the months of September, October, and November

A "***subecoregion***" is a smaller, more homogenous area that has been delineated within an ecoregion.

"***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

The term, "***washout***" is applicable to activated sludge plants and is defined as loss of mixed liquor suspended solids (MLSS) of 30.00% or more from the aeration basin(s).

"***Waters***" means any and all water, public or private, on or beneath the surface of the ground, which are contained within, flow through, or border upon Tennessee or any portion thereof except those bodies of water confined to and retained within the limits of private property in single ownership which do not combine or effect a junction with natural surface or underground waters.

The "***weekly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar week when the measurements were made.

The "***weekly average concentration***", is the arithmetic mean of all the composite samples collected in a one-week period. The permittee must report the highest weekly average in the one-month period.

4.2 ACRONYMS AND ABBREVIATIONS

1Q10 – 1-day minimum, 10-year recurrence interval
30Q5 – 30-day minimum, 5-year recurrence interval
7Q10 – 7-day minimum, 10-year recurrence interval
BAT – best available technology economically achievable
BCT – best conventional pollutant control technology
BDL – below detection level
BOD_5 – five day biochemical oxygen demand
BPT – best practicable control technology currently available
$CBOD_5$ – five day carbonaceous biochemical oxygen demand
CEI – compliance evaluation inspection
CFR – code of federal regulations
CFS – cubic feet per second
CFU – colony forming units
CIU – categorical industrial user
CSO – combined sewer overflow
DMR – discharge monitoring report
D.O. – dissolved oxygen
E. coli – *Escherichia coli*
EFO – environmental field office
LB (lb) - pound
IC_{25} – inhibition concentration causing 25% reduction in survival, reproduction and growth of the test organisms
IU – industrial user
IWS – industrial waste survey
LC_{50} – acute test causing 50% lethality
MDL – method detection level
MGD – million gallons per day
MG/L (mg/l) – milligrams per liter
ML – minimum level of quantification
ml – milliliter
MLSS – mixed liquor suspended solids
MOR – monthly operating report
NODI – no discharge

NOEC – no observed effect concentration
NPDES – national pollutant discharge elimination system
PL – permit limit
POTW – publicly owned treatment works
RDL – required detection limit
SAR – semi-annual [pretreatment program] report
SIU – significant industrial user
SSO – sanitary sewer overflow
STP – sewage treatment plant
TCA – Tennessee code annotated
TDEC – Tennessee Department of Environment and Conservation
TIE/TRE – toxicity identification evaluation/toxicity reduction evaluation
TMDL – total maximum daily load
TRC – total residual chlorine
TSS – total suspended solids
WQBEL – water quality based effluent limit

ADDENDUM TO RATIONALE

Memphis - Maynard C. Stiles STP
NPDES Permit No. TN0020711
Permit Writer: Gary Davis

This Addendum to Rationale includes the draft permit written comments (provided in the following appendices). To finalize the new permit, the division has abbreviated the comments and provided a response presented in **bold *italics*** font. This "Addendum to Rationale" provides the basis for augmenting the draft permit's "Rationale" and finalizing the new permit.

Written Comments Appendices:

AD-A1 – Permittee's.....AD-A1
AD-B1 – EPA's.....AD-B1
AD-C1 –Tennessee Clean Water Network/Sierra Club.....AD-C1
AD-D1 – Buckeye Technologies Inc.....AD-D1
AD-E1 – American Yeast Corporation AD-E1
AD-F1 – Ms. Mary Wilder.....AD-F1

The following section compiles Permittee's Draft Permit Comments Provided in Appendix AD-A1, Buckeye Technologies Draft Permit Comments as Provided in Appendix AD-D1 (submitted by Bass, Berry and Sims), American Yeast Corporation Draft Permit Comments Provided in Appendix AD-E1 (as submitted by Nutter) and Ms. Mary Wilder's Draft Permit Comments Provided in Appendix AD-F1.

Permittee's August 15, 2011 cover letter comments and division's responses:

(i) inclusion of a foam, color or other narrative permit requirement should be "void for vagueness" - ***Narrative permit requirements for some parameters are included where establishing numeric limits is infeasible. This standard language is consistent with federal permitting guidelines and has been shown to be protective of receiving stream's designated uses***.

(ii) narrative water quality standards should be implemented via numerical effluent limitations, or if those are infeasible, through BMPs – ***a study to provide data that would establish a relationship between the narrative color requirement and an effluent numeric limitation would need to be conducted. Upon completion of any such study, the division may modify the permit as necessary.***

(iii) Oct 12, 2009 Memphis' letter confirming agreements pursuant to position regarding to prior draft permit(s) – ***The division will consider all permit comments and requests received as a result of previous permit drafts.***

p. A-1: **A1**. Permit Expiration Date should be 5 years from the issuance date – ***the division agrees and the new permit is issued on a 5 year term***.

p. A-2: **A2**. Section 1.1 – BOD & TSS – monthly and weekly mass limits are not necessary – ***the division agrees with the permittee's request; minimum percent removal of***

BOD and TSS on a monthly average and daily basis will be retained in the final permit.

p. A-3: **A3**. Section 1.1 – E. coli Permit Limits – daily max should not be required since there's no bathing beach downstream of discharge – ***the division considers a daily maximum E. coli discharge limit to be appropriate since the relevant water quality requirements are for all receiving stream recreational usages. As such, the E. coli discharge limits are not subject to the existence of downstream bathing beaches.***

p. A-4: **A4**. Section 1.1 – Effective Date of E. coli Permit Limits and Monitoring Requirements - per permit footnote, must comply with limits within 36 months which does not say no monitoring required. Memphis wants "During the interim period, there are no E. coli limitations nor monitoring requirements." – ***the division considers its E. coli database to be very limited and E. coli monitoring will be required pursuant the new permit. E. coli discharge limits will be applicable following the permittee's disinfection system installation/startup/stabilization period. The permittee must inform the division in writing that it disinfection system is functional and it treated effluent is subject to the new permit's E. coli discharge limits.***

p. A-4: **A5**. Section 1.1 – Total Residual Chlorine or Oxidant Limits – premature to include TRC or TRO limits – wants limits removed/reopener for appropriate limit based on selected disinfectant & TRC calculated acute & chronic -> not TDEC's std technology–based TRC of 2.0 mg/L. – ***the division has finalized the permit to provide for its reopening for the inclusion of appropriate discharge parameter(s) limits/monitoring requirements pursuant to the specific disinfection system selected. Reopening the permit is subject to the division's applicable public participation procedures.***

p. A-6: **A6**. Section 1.1 – Addition of Benzidine and Hexachlorobenzene Monitoring – no basis for including parameters in permit. – ***the division has finalized the new permit to include monitoring requirements for Outfall 001 treated effluent benzidine and hexachlorobenzene. Benzidine is used in some dyes/pigments manufacturing/usage and the permittee has many relevant industrial users, which may be discharging benzidine. Hexachlorobenzene can be formed as a byproduct during solvents, pesticides and other chemicals manufacturing, and is required to be limited pursuant to OSPSF categorical pretreatment standards for toxic pollutants. The permittee has many industrial dischargers subject to OSPSF categorical pretreatment standards.***

p. A-7: **A7**. Addition of Color Monitoring – the permittee requested for color monitoring to be removed from the final permit. – ***the division agrees and color monitoring was deleted/replaced via the permit's reopener provision "The division may reopen the permit to incorporate color investigation results/recommendations." All reopener provisions will be subject to the division's applicable public participation requirements.***

p. A-8: **A8.** Section 1.1- Addition of Visual Outfall Observations – daily observations to include "distinctly visible matter and/or objectionable instream color" standard is vague and

subjective. Therefore, if not unsafe and if outfall pipe is not underwater, record yes/no for presence of floatables, scum, foam, oily slick. – ***the division agrees with the permittee request and the monitoring requirements are described in section 3.5 of the final permit.***

p. A-9: **A9**. Section 1.1 - Addition of Effluent Flow Monitoring – current permit influent only, effluent monitoring considered unnecessary and extremely difficult/expensive. – ***the current permit does include influent monitoring, however, per its Part I.B.1 the current permit also includes the following requirement: "Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements are consistent with accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes." As such, the new permit includes a requirement for the permittee to investigate the correlation between the "actual" influent and effluent flow rates. The permittee must determine options for actually monitoring effluent flow. The division understands that the permittee currently considers its influent flow rate to represent its effluent value. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. The new permit's reopener clause was supplemented with the prior sentence to allow the division to make permit modifications if warranted, based on the permittee's influent/effluent flow report.***

p. A-9: **A10**. Section 1.1 – TRC Monitoring, p. 3 – would include H_2O_2 as other oxidants – too broad (want when chlorine, bromine or other halogenated oxidants added). – ***the new permit's reopener clause was changed to allow the division to account for the permittee's selected disinfection system and make appropriate permit adjustments.***

p. A-9: **A11**. Section 1.1 - Narrative standards, p. 3 – color/foam and other visible materials – related to designated uses and cannot omit qualifying language (e.g., "considering the nature and location of the water") – thus, TDEC - incumbent to include numerical color limit(s) and if not feasible then BMPs. – ***the division must apply narrative standard consistent with its rules for all permittees. Certainly, equivalent/more stringent permitting requirements can be applicable per the specific situation, e.g., to provide for warranted water quality improvements.***

p. A-11: **A12.** Section 1.2.1.a – BOD5 effluent sampling location p. 5 – permittee wants to be able to collect final effluent BOD5 sample before disinfection for any disinfectant used. – ***Section 1.2.1.(a) of the final permit states: "If chlorination is used for disinfection, final effluent BOD5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD5 testing procedures approved by the division for its treated effluent analyses."***

p. A11: **A13**. Section 1.2.3.a – mercury and methyl mercury analytical methods – requires non-routine techniques and additional expenses – considers it on-going research. – ***The designated uses of the receiving stream are not fully supported due to mercury in fish tissue. For that reason, the new permit simply requires annual monitoring of mercury and methyl-mercury.***

p. A-12: **A14**. Section 1.2.3.a – PCBs analytical method – low detection method not warranted as PCBs not found in 9 years of annual monitoring/not manufactured/used in US for decades. – ***The designated uses of the receiving stream are not fully supported due to presence of PCBs in the sediment and is subject to TMDL requirements. A more sensitive analytical method is required in order to confirm that facility is not contributing PCBs to the receiving stream.***

p. A-12: **A15**. Reporting requirements –Section 1.3.5.1 summary report to ID number of sanitary sewer overflows, dry weather overflows and in-plant bypasses and basement backups separately. DMR reporting only provides for sanitary sewer overflows, dry weather overflows and in-plant bypasses. "Suspected" instances should be deleted. – ***The division agrees to include a "Sewer Backups to Buildings" monitoring parameter in the new permit. The "Suspected" permit provision will be retained, since the division considers the requirement to be consistent with its other permits. The overflow permit language will not be based on a single rain event, as proposed by the permittee.***

p. A-14: **A16** Section 1.5 – Reopener provisions – unclear why TDEC may want to be able to reopen permit to make changes to E. coli compliance schedule. – ***The language regarding E. Coli compliance schedule has been removed from the reopener provision.***

p. A-14: **A17**. Section 2.1.4 Proper Operation and Maintenance, p. 10 – the "standard" permit condition regulation does not address the "collection" system and can't be referenced/included since this would amount to a change from "standard". – ***The collection system is considered an integral part of the POTW. This language is consistent with all other municipal permits and will remain in the final permit.***

p. A-14: **A18**. Section 2.3.2 Reporting of Noncompliance, p. 13 – notification to state with 24 hr for "...threat to drinking water supplies, ... threat to human health or the environment" - permittee wants clarification to note that such notice not required if overflow has been addressed within 24 hr. – ***The permit allows the permittee discretion to determine whether or not non-compliance remedied within 24 hours pose a threat to human health and environment.***

p. A-14: **A19**. Section 2.3.3 – Overflow, p. 13 – overflow per rule based on "discharge" not "release" as in draft permit. Other "releases" not addressed by standard permit conditions nor rules. New permit must provide compliance schedule (requesting 20 years) if no feasible alternative to overflow. State has established a new zero discharge technology-based standard for the collection system. – ***The word "release" was replaced with the word "discharge" in the final permit.***

p. A-16: **A20**. Section 2.3.6.c – Bypasses, p. 16 – "All other bypasses are prohibited" should be changed to "All other bypasses are subject to the prohibition in subsection (b) above." Which permittee notes say they are only prohibited if they do not meet the subsection (b)(i) through (iii) criteria. – ***The proposed language was included in the final permit.***

p. A-16: **A21.** Section 3.2(a)(ix) – Local Limit Evaluation, p. 18 – division's pass through limits have not been established by regulation/should be deleted – no document explaining the derivation of such limits and why those are appropriate for municipalities. – ***The language in Section 3.2.(a)(ix) of the final permit was changed to state: "The evaluation should consider the most recent pass-through limits proposed by the division."***

p. A-16: A22. Section 3.2(b)(vi) – Pretreatment, p. 18 – prohibit the IU discharge of "any priority pollutant in amounts that will contaminate the treatment works sludge" should be deleted as it is already addressed by the general prohibitions. - ***The language in Section 3.2.(b)(vi) of the final permit was changed to state: "Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal."***

p. A-16: **A23**. Section 3.2(c) – POTW Pretreatment Program, p. 19 – thirty day notification "If this discharge necessitates a revision of the NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization." - permittee wants quoted sentence deleted because no regulation basis. TDEC has failed to adopt it so-called "pass through guidelines" as a rule instead of using internal TDEC policy, therefore cannot be used to establish industrial user "violations". – ***Permit modification requirements are described in TN Rules, Chapter 1200-4-5-.08(2), which states: "All discharges authorized by the permit shall be consistent with the terms and conditions of the permit; that facility expansions, production increases, or process modifications which result in new or increased discharges of pollutants must be reported by submission of a new application or, if such discharge does not violate effluent limitations specified in the permit, by submission to the commissioner of notice of such new or increased discharges of pollutants; that the discharge of any pollutant more frequently than or at a level in excess of that identified and authorized by the permit shall constitute a violation of the terms and conditions of the permit." Therefore, the language in section 3.2(c) does not have its basis in pretreatment rules, but is derived from the requirement that all pollutant sources must be adequately identified and authorized through an NPDES permit prior to commencement of discharge.***

p. A-17: **A24**. Section 3.4.2 – Dilution Water, p. 25 – the permittee requested an authorization to use "hard" water for chronic (IC25) testing. – ***The division agrees with using hard instead of moderately hard dilution water.***

p. A-18: **A25**. Section 3.4.1 and 3.4.2 Frequency of WET testing, pp. 23-27, wants automatic WET testing reduction to 2x/yr if 4 consecutive compliances reported. – ***the new permit includes report-only for WET testing, with 48-hr LC50 acute monitoring on an annual basis. The new permit's IC25 WET chronic testing (scans) is for the permit***

renewal application. Therefore, the division does not consider WET monitoring frequency reductions to be applicable.

p. A-18: **A26**. Section 3.5

a) Bacteria compliance schedule – While the permittee agrees that compliance schedule for the treated effluent *E. coli* disinfection is necessary, the timeline should be reasonable so to encourage completion of project consistent with sound engineering practices and reflective of administrative procedures associated with a major financial commitment. – ***The division has accepted permittee's proposed disinfection compliance schedule, albeit with minor modifications, so that the project completion is not outside of mandatory 5 year permit issuance restriction. Pursuant to the permittee's request, the division agrees that a single sign at the Outfall 001 discharge will be required rather than the several signs as described in the draft permit.***

b) Disinfection byproducts research (draft requests Memphis to investigate universe of potential halogenated compounds, rather than a proposed disinfection byproducts list pursuant to known effects regarding designated river usages which are determined before studies are initiated and should be identified in (draft) permit. – ***the division considers newly-generated disinfection byproducts to potentially adversely impact the receiving stream's water quality. Also, the byproducts may increase the amounts of chemicals already identified as needing additional controls (e.g., dioxin, and chloroform) for the receiving stream. The division requires that the permittee identify for its selected E. coli control method, the resulting types/amount of newly-generated disinfection byproducts, and corresponding water quality/antidegradation (pursuant to the division's Chapter 1200-4-3-.06(4)(f)) implications. The list of disinfection byproducts of concern should, at a minimum, consider pollutants with published water quality criteria (TN Rules, Chapter 1200-4-3).***

c) effluent transport/dispersion study (Memphis studies not needed/should be deleted/no rationale, study requirements to vague/broad, any in-stream effluent plume definition should await modifications to existing outfall structure. Study monitoring plan/modeling approach, etc. should be defined and agreed upon and timeframe needed. – ***Considering that end-of-pipe water quality criteria is imposed on E. Coli (following compliance schedule) and other pollutants of concern, the division agrees that effluent transport/dispersion study does not have to be included in this permit. However, such study may be required in the next permit cycle, if deemed necessary.***

d) effluent diffuser (Memphis says that based on discussion w/ACOE diffuser is not feasible – per July 2011 mtg w/TDEC diffuser requirement removed) – ***based on the permittee's effluent diffuser infeasible determination the division agrees not to include the diffuser requirement in the new permit. Thus, "This summary must also address an Outfall 001 diffuser(s)." from the draft permit was not included in the new permit.***

e) antidegradation analysis if newly-formed disinfection contaminants above *de minimis* amounts (antidegradation analysis should not be required/adding treatment. If antidegradation analysis is required, Memphis wants TDEC guidance for what is required to pass *de minimis* test and newly-formed contaminants to be limited to only Rule 1200-4-3 parameters. Memphis says TDEC agreed contaminants based on existing WQ per TN regulations.) – ***the division has finalized the permit to include permittee's antidegradation assessment requirements focused on the newly-formed chemicals which would be discharge pursuant to the permittee's selected disinfection system e.g., total residual chlorine, disinfection byproducts. Certainly the permittee must use the water quality criteria/chemicals included based on narrative criteria (including human health consideration). Also, the division expects that the permittee must use its knowledge regarding its industrial discharger wastestreams in its disinfection byproducts investigations. The permittee must address pollutants included in TN Rules, Chapter 1200-4-3 per the receiving stream's designated usages. The receiving stream is classified as an "Exceptional Tennessee Water" and the division's antidegradation requirements are provided in Rule 1200-4-3-.06, which addresses non-degradation due to de minimis contaminant discharge and social/economic justification requirements pursuant to contaminants resulting in receiving stream degradation. The division may not renew/finalize a discharge permit that results in receiving stream pollution.***

Permittee's Draft Permit Rationale Comments:

p. A-24: **A27. Total Nitrogen and Phosphorus Monitoring Requirements –** reasons for TN and TP monitoring not reasonable; acknowledge increased monitoring/loads w/ID sources; however, no mandate for states to impose monitoring on permittee. 308 letter issued for Mississippi River basin dischargers? Wants nutrients monitoring removed from permit. – ***the division disagrees and considers its rationale for including nutrients (total nitrogen and total phosphorus) sufficient given the very limited database, 3 nutrient-related permit renewal application values, and the magnitude of discharge flow, numerous/diverse industrial user wastewaters (many having nutrients), and noting that the permittee's treatment system is not designed nor operated for nutrient removal.***

Attachments B, C, and D @ Memphis' per prior draft comments submittal

Attachment B – Imposition of narrative color criteria and industrial user "pass through" requirements as a permit conditions are inappropriate and would be "Void for Vagueness"- ***the division understands the permittee's concerns regarding narrative color criteria and industrial user "pass through" and the new permit continues to include narrative requirements (e.g., "The wastewater discharge shall not contain pollutants in quantities that will be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.". However, regarding the permittee's specific color and pass through concerns, both have been specifically addressed for the new permit. See the division's above responses for the permittee's comments "A7" (for color) and "A21"/"A23" (for "pass through").***

Attachment C – Permitting requirements for compliance with narrative water quality criteria "The wastewater discharge must not cause an *objectionable color contrast* in the receiving stream."– ***the division agrees that this narrative requirement is in the permittee's current permit and pursuant to its above response to the permittee's "A7" draft permit comment, provides for subsequent color investigations/permitting requirements integration.***

Attachment D – October 12, 2009 Permittee's Letter - Comments on M.C. Stiles draft NPDES permit – ***based on additional information/considerations the division has addressed the various issues discussed with the permittee, as presented in the new permit.***

EPA's Draft Permit Comments Provided in Appendix AD-B1

EPA's cover letter notes that the new permit's rationale needs to document the appropriateness of including compliance schedules for *E. coli* and total residual chlorine (or total residual oxidants), including interim requirements and dates if schedule more than one year. ***The new permit reflects the permittee's newly-developed schedule pursuant to the justifications provided by the permittee (re: comment A26) with the division's determinations as included in this Addendum to Rationale. The new schedule includes a requirement for the permittee to submit to the division a progress status report every 6 months, starting with the new permit's effective date until the disinfection system is functional and the E. coli limits compliance are enforceable.***

EPA's comments (as summarized by division) and division's responses follows:

1. Re: Section 1.1 - EPA recommends that composites instead of grabs be used for monitoring organic pesticide chemicals, heptachlor and total chlordane. ***The division agrees with EPA's request.***

2. Re: Section 1.1 - EPA recommends that the division provide clarification regarding monitoring total mercury using composite sampling and grabs for methyl mercury. ***The division considers composite sampling for total mercury testing to be appropriate since the permittee's wastewater treatment system has a relatively short hydraulic detention time and expects significant raw wastewater variability (due to the numerous/diverse industrial user wastewater inputs). Since methyl mercury is volatile, grab sampling is required. However, the new permit's reopener clause has been revised to include the following provision: "The permit may also be reopened if the total mercury results appear much lower than expected in comparison with the methyl mercury grab data. If so, the division may require the permittee to determine the total mercury based on grab samples."***

3. Re: Section 1.1 – EPA noted that the total chlordane footnoted as "technical" chlordane. ***The division agrees with EPA and has changed the footnote to by deleting "technical" to be consistent with EPA's "Persistent Chlorinated Hydrocarbon Pesticides" classification.***

4. Re: Section 1.2.3.a - EPA noted the transposition "PBCs" for "PCBs". ***The division agrees and has made the correction.***

5. Re: Section 3.5 – EPA notes that any compliance schedule must be justified pursuant to 40 CFR 122.47(a), require the permittee to provide the division written progress notifications within 14 days of each interim milestone or final compliance with a written statement as to whether compliance dates achieved. ***The division agrees with EPA's comment and has supplemented the schedule with the statement "The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved." (See disinfection compliance schedule table, note (a))***

6. Re: Section 3.5.1 – EPA recommends that specific dates for each report be included. ***The division does not agree that dates must be included and has included a enhanced disinfection compliance schedule that incorporates specific work tasks, milestones, timing elements and the supplementary requirement (permittee must provide the division with progress status reports every 6 months, starting with the permit's effective date and continuing until the permittee's disinfection treatment system is functional.***

7. Re: Section 6.3.4 – EPA recommends that the division specify if chronic toxicity (IC25) monitoring and/or limits are appropriate based on a reasonable potential evaluation. ***The dilution factor (DF) for outfall 001 is approximately 1:522. This is outside of a range of dilution factors for which WET testing is required per EPA's guidance. However, the final permit does require annual acute testing and one chronic test to be submitted with the permit application.***

8. Re: Rationale 8.10 – EPA recommends that the new permit include a date for the permittee to submit the chlorinated byproducts information to the division. ***See response (above) to comment number A26.***

9. Re: Rationale 9.1 - EPA recommends that the new permit include a date for the permittee to submit the treated effluent transport/dispersion within the receiving stream information to the division. ***The division removed the requirement for the treated effluent transport/dispersion study from the final permit.***

10. Re: Rationale 10 – EPA recommends that the division discuss how the TMDL wasteload allocations for chlordane, dioxins and PCBs are consistent with the new permit's requirements and deleting/clarifications for the 3rd paragraph's last sentence. ***The <u>TMDL for chlordane, dioxins and PCBs</u> states, in Part 9 (Implementation Plan):***

"9.1 Point Sources
There are currently no NPDES permitted facilities in the Mississippi River Watershed with an existing allocation to discharge chlordane, dioxins, or PCBs to the Mississippi River."

Therefore, there are no wasteload allocations for chlordane, dioxins, or PCBs in the final permit, but annual monitoring is required to evaluate consistency with the TMDL.

11. For Appendix 2e (treated effluent biomonitoring), Appendix 2f (landfill groundwater monitoring results – mercury) and Appendix 2g (sludge mercury content) EPA recommends that the division obtain more recent data (effluent data limit is 4.5 years). ***The effluent data was timely submitted when the division started this multiple-year complex permit renewal process and plans to finalize the permit using the best information available. The new permit requires that the treated effluent mercury must be analyzed using more sensitive analytical methods.***

TCWN/Sierra Club's Draft Permit Comments Provided in Appendix AD-C1

1. Foam and color
   Request division specifically address foam – proposes "There shall be no distinctly visible floating scum, oil, foam, or other matter contained in the wastewater discharge." TDEC & EPA have noted the discharge of foam from plants, therefore a WQBEL limit warranted due to reasonable potential to violate instream water quality criteria. ***The final permit addresses these discharge parameters using a narrative WQBEL approach.***
2. Imposing E. coli limits long overdue – final permits should be issued w/o compliance schedules. If schedule included, ASAP compliance w/3 yrs max. for WQBEL compliance. ***The division concluded that a compliance is appropriate. The final permit requires the permittee to complete parallel work tasks and simplifications such that E. coli compliance must be achieved within the new permit's duration.***
3. TN & TP – drafts fail per WQ for nutrients (per ... Ecoregion 68a at the 75th percentile for nitrite + nitrate). Memphis watershed significant contributor to Gulf of Mexico hypoxic zone. ***The division does not consider the Ecoregion 68a reference stream values to be applicable to the Mississippi River (Ecoregion 73a). Therefore, the new permit retains Outfall 001 discharge total nitrogen and total phosphorus monitoring requirements from the draft permit.***
4. Mercury – numeric WQBELs should be included in the final permit - ***The receiving stream is identified as impaired for mercury (atmospheric deposition). The city has monitored its effluent for mercury, and the results have been below detection levels. However, the division is requiring the city to monitor mercury concentrations using the more sensitive method to better quantify their contribution, if any.***
5. Overflows – permits Part 2.3.3(d) unclear what "this requirement" means – ***The first sentence in paragraph d was changed to read: "Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after [...]"***
6. Dieldrin and DDT – Stiles, WQ reasonable potential is insufficient basis for limits elimination – specific exception of antibacksliding trigger needs to be presented. ***The current permit includes the following rationale for dieldrin and DDT limits "...since the ambient river concentrations of DDT and Dieldrin have been calculated to currently exceed the state water quality criteria, effluent limitations for these two pesticides are required in the permit." As such, water quality reasonable potential was the basis for including discharge limits for these treated effluent parameters, and rationale for continuing the limits does not apply. This permitting action is consistent with the division's antidegradation policy and***

these parameters no longer require additional controls pursuant to the division's 2008 and 2010 EPA-approved 303d lists.

Appendix AD-A1
Permittee's Written Comments (Submittal By CDM)

CDM

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August 15, 2011

DELIVERED BY EMAIL AND
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Mr. Vojin Janjic
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401 Church Street
L & C Annex, 6TH Floor
Nashville, Tennessee 37243-1534

AUG 16 2011

Subject: Comments on Draft NPDES Permit No. TN0020711
Memphis - Maynard C. Stiles STP

Dear Mr. Janjic:

This letter and the accompanying comments on the May 17, 2011 draft NPDES permit for the M.C. Stiles STP is being submitted on behalf of the City of Memphis. The City appreciates TDEC's granting an extension of time until August 16, 2011 to comment on the draft permit (as set forth in your letter to Mr. Dwan Gilliom).

The comments attached provide details of the City's concerns with the revised conditions that either are unclear or would appear to not be supported from a technical, regulatory or a water quality standpoint. We have provided an explanation of these concerns based upon the draft permit language. Where applicable, we have indicated instances in which TDEC agreed to potential resolution of the issue at the July 18, 2011 meeting between TDEC and the City.

Once TDEC has had an opportunity to review these comments, as well as comments submitted by others, the City is willing to meet to discuss any remaining issues and explore approaches for developing final permit conditions that achieve our mutual goals.

In addition to Attachment A, which addresses most of the City's draft permit concerns, the City's comments for the permit includes (i) an analysis why inclusion of a foam, color or other narrative requirement in the City's NPDES permit would be "void for vagueness" (Attachment B), (ii) an analysis setting forth the requirement that a narrative water quality standard be implemented through numerical permit limits or, if infeasible, BMPs (Attachment C), and (iii) a copy of the October 12, 2009 letter from the City to TDEC confirming agreements on the prior draft (Attachment D). Attachments B, C, and D are included to the extent such concerns have not already been adequately addressed by the revised permit.

CDM

Mr. Vojin Janjic
August 15, 2011
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If you have any questions, please do not hesitate to contact Paul Patterson, Administrator of Environmental Engineering, City of Memphis, at 901.576.7125 or me. Thank you for your time and attention.

[redacted]

Christopher A. Provost, P.E., BCEE
Vice President
Camp Dresser & McKee, Inc.

cc: Dwan Gilliom
Paul Patterson
Don Hudgins
Gary Cohen
Carmalita.Carletos-Drayton
Saya Qualis
Gary Davis

Attachment A

Comments on Draft M.C. Stiles NPDES Permit No. TN0020711
August 2011

The City of Memphis offers the following specific permit issues that have been identified in its review of the current draft permit and rationale issued May 17, 2011.

In preparing its comments on this draft permit, the City has considered.

(1) Discussions held with TDEC on July 18, 2011 about permit issues for the current draft permit; the City's understanding of the agreements reached during these discussions is included in the comments below.

(2) Previous discussions with TDEC related to the draft permit issued in 2009. Specifically, the City reviewed the agreements resulting from a meeting with TDEC on September 30, 2009 and summarized in the letter on October 12, 2009 from Paul Patterson (Memphis) to Vojin Janjic; this letter has been included as Attachment D and is hereby incorporated by reference to the extent such prior comments have not been adequately addressed to the City's satisfaction.

In addition, we incorporate the City's comments on previous draft permits, inclusive of the Attachments, to this document to the extent that these have not been adequately addressed to the City's satisfaction.

Comments on the Revised Draft Permit

A1. Permit Expiration Date

The initial page of the permit lists the permit's expiration as 2015. The rationale provided at Section R.9.5 for shortening the typical 5-year term of a NPDES permit to 2015 (4± years) is "The extended period involved in reissuing the permit." The City contends that due to the level-of-effort involved to develop the draft permit (and assuming that the City's comments are addressed satisfactorily) that a thorough review was completed.

The City believes that permit should be issued for a full five year period from the effective date, and requests that a specific expiration date be used in the permit. As TDEC, the City and others have devoted significant resources in the development of a permit; this period for this permit should not be shorter. Moreover, with the City's WWTPs being the primary dischargers in the area, any adjustments to permit schedules should be based upon the City's NPDES permit term.

The City discussed this comment with TDEC during the meeting in July 2011 and TDEC agreed that the permit term should be for five years from the effective date.

A2. Section 1.1 – Mass Limits for BOD/TSS

The draft permit includes both concentration and mass limits for BOD and TSS.

The City notes that the monthly and weekly mass limits for BOD/TSS are not necessary and requests they be removed from the permit. , These limits are not required by 40 C.F.R. § 122.45(f). Under this regulations no mass limits are required if the standard is in concentration. Similarly, in Tennessee regulations only a concentration limit is required for BOD and TSS. Per Rule 1200-4-5-.09(1)(a),

> "Municipal and domestic wastewater treatment plants shall be limited by application of monthly average concentrations, weekly average concentrations, daily maximum amounts, and daily maximum concentrations of the five-day, 20°C biochemical or carbonaceous biochemical oxygen demand (BOD5 or CBOD5) and suspended solids. In some cases, the daily maximum amount may be replaced by a minimum daily percent removal requirement."

As clearly reflected in this rule, the underlying standard only provides for concentration limits for monthly average and weekly average permit limits, while daily maximum limits include concentration and maximum amount or minimum daily percent removal.

The City has made this comment on the prior draft permit and the new rationale does not appear to provide abasis for including both concentration and mass limits. The City again request that the mass limits for these pollutants be eliminated.

In the July 2011 meeting with TDEC, the City raised this issue. The City's noted some of the exceedances of the mass loading limits occur as a result of the significant amount of inflow that occurs during seasonal rise of the Mississippi River. During these periods, the plant reached its maximum hydraulic capacity of 250 mgd (including recycle flows) for sustained periods.

The City reviewed operating records for the M.C. Stiles plant from January 2008 through June 2011. During that period there were three exceedances of monthly average load limits for BOD or TSS in two months (*i.e.*, April 2008 and May 2011) where the corresponding concentration-based limits were met. During these two months as well as May 2010, there were six weeks when the weekly load limit for BOD or TSS was exceeded but the respective weekly concentration limits were met. These are summarized below. During the three months involving the exceedance of mass limits, the average flow to the Stiles WWTP ranged from 162.2 – 203.9 mgd, well above the 135 mgd upon which the permit's mass limits were based

Violations of Loading Permit Limits for the M.C. Stiles Plant (2008-June 2011)			
Week-Month -Year	Parameter	Reported Value (lb/day)	Permit Limit (lb/day)
Week 1 - April 2008	TSS Weekly Average	96,483	87,820
Week 2 - April 2008	TSS Weekly Average	89,058	87,820
April 2008	TSS Monthly Average	73,309	58,547
Week 2 - May 2010	BOD Weekly Average	76,630	76,561
Week 3 - May 2010	BOD Weekly Average	99,164	76,561
Week 3 - May 2011	BOD Weekly Average	92,765	76,561
Week 4 - May 2011	BOD Weekly Average	101,957	76,561
May 2011	BOD Monthly Average	70,589	50,666
May 2011	TSS Monthly Average	64,765	58,547

These are examples of instances in which the City was in full compliance with the underlying statutory and regulatory standard (*i.e.*, secondary treatment), yet the permit would purport to artificially indicate noncompliance. While mass limits may be appropriate in other situations to prevent dilution as a means of achieving compliance, such concern would not be applicable here as the City has percent removal requirements, as well as concentration-based limits that apply to BOD and TSS. The City requests that the mass limits for BOD and TSS be deleted because, as reflected above, it can result in noncompliance when the City is in full compliance with the underlying applicable standard.

Without waiving its above argument, if weekly mass limits are to be included, then these limits should be increased. Weekly limits should not be based upon the monthly design flow (135 mgd), they should instead be based upon a higher weekly design flow. We note that the weekly design flow would be between the monthly and the daily design flows.

A3. Section 1.1 - E. coli Permit Limits

The City has the following comments on the *E. coli* permit limits themselves. First, EPA has stated in its BEACH Act regulations that bacteria daily maximum water quality standards should not be used to establish daily maximum limits because the single sample maximum was only intended to provide health authorities with a rational for closing beaches. Only monthly average standards are required (except for bathing beaches), *see e.g.*, 69 Fed. Reg.

67218 *et seq.* (November 16, 2004).[1] Even when a state has a geometric mean and a daily maximum component to its water quality standard for *E. coli*, EPA guidance indicates that the permit effluent limitation may appropriately be limited to monthly averages and not include a daily maximum limit. Section 4.2.2 of EPA's *Implementation Guidance for Ambient Water Quality Criteria for Bacteria* reflects that:

> Under the Clean Water Act and the implementing federal regulations, states and authorized tribes have flexibility in how they translate water quality standards into NPDES permit limits to ensure attainment of designated uses. In implementing state and tribal water quality standards that include both the geometric mean and upper percentile value components, there are multiple acceptable approaches. Because effluent limits are generally based on monthly averages, EPA recommends that states and authorized tribes use the geometric mean component for NPDES water quality-based effluent limits.

In summary, daily maximum permit limits are not required to be included in the permit even though the state standards may include an upper percentile value. As discussed above, there is no bathing beach downstream of the M.C. Stiles discharge, therefore the maximum day limits should be removed from the permit.

A4. Section 1.1 – Effective Date of *E. coli* Permit Limits and Monitoring Requirements

Footnote (a) to Section 1.1 states that "the permittee must comply with the *E. coli* limits within 36 months from the permit's effective date." This condition is tied to the compliance schedule provided in Section 3.5 of the permit. The footnote, however, does not release the City from the responsibility of monitoring for *E. coli* under the draft permit. While this might be tacitly assumed from the footnote, the City would prefer that this language to clearly specified by including the following text at the end of the footnote: "During the interim period, there are no limitations or monitoring requirements."

The City also has significant concerns regarding the short duration of the bacteria compliance schedule. Further discussion of this issue is included below in the comments on Section 3.5.

A5. Section 1.1 –Total Residual Chlorine or Oxidant Limits

Given that studies will be conducted as outlined in Section 3.5 to the draft permit to select a disinfectant, it is premature to include limits for total residual chlorine or total residual oxidant in the permit. Indeed, TDEC seems to acknowledge this in Appendix R-4 to the

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[1] In the BEACH rulemaking, EPA states that:

> *Other than in the beach notification and closure decision context, the geometric mean is the more relevant value for ensuring that appropriate actions are taken to protect and improve water quality because it is a more reliable measure, being less subject to random variation, and more directly linked to the underlying studies on which the 1986 bacteria criteria were based.*

Rationale (page R-30), which states that "should the permittee start using chlorination for effluent disinfection the following approach [to deriving a permit limit] would be applied."

The TRC limits derived in Appendix 4 are: acute = 9.9 mg/l and chronic = 5.8 mg/l. The proposed limit, however, is set at a lower value -- 2 mg/l, which is "from industry practice for breakpoint chlorination where 2.0 mg/l of free residual chlorine is associated with a hydraulic retention time." Such rationale would not justify making a potential water quality-based effluent limit more stringent than that calculated utilizing the applicable water quality standards. If a limit were to be included at all, it should be based upon the calculations as set forth in Appendix R-4. As further discussed below, the City, however, does not believe that it is appropriate to include TRC limits at this time based upon a contingency that the City chooses chlorination for disinfection.

The City is unclear how this rationale can be used to justify the selection of a permit limit for TRC. Because the ammonia concentrations in the effluent are greater than 2 mg/l, the mechanisms of chlorine disinfection will not be free chlorine, but rather will be chloramination. That is, breakpoint chlorination will not occur at the concentrations of chlorine that would be needed to disinfect the effluent. Reaching breakpoint chlorination for the M.C. Stiles plant effluent would require huge doses of chlorine.

The City is also unclear why a possible limit for total residual oxidant is included in the draft permit. An internet search revealed different definitions of the compounds that would be included in a total residual oxidant test. In one case TRO is defined as chlorite + TRC + chlorine dioxide, and in another it is TRC (free and combined chlorine) and free and residual bromines that are formed during chlorination of saltwater. In either case, the additional parameters beyond TRC are not found in Tennessee's water quality standards. Thus, the City believes there is no justification for a permit limit for TRO and asks that it be removed from the permit.

The City requests that TDEC take the following actions:

- The limits are removed from the permit and a re-opener clause is included that would allow for appropriate limits to be added based on the disinfection selected, or
- Include the TRC limits for acute and chronic concentrations as derived in Appendix R-4.

If TDEC wants to address this at all, then the City requests that one of the following happen:

- The limits are placed in abeyance until a new disinfection process is placed in operation using language similar to the following: "The permittee shall achieve compliance with the effluent limits for TRC in accordance with the compliance schedule for disinfection, assuming that chlorine is used for disinfection. During the interim period, there are no limitations or monitoring requirements."

- The intended effluent limits are discussed only in the Rationale for the permit broadcasting TDEC's intent but omit the effluent limits (and monitoring requirements) from the NPDES permit. A permit reopener could be included reflecting that the permit will be amended should the City decide to use chlorine for disinfection.

The City acknowledges that footnote (b) to the table includes the provision that TRC limits are not applicable until a disinfection system is installed and operated. If the NPDES permit is to include TRC effluent limits, the language should be clarified to reflect that these limits only get triggered if a disinfection involving the addition of chlorine, bromine or other halogenated oxidants is undertaken.

A6. Section 1.1 – Addition of Benzidine and Hexachlorobenzene Monitoring Requirements

The Rationale does not provide a sufficient basis for including monitoring for benzidine and hexachlorobenzene in Section 1.1 of the draft permit. In Section R8.7 (on page R-12), the reason provided for including these requirements is "for its permit renewal application the permittee did not use sufficiently sensitive analytical procedures to demonstrate that no reasonable potential to violate water quality exists. The permittee treats industrial wastewaters from numerous dischargers that manufacture or use organic chemicals, therefore Outfall 001 monitoring is included in the new permit." According to footnote (c) of the table on page R-44, additional testing is required if the detection limit used in the scan is higher than state RDL/approved EPA MDL and the industry is known to have that pollutant."

In the case of these two parameters the state water quality criteria are so small that analysis conducted at the required RDL/MDL could trigger additional monitoring requirements for every discharge in Tennessee unless the discharge had tremendous dilution in its receiving water. The required dilutions are determined by dividing the required detection limit by the water quality criterion, and are

- For benzidine, 22,000:1 for the organism only human health criterion and 51,163:1 for the water/organism human health criteria, and
- For hexachlorobenzene, 655:1 for the organism only human health criterion and 678:1 for the water/organism human health criteria.

Since few (and more likely no) discharges in the state enter receiving waters that afford the above calculated dilutions (for instance, the Stiles plant's discharge to the mighty Mississippi is calculated at 522:1), the trigger for additional testing becomes axiomatic unless the state takes the extra step and performs testing to verify that these chemicals enter the treatment plant and will not be sufficiently removed in the effluent at levels to result in a 'reasonable potential to exceed.' In other words, continued testing for these chemicals is a waste of money because the approved detection limits do not afford a permittee an opportunity to demonstrate that the ambient water quality criteria can be met.

For the above reason alone, The City requests that the monitoring requirements for benzidine and hexachlorobenzene be removed from the draft permit. Notwithstanding this reason for removing the limits, the City further notes that, as is discussed in detail below, the calculations in Appendix R-6 do not meet the stated requirements therein to require the City to perform additional monitoring.

Background. Appendix R-6 of the draft permit provides tables with the calculations comparing the analytical results to water quality criteria. The calculations for benzidine and hexachlorobenzene are found on Page R-44. The table notes that the detection limits for the analyses of these parameters were 10 µg/l.

The column 3 of the table specifies the state's WQC recommended detection limits or calls for use of EPA method detection limits. For benzidine, the table calls for the EPA MDL, while for hexachlorobenzene it lists a WQC RDL of 1.9 µg/l. A review of approved EPA analytical methods for benzidine yielded the following for MDLs:

- 44 µg/l using EPA Method 625 GC/MS
- 50 µg/l using method 1625B using GC/MS isotope

Benzidine. Because (1) the analytical result for benzidine was non-detect, (2) the detection limit used (10 µg/l) is lower than the approved EPA analytical detection limit (44 µg/l), and (3) the result of the analysis was not detected, there is no basis for including a monitoring requirement for this parameter in the permit. The City requests it be removed from the permit.

Hexachlorobenzene. The result for the test for hexachlorobenzene below the detection limit, though the detection limit used by the City in the analysis was above that required - 10 vs. 1.9 µg/l. Since the state has not shown that hexachlorobenzene is used by industries in the M.C. Stiles plant service area, the conditions cited in the Rationale for requiring additional testing have not been met. Therefore, the monitoring requirement should be removed from the permit.

A7. Addition of Color Monitoring Requirement

The draft permit includes a new monitoring requirement for weekly analysis of true and apparent color. Pending the development of a non-narrative color permit limit (that is proceeding on a separate track), asking the City to spend limited monies to quantify color is unnecessary. The color monitoring requirements should be removed from the permit.

In July 2011, during a meeting with the City of Memphis and its engineers, TDEC agreed that color monitoring was not currently needed in the permit.

A8. Section 1.1, Addition of Visual Outfall Observations

The draft permit includes a new provision for daily visual observations at the outfall to include "distinctly visible matter and/or objectionable instream color."

There are absolutely no criteria spelled out as to when something is "distinctly visible matter and/or objectionable instream color", and therefore the standard is vague and subjective. Moreover, such determinations are based upon the individual perception of the person making the evaluation. The City is unclear about how distinct visible matter or an objectionable instream color differences are to be noted and objects to this permit condition.

First, the City notes that these conditions in the General Water Quality Criteria Rules are all tied to the potential for effect on a use of the receiving water. For example, for the recreation use, the criteria related to visible matter notes that "There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to recreation." Similar the criteria related to color notes that there should be none in amounts that result in an objectionable appearance including the phrase "considering the nature and location of the water." These are important considerations because the Mississippi River is highly colored (and contains much visible matter in the form of debris and foam traveling downriver).

By their nature, these criteria are subjective and thus will be evaluated differently by each observer. Unless TDEC can provide objective criteria in the permit, this proposed permit condition should be removed.

In addition to the above comment, and without waiving its rights regarding the appropriateness of daily visual observations, the City further provides that it is impossible to comply with this condition on a daily basis. During certain flow conditions, it is unsafe to obtain this information. Under normal river flow conditions, it is possible for employees to stand on the top of the outfall structure to make the required observations. When the river flow is high this structure is submerged and employees cannot safely approach the structure where the discharge is occurring in the river. Visual observations should not be required on a daily basis.

During the July 2011 meeting with TDEC on the draft permit, TDEC stated that the intent of the requirement is for the City to document "obvious" visual differences. TDEC requested that the City propose language that could be included in the permit.

On a daily basis, when safety considerations reasonably permit a person to stand on top of the outfall structure and observe the discharge of the M.C. Stiles treated effluent (*i.e.*, the river level is below the top of the outfall pipe), an observation shall be made and noted in an operations log, which would be maintained on site and not submitted with the DMRs, as to whether there are floatables, scum, foam, or an oily slick emanating from the outfall itself and that are not also found in the immediately adjacent waters of the Mississippi River. The operations log should allow the operator to check the following boxes, where the floatables,

scum, foam and oily slick notations are only answered if negative responses are recorded by safety and water level:

- Unsafe to make observation (yes/no)
- Water above top of outfall pipe (yes/no)

Only if the answers to the first two questions above are no, answer the following:

- Floatables present (yes/no)
- Scum present (yes/no)
- Foam present (yes/no)
- Oily slick present (yes/no)

A9. Section 1.1, Addition of Effluent Flow Monitoring Requirement

The current permit for the M.C. Stiles plant only requires monitoring of flow in the influent. This draft permit requires additional flow monitoring of the effluent. The City requests that this addition be removed from the permit as it is unnecessary (a single flow monitoring point is all that is needed). Further, there is no portion of the effluent pipe that is exposed making it extremely difficult and costly to install a flow meter.

A10. Section 1.1, TRC Monitoring, page 3

The permit includes a statement that TRC monitoring shall be applicable when chlorine, bromine or any other oxidants are added. This statement is too broad in that it can include oxidants such as hydrogen peroxide. There is no reason to require monitoring for TRC under these circumstances. We request the sentence be changed to "…. when chlorine, bromine or other halogenated oxidants are added."

Further, the first paragraph on this page requires that "the method detection level (MDL) for TRC shall not exceed 0.05 mg/l, unless the permittee demonstrates that its MDL is higher." Given that the proposed permit limit for TRC is 2 mg/l (40 times higher at the MDL) it is unclear why so stringent a MDL is required. The City requests that a higher method with a higher MDL be allowed and that this sentence be removed from the permit.

A11. Section 1.1 – Narrative Standards, page 3

Color/Foam and Other Visible Materials. The permit provides that "[t]here shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge. The wastewater discharge must not cause an objectionable color contrast in the receiving stream."

First, , the proposed language could be interpreted as an arbitrary revision of the underlying water quality criteria. If the narrative criterion is to be changed, it must be undertaken

through rulemaking. The applicable narrative criteria for solids, floating materials and deposits does not impose a zero discharge visibility standard for these materials, it only prohibits those which actually impact the designated use. For example, where the water quality criterion is for protection of fish and aquatic life, the WQS at 1200-4-3.03(3)(c) prohibits the discharge of materials "of such size and character that may be detrimental to fish and aquatic life. Similarly, the water quality criterion for:

- Industrial water supply at 1200-4-3.03(4)(c) prohibits the discharge of the stated materials of such size and character that "may impair the usefulness of the water as a source of industrial water supply."
- Recreation at 1200-4-3.03(2)(e) prohibits the discharge of the stated materials of such size and character "that may be detrimental to recreation."
- Irrigation at 1200-4-3.03(5)(d) prohibits the discharge of the stated materials of such size and character that may "impair the usefulness of the water for irrigation purpose."
- Livestock watering and wildlife at 1200-4-3.03(6)(d) prohibits the discharge of the stated materials of such size and character to "as to interfere with livestock watering and wildlife."
- Navigation at 1200-4-3.03(7)(a) prohibits the discharge of the stated materials of such size and character as to "interfere with navigation."

Even if it were appropriate to include a narrative permit requirement for solids, floating materials and deposits in the permit, the permit condition could not arbitrarily be changed from the underling criterion and omit the qualifying language.

Similarly, the narrative requirement for color included in the draft permit does not fully represent the water quality standards, which in Rule 1200-4-3-03(4) (d), for example, provides that there shall be no color "in such amounts or character that will result in any objectionable appearance to the water, <u>considering the nature and location of the water</u>." (underline added) Given this qualifier it is unclear how the City would know what would be considered an "objectionable appearance." This is particularly valid because the Mississippi River, commonly referred to as "Big Muddy" is quite turbid, and often contains floating debris and foam."

In light of the fact that the narrative criteria fail to apprise the City (and its industrial users) of their legal obligations regarding color, foam and other visible materials, we believe it is incumbent upon TDEC to include a numerical color limit(s) in the NPDES permit. In the event such limits are not feasible, then BMPs may be used. Attachments B and C address concerns associated with TDEC's use of a water quality criterion narrative standard as a permit limit. We believe such permit provisions to be void for vagueness. Furthermore, we believe that TDEC has the legal obligation to develop numerical limits for implementing the narrative standard.

Hazardous. The draft permit (Section 1.1 at Page 3) also provides that "[t]he wastewater discharge shall not contain pollutants in quantities that will be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream." The origin of this narrative standard is unclear.

For the reasons stated above pertaining to color and foam, we believe that such permit condition should be deleted in that it fails to apprise the City (and its industrial users) of the applicable standard upon which it can determine whether its discharge actions are in compliance with the underlying permit condition. If there is a specific pollutant of concern (or indicator pollutant) then TDEC should be developing a numerical permit limit rather than including the narrative permit condition.

Sludge. Page 3 of the draft permit states "Sludge or any other material removed by any treatment works must be disposed of in a manner that prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq."

The City requests this provision be removed from the permit. The City's current sludge practice is to manage all sludge on-site and no sludge leaves the plant, and thus, these provisions do not apply. Furthermore, should the City ever change this practice and remove sludge from the site, the state's regulations cited above will govern the new practice and it is unnecessary to include these regulations in this permit.

A12. Section 1.2.1.a – BOD_5 Effluent Sampling Location, page 5

The revised draft permit allows "if chlorination is used for disinfection, final effluent BOD_5 samples can be collected before disinfection…" The City requests that this provision be made for the use of any disinfectants.

A13. Section 1.2.3.a – Mercury and Methyl Mercury Analytical Method

Section 1.2.3.a of the draft permit requires the use of EPA Method 245.7 or 1631E for mercury and EPA Method 1630 for analysis of monomethyl mercury. The methods state that the ease of contaminating water samples with the parameter of interest or interfering substances cannot be overemphasized. It also states that the ability to obtain low detection limit samples is constrained by the background levels of mercury. Contamination sources cited in Method 1630 include:

> Samples may become contaminated by numerous routes. Potential sources of trace metal contamination during sampling include: metallic or metal-containing labware (e.g., talc gloves that contain high levels of zinc), containers, sampling equipment, reagents, and reagent water; improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust. Even human contact can be a source of trace metal contamination. For example, it has been demonstrated that dental

work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation.

This analysis is designed to detect the very lowest levels of methyl mercury in a water sample and thus has to be undertaken using special sampling techniques (as defined in EPA Method 1669) and can only be conducted at a laboratory that maintains instrumentation for "clean" samples.

The use of EPA Method 1669 by wastewater utilities to collect samples is not routine. It requires special training of the staff to collect the sample, and given that samples would only be collected twice a year the training would have to be repeated each sampling cycle or an outside consultant/laboratory be hired to meet the sampling requirements. Since there are few laboratories who can meet these requirements, it is likely that additional expense would be incurred shipping and processing the samples. Thus, the use of a non-routine analytical detection limit as a monitoring requirement in an NPDES permit essentially asks Memphis to conduct research on its effluent. Tennessee's Water Quality Criteria rule (1200-4-3-.05.8) and has a required detection level (RDLs) of 0.2 µg/l, whereas the detection limit that could be obtained (barring background contamination or interferences) is 0.02 ng/l (or 10,000 times lower).

The use of these methods should be removed from the permit as the City should not be expected to conduct on-going research as part of its permit requirements.

A14. Section 1.2.3.a - Analytical Method for PCBs

Similar to the above discussion about the analytical method for mercury, the method specified for PCBs is not necessary. In this case EPA Method 1668B is required, which allows for determination of chlorinated biphenol congeners, whereas the traditional PCB analysis determines concentrations for groupings of congeners in their commercial mixes (known as aroclors). As with the mercury discussion above, the ability to achieve the lower detection limits depends on the level of interferences and background levels in the laboratory, and not on instrumentation limits.

Again the use of this method is not appropriate for the M.C. Stiles effluent monitoring program. PCBs have not been found in nine years of annual monitoring data. PCBs have not been manufactured or used in the US for decades. The rationale provides no basis for requiring these very low detection limits. The requirement to use this analytical method should be deleted from the permit.

A15. Reporting Requirements

The draft permit in Section 1.3.5.1 now provides for the summary report to identify the number of sanitary sewer overflows, dry weather overflows, in plant bypasses and basement backups separately. In contrast, the DMR reporting only provides for the reporting of sanitary sewer overflows, dry weather overflows and in-plant bypasses.

The City of Memphis has conscientiously been addressing its collection system and has made significant progress in reducing the number of overflows. The City is concerned that the new reporting format will result in the inappropriate appearance that the number of overflows is increasing when, in actuality, any increase would be the result of a new reporting structure. The City requests that the reporting be consistent with prior practices so that the City can appropriately evaluate its continued improvements. The DMR should also provide a separate line for the reporting of basement backups.

In the July 2011 meeting with TDEC this topic was discussed and TDEC agreed to either provide a new DMR code for basement backups to allow for separate recording or to allow them to be included as a separate sentence in the DMR.

Furthermore, the summary report in Section 1.3.5.1 is supposed to identity, not only, known instances of overflows or bypass, but "suspected" instances. The City requests that the provision pertaining to "suspected" instances be deleted. If overflows are to be reported, only those overflows that are known to have occurred should be covered. A "suspected" overflow is too subjective and cannot appropriately be covered by a certification accompanying any report.

Related to the concern with the new permit resulting in overreporting of overflows due to a different means of counting overflows is the new definition of "sanitary sewer overflow" in Section 4.1 of the draft permit (page 31). The City's existing NPDES permit defines a "sanitary sewer overflow event" as an "unpermitted discharge of wastewater from the collection or treatment system other than through the permitted **outfall that is directly related to a specific rainfall events. Multiple discharge occurrences within a single rainfall event are considered a single sanitary sewer overflow event.**" (Emphasis added.). The new draft permit, however, omits the bolded language. No longer would a sanitary sewer overflow be related to a specific rainfall event. Moreover, multiple overflows due to the same rainfall would now be counted as multiple sanitary sewer overflows. The City requests that the language from the 2000 existing permit be retained. This is an example of where the draft permit would result in the artificial increase in reporting of overflows when underling condition have not changed (or even potentially improved).

The City further points out that both the civil and criminal penalty sections of the Clean Water Act as provided in CWA §309(d) and §309(c)(5), respectively, specifically provides that a single operational upset that leads to simultaneous violations of more than one pollutant parameter will be treated as a single violation. As the new draft permit purports to have a prohibition of all sanitary sewer overflows (i.e., a zero discharge standard), multiple discharge occurrences due to a single rainfall event should continue to be treated as a single violation. The permit rationale provides absolutely no explanation for this very significant change from the existing permit to the new draft permit.

A16. Section 1.5 - Reopener Provisions

The new draft permit contains several changes to the prior proposed reopener clause. Some of these changes are confusing. For example, it is unclear why the new permit contains language that "the division may reopen the permit to make changes in the E. coli compliance schedule." As Section 2.2.2 ("Permit Modification, Revocation, or Termination") sets forth the requisite authority of TDEC to, among other things, modify the NPDES permit, there does not appear to be a need for a reopener provision. To avoid confusion, it is suggested that the reopener provision be deleted.

A17. Section 2.1.4 – Proper Operation and Maintenance, page 10

Rule 1200-4-5-.07(2)(c) sets forth a "standard" permit condition to be included in NPDES permits, in this case regarding proper operation and maintenance. This provision requires the permittee to properly operate and maintain all facilities and systems of treatment and control (and related appurtances) which are installed or used by the permittee to achieve compliance with the conditions of the permit. In contrast, Section 2.1.4.a of the draft permit would provide for the permittee to properly operate and maintain all facilities and system for "collection" and treatment, . . . The standard permit condition regulation does not address the "collection" system. The state regulations (Rule 1200-4-5-.07(2)) set forth "standard conditions" to apply to NPDES permits. These conditions are modeled after the federal standard permit conditions which are to be included in NPDES permits either expressly or by incorporation by reference. 40 C.F.R. § 122.41 (prefatory paragraph). These "standard" permit conditions are not intended to be changed. We therefore request that the language from Rule 1200-4-5-.07(2)(c), which sets forth the applicable standard, be used in the permit instead.

A18. Section 2.3.2 – Reporting of Noncompliance, page 13

The draft permit includes language about providing notification to the state within 24 hours from when the permittee becomes aware of a "case of any noncompliance which could constitute a threat to drinking water supplies, or any other discharge which could constitute a threat to human health or the environment." The City requests that this language be clarified to reflect that it does not require notice of any overflow that has been addressed within 24 hours.

A19. Section 2.3.3. – Overflow, page 13

The existing NPDES permit defines "overflow" as the "discharge of wastes from any portion of the collection, transmission, or treatment system other than through permitted outfalls." The definition of "overflow" in the draft NPDES permit inexplicably is no longer based upon a "discharge" having occurred but, instead, would now be based upon a "release" of sewage from any portion of the collection, transmission, or treatment system other than through permitted outfalls. The definitions of "sanitary sewer overflow," "dry weather overflow" and "wet weather overflow" as defined in Rule 1200-4-5-.02 are all based upon an unpermitted "discharge." Other "releases" that are not unpermitted "discharges" are not addressed by the

State regulations nor prohibited by the State's standard permit conditions as set forth in Rule 1200-4-5-.07.2(n). The permit language should be changed back to "discharge."

In addition, Part II.C.3.b of the existing NPDES permit for the Stiles plant prohibited sanitary sewer overflows and dry-weather overflows unless, among other things, there are no feasible alternatives to the overflow. The new permit has eliminated the no feasible alternatives defense and now would prohibit all overflows, even when there are no feasible alternatives. In light of this new requirement that even overflows for which there are no feasible alternatives be eliminated, it is imperative that the permit provide an appropriate compliance schedule to now meet this new permit requirement. The City requests that the permit provide the City twenty (20) years to meet this new requirement. In support of this request, the City notes that in the June 1, 2010 *Federal Register* ((75 Fed. Reg. 30400), EPA specifically acknowledged that "[e]ven municipal collection systems that are operated in an exemplary fashion may experience unauthorized discharges under exceptional circumstances." Furthermore, it is not uncommon for EPA to provide municipalities twenty-years in a consent decree to address overflows. The City recognizes that EPA may come out with a federal regulation addressing SSOs in the near future which may then provide further indications of an appropriate standard.

In further support of this comment, the City provides that since the State, in essence, has established a new technology-based zero discharge standard for collection systems, it must undertake the necessary analysis to jusrify a zero discharge standards. Furthermore, it is imperative for the State to provide a defense in the permit for those instances in which it is not reasonably expected that the technology-based standard can be achieved. This defense is required whether or not a particular State regulation so-provides. In fact, EPA's guidance sets forth the applicable legal standard:

> In Marathon Oil [Marathon Oil v. Environmental Protection Agency, 564. F.2d 1253 (9th Cir. 1977)], the court held that EPA was required to insert a special "upset" provision into the permit of each of the defendants in the case. The court concluded that a facility using proper technology operated in an exemplary fashion would not necessarily be able to comply with its technology-based effluent limitations one hundred percent of the time. Further, the Act only required dischargers to meet effluent limitations by application of "best available technology." Therefore, lack of a mechanism providing an excuse from liability for those rare circumstances when a violation occurs that the discharger could not avoid set a standard higher than that set by the Clean Water Act.

US EPA, Memorandum titled "Issuance of Guidance Interpreting 'Single Operational Upset,' from Robert G. Heiss (Associated Enforcement Counsel for Water), Keith A. Onsdorff, Associate Enforcement Counsel for Criminal and James R. Elder, Director, Office of Water Enforcement and Permits, dated September 28, 1989, at 7.

In conclusion, an affirmative defense and a reasonable compliance schedule must be provided.

A20. Section 2.3.6.c –Bypasses, page 16

The City requests that language "All other bypasses are prohibited" should be changed to "All other bypasses are subject to the prohibition in subsection (b) above." This change would clarify that they are only prohibited if they do not meet the subsection (b)(i) through (iii) criteria.

A21. Section 3.2(a)(ix) – Local Limit Evaluation, page 18

This section provides for a written technical evaluation of the need to revise local limits to be submitted and further provides that "the evaluation shall include the most recent pass-through limits proposed by the division." The division's pass through limits have not been established by regulation. Furthermore, there is no document explaining the underlying derivation of such limits and why it is appropriate to require such limits to be utilized by municipalities. The City requests that the reference to the division's pass through limits be deleted.

A22. Section 3.2(b)(vi) – Pretreatment, page 18

This section would prohibit the IU discharge of "any priority pollutant in amounts that will contaminate the treatment works sludge." It is unclear as to what the term "contaminate" means, beyond that already provided by Section 3.2(b) which contains the general prohibition against Pass Through and Interference. While the purpose section of TDEC Rules at Rule 1200-4-14-.01(1) reflects an intent to prevent contamination of sewage sludge, such intent is implemented by the prohibition against Interference or Pass in Rule 1200-4-14-.05(1)(a). The definition of "Interference" at Rule 1200-4-14-.03 addresses an industrial user discharge that inhibits or disrupts the sludge processes, use or disposal. The pretreatment rules do not elsewhere address contamination of sewage sludge. As such, permit condition 3.2(b)(vi) should be deleted as it is already addressed by the general prohibitions.

A23. Section 3.2(c) – POTW Pretreatment Program, page 19

Rule 1200-4-5-.07(2)(s) also sets forth a standard NPDES permit condition pertaining to POTW notification of changed circumstances. Section 3.2.c of the draft permit contains such requirements, but added a thirty day notification requirement and included the following provision: "If this discharge necessitates a revision of the NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization." While the City does not object to the thirty-day notification requirement, it requests that the last sentence be deleted as it is not set forth in the applicable regulation. Moreover, neither Rule 1200-4-5-.07, the pretreatment regulations in Chapter 1200-4-14, nor other applicable State or federal regulation requires changes to industrial user indirect discharges to await action by the NPDES permitting action, particularly as there is no reasonable maximum timeframe provided in which State action would be taken.

Furthermore, TDEC has failed to adopt its so-called "pass through guidelines" as a rule. Applicable regulations do not require compliance with such internal TDEC policy. If TDEC wants to apply such standards as a permit requirement, it is imperative for TDEC to first undertake the requisite rulemaking.

In addition, Section 3.2.d.ii (page 20) of the draft permit states that "all upsets, interferences, and pass-through violations must also be reported on the annual report." TDEC inconsistently uses the term pass-through. Under the federal and State pretreatment regulations, pass-through is prohibited and is defined as an industrial user discharge that passes through the POTW and is a cause of the POTW violating its NPDES permit. *See* 40 C.F.R. § 403.3(p) and Rule 1200-4-14-.03. As indicated above, TDEC has come up with its own informal pass-through standards and has sought to superimpose these nonregulatory provisions upon POTWs. If Section 3.2.d.ii is referring to the former definition of pass-through then Memphis has no further comment on this section. If, however, the permit is referring to the latter definition, Memphis objects to such permit condition. The informal pass-through values established by the TDEC policy cannot establish industrial user "violations."

A24. Section 3.4.2 – Dilution Water, page 25

The City appreciates the flexibility that has been included in the permit to allow exploration of the use of Mississippi River water as the control. Previously, the City has also requested that if synthetic dilution water is used, the City requests that hardness for this water be changed to "hard" per EPA's *Methods for Measuring the Acute Toxicity of Effluent to Freshwater and Marine Organisms*. In this 2011 draft permit, the change was included in Section 3.4.1 for acute toxicity testing, but was not included in Section 3.4.2 for chronic toxicity testing on Page 25.

The reasons for the request for hard water for synthetic dilution water are described below. The City requests this change also be made in Section 3.4.2.

First, the reasonable potential calculations performed in Appendix 6 to the Rationale of this draft permit assume a hardness value of 192 mg/l. Further support for a "hard" value for hardness in the Mississippi River at Memphis is described below.

- www.ck.mnscu.edu/kscott/chem1425/wqlabs/Test14TotalHardness.pdf reports a total hardness measurement made at Memphis in the fall season of 178.3 mg/l.
- www.rowan.edu/colleges/engineering/clinics/asce/papers/2004/2213-Dunbar.pdf reported total hardness in water collected in March 2000 at Memphis as 183 mg/l.

While not site-specific as the above two references, a USGS publication on water chemistry in the Mississippi River system states "The water remains hard (140-154 mg/l) at gaging stations between the Mississippi-Ohio River confluence and New Orleans, Louisiana." pubs.usgs.gov/circ/circ1133/chemsetting.html

A25. Section 3.4.1 and 3.4.2 – Frequency of WET Testing, pages 23-27

The City requests that a provision be added to the acute whole effluent toxicity testing requirements of the permit to provide an automatic reduction in WET testing frequency to two tests annually if four consecutive compliances are reported. This type of provision is frequently included in NPDES permits to avoid unnecessary expenditures after the effluent has been demonstrated to be non-toxic. Inclusion of an automatic reduction of WET testing frequency would also avoid the need for TDEC to devote resources in responding to and processing a permit modification request.

A26. Section 3.5 – Bacteria Compliance Schedule

The City agrees that the inclusion of a compliance schedule for bacteria is necessary to allow for, among other things, analysis of options of the best approach to take to comply with the new *E. coli* permit limit. There are, however, several conditions that have been included in the compliance schedule that are, in the City's opinion, unnecessary, confusing or not possible to complete on the schedule allowed. These include:

- Schedule issues
- The requirements concerning the posting of signs along the river
- The requirement that the City conduct research on disinfection byproducts
- The inclusion of a requirement to conduct a treated effluent transport/dispersion study and develop a mathematical model of the river
- The requirement to address an Outfall 001 diffuser(s)
- Requirement for an antidegradation analysis if disinfection will result in newly-formed Outfall 001 discharge contaminants above a *de minimis* amount

Each of these is discussed below.

Schedule Issues. Section 3.5 of the draft permit states that the City "shall design/install and operate an end-of-pipe disinfection system and comply with the Outfall 001 treated effluent *E. coli* and total residual chlorine (TRC) limits presented in Section 1.1 within 36 months from the permit's effective date."

In the meeting with TDEC in July 2011, TDEC agreed that they want the Compliance Schedule to be one that the City can reasonable meet and accordingly invited the City to propose a schedule, which is provided in the table below.

Milestone	Schedule
1. **Submission of Disinfection Study Work Plan**	Within 2 months of Permit Effective Date
2. **Conduct Disinfection Study**	Within 12 months of Work Plan approval by TDEC
3. **Additional Studies if Chlorine is recommended**	Within 12 months of Completion of Study to perform • Dechlorination studies • Antidegradation analysis (if appropriate) • Studies required by Section 3.5.1 of the Draft Permit
4. **Submit Disinfection Recommendations report**	Within 6 months from Completion of Study
5. **Complete Design**	Within 16 months from TDEC approval of Recommendations Report
6. **Bidding and Notice to Proceed**	Within 6 months from Completion of Design and TDEC Approval of Construction
7. **Construction**	Within 24 months from Notice to Proceed
8. **Startup Operations**	Within 3 months of Construction Completion

Notwithstanding the ability to offer the above timeframe to meet the Disinfection Compliance Schedule, the City is compelled to offer the following comments on the current draft permit.

The schedule included in the draft permit cannot be met. It does not allow time to recognize the realities of the process the City must follow to execute engineering and construction work. Such considerations were recognized in the August 30, 2010 draft permit, but for some inexplicable reason, the new draft permit now sets forth a totally unworkable compliance schedule. As further explained below, the compliance schedule also fails to account for the various studies required under the permit that would impact the various disinfection decisions.

Signage. The current draft permit requires that the City erect signs at the outfall, any bypass/overflow in the collection system that has discharged five or more times in the past year, and other locations "specified by the division's WPC Memphis Environmental Field Office." It does not appear that the State rules have any requirement for signage associated with discharge locations. The only reference to a "sign" that we identified is in Rule 1200-4-5-.06(1) which requires an individual application for a new or expanded discharge to post a sign near the entrance of the facility, with such sign being of sufficient size that it is legible from the public road. Inasmuch as the State rules specifically require signs where it has been deemed appropriate, the absence of such a requirement for other circumstances (such as at discharge locations) indicates a decision by the State not to require signage for these other situations.

Moreover, the fact that bacteria is not of such a crucial concern that signs must be posted is belied by TDEC's own actions/inactions. The lack of bacteria standards in the City's existing NPDES permit is based upon TDEC's past determination that such limits were unnecessary. Moreover, TDEC did not deem it necessary to amend or timely reissue the expired permit -- something it surely would have done if there were significant bacteria concerns. For these reasons, the draft permit conditions requiring signage should be deleted.

This topic was also discussed at the City's meeting with TDEC in July 2011 and an agreement was reached that the permit language would be revised to state that the City would erect a single sign at the main outfall of the M.C. Stiles plant and that signs would otherwise be placed only at bypass/overflow locations in the collection system that has discharged five or more times in the past year.

Notwithstanding this agreement, the City is compelled to offer the following permit comments on the draft permit.

In the event the State rules do provide for signs at the discharge locations, we make the following comments.

The draft permit specifies that signs be installed within 60 days of the permit's effective date at Outfall 001 and any bypass/overflow point in the collection system (the latter being any location that has had 5 or more discharges in the last year). The sign for Outfall 001 must include a warning for recreational users regarding human health hazards associated with treated non-disinfected wastewater. The City is to coordinate with the Memphis Field office on the actual number and locations of the signs.

The City requests that the sign for outfall 0001 also state that "Although the City of Memphis is in full compliance with applicable permit requirements, the City has been requested to inform the public of the following:"

The City further proposes that to meet the requirements that the sign at Outfall 001 include a warning to recreational users regarding the potential human health hazards associated with the non-disinfected treated wastewater that the sign include a glass of water with a red circle and diagonal line through it and the statement "Avoid ingestion of river water."

In addition, while the City is willing to coordinate with the Memphis Environmental Field Office to address the actual number and locations of these signs, the City is not willing to waive its due process right or necessarily defer to the opinion of that office should there be a disagreement. Should a disagreement result, the City recognizes that the NPDES permit would need to be amended to provide the City its due process rights associated with the particulars.

Disinfection Byproducts. The language of the additional permittee submittals (Section 3.5.1) is insufficiently defined regarding which potential disinfection byproducts will be included in the evaluations. During discussions with TDEC on the 2009 revised draft permit (see letter in

Attachment D summarizing these discussions), the City agreed to develop a list of DBPs of possible concern as part of the disinfection study, and will provide the list in the Disinfection Study Work Plan.

In the current draft permit, the City is concerned that as written, the language is wide open in that the permit would require the City to provide TDEC with "the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 and how newly generated byproducts are related to TRC." Thus, it appears that the draft permit is requiring the City to investigate the universe of potential of halogenated compounds that could result from chlorine disinfection, rather than have the City propose DBPs of possible concern as previously agreed.

The City should only be obligated to investigate compounds for which a known effect that relates to designated uses of the river, and these compounds should be identified in the permit before the studies are initiated. For instance, the study should not include compounds only known to have a human health effect through consumption of water as (1) the Mississippi River is not designated as a water supply and (2) incidental ingestion of water by recreational users does not meet the exposure conditions for human health effects (drinking 2 liters a day, every day for 70 years). Similarly, the study should not include compounds for which water quality standards do not exist as there is no basis for evaluating whether presence or concentration of the compound poses a potential impact. The study should be focused on a list of compounds identified in the draft permit and not be an academic exercise to identify halogenated compounds that could result from chlorine disinfection.

Treated Effluent Transport/Dispersion Study and Mathematical Model. The draft permit (Section 3.5.1) requires treated effluent transport/dispersion studies if a chlorination disinfection system is selected. The study requires that the City:

- Define the lateral, vertical and longitudinal extent of the Outfall 001 treated effluent plume within the Mississippi River under varying stage, flow and velocities, and
- Develop or use an existing mathematical model to predict treated effluent transport/dispersion characteristics within the Mississippi River.
- Provide a summary that includes study objectives, procedures used, data in terms of results of monitoring and modeling, mitigation measures, implementation plans, schedules, conclusions and recommendations. [The summary must also address a diffuser; comments on a diffuser are provided separately below.]

First, the City contends that these studies are not needed and requests they be dropped from the permit. The rationale provides no basis for their inclusion in this permit. Notwithstanding the request to remove this requirement from the permit, the City has developed detailed comments which are provided below.

The purpose of these studies is too vague; to wit: – what specific problem(s) or potential problem(s) is being studied? What is the mitigation measures being evaluated to mitigate? What implementation plans and schedules are being sought?

The requirements of the studies are too general and open to broad interpretation – What stage, flow and velocity conditions are to be evaluated? Why would it be necessary to assess conditions other than the regulatory specified low flow conditions for developing permit limits? What is meant by extent of the plume within the river (*i.e.*, when is mixing sufficient to not need to identify the plume's location)? Without clarity on these issues, a targeted, cost-effective study cannot be designed. If this provision remains in the permit then the program should be well defined and approved to allow for the best use of limited resources.

To establish a monitoring program that meets sampling objectives, the details of the monitoring program should be agreed before any field work is started. Thus any monitoring work should follow the steps of (1) agreement on objectives and interpretation of results, (2) design of sampling program to achieve those objectives, (3) submittal of sampling program to the division, and (4) approval of sampling program by the division. A reasonable timeframe is needed to complete this work.

And finally on the field studies, the City is the process of discussing modifications to the existing outfall pipe with the regulatory agencies. Any field work to examine the location of the plume in the river should await completion of these improvements

The same is true for a mathematical model; some potential issues related to the plume's location (*e.g.*, backflow up the Wolf River) will require at least a 2-dimensional hydrodynamic model and possibly a 3-dimensional model of the river. The data collection required to develop calibration targets is extensive and expensive, particularly if the conditions of interest (*e.g.*, high flows causing a backflow up the Wolf River) are uncommon. Data collection would include (1) obtaining detailed bathymetry, particularly at the Wolf River confluence; (2) obtaining velocity measurements through either moored instruments or acoustic Doppler transect surveys, including under high flow conditions when safety issues for operations from boats or potential damage to moored instruments from debris flow in the river will be crucial; and (3) possibly conducting dye-dilution studies, which could be very expensive and potentially unfeasible under high flow conditions. Further the Mississippi River bed is not stable and the presence of shoals and sandbars will affect the hydrodynamics in the river. Therefore, similar to the field studies on defining the extent of the plume in the river, the objectives of any mathematical model should be agreed before the work is started. A monitoring plan should be defined and agreed, as should the selection of the modeling approach. A reasonable timeframe is also needed to complete this work.

Diffuser. The draft permit requires the City to address an Outfall 001 diffuser(s). This requirement is also vague and it is unclear what actions would be necessary to allow the condition to be met. The City recognizes that an effluent diffuser could increase the initial dilution of the discharge of treated effluent, but believes that such option does not exist. In

2009, the City held discussions with the Memphis District of the ACOE about the feasibility of adding a diffuser to the existing outfall. The Corps has indicated that placing a diffuser in the Mississippi River would not be reasonable due to, among other things, the moving river bottom and the occurrence of sand waves. The requirement to examine an effluent diffuser has thus already occurred and should be removed from the permit.

During the July 2011 meeting with TDEC, the City's concerns about the infeasibility of a diffuser were raised. TDEC agreed that the permit would be modified to remove the requirement to address a diffuser.

Antidegradation Analysis. Section 3.8 (Page 29) of the draft permit includes a requirement of an antidegradation analysis if the disinfection method to be used at the Stiles plant will "result in newly-formed Outfall 001 discharge contaminants above a *de minimus* amount (*e.g.*, chlorinated byproducts if chlorination disinfection system used)." A similar provision has been added to Section 3.5 (Page 26).

The City does not believe that an anti-degradation analysis is required where the City is adding pollution control and reducing potential impacts to the receiving water to meet an effluent limitation newly imposed by the permit. The requirement to undertake an antidegradation analysis should be deleted.

Notwithstanding the City's belief that an antidegradation analysis should not be required of the permittee, the City provides additional comments on the draft permit conditions. These additional comments are provided without prejudice to the City's position stated above. The City requests that further guidance be provided about what conditions constitute "passing" the *de minimis* test for an antidegradation analysis. Tennessee regulations (Rule 1200-4-3-.04(4) define *de minimis* for several conditions (discharges other than domestic wastewater, water withdrawals and habitat alterations) but do not include a definition applicable to the Stiles plant's discharge (discharge of domestic wastewater).

The City also notes that requiring an antidegradation analysis for "newly-formed discharge contaminants" is too broad, and that to the extent an analysis can appropriately be required, it be limited to parameters for which water quality criteria are found in the Rule 1200-4-3.

The City discussed the antidegradation requirements with TDEC during the July 2011 meeting. TDEC agreed that the Tennessee regulations are not specific about the conditions for "passing" the antidegradation analysis for a domestic wastewater discharge, and stated that the "passing" condition should be the same as for "discharges other than domestic wastewater." TDEC also agreed that the analysis would be limited to parameters with existing water quality criteria in Tennessee regulations. Should the permit appropriately impose any antidegradation requirements, the City requests that these clarifications be added to the next version of the Stiles plant permit.

Comments on the Rationale

Some issues identified in permit rationale are presented below. As the controlling document is the NDPES permit and not the rationale, we have focused our review on the NPDES permit.

A27. Total Nitrogen and Phosphorus Monitoring Requirements

Page R-12 of the Rationale provides a discussion of the monitoring requirements for total nitrogen and total phosphorus. The reasons provided in this section are not reasonable. The logic provided in the Rationale for TN and TP monitoring, as the City understands it, along with our comments (in italics) on that logic is explained below:

1. The monitoring requirements are imposed pursuant the joint State/Federal Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. *Our review of the task force documents found that they recommend improved monitoring throughout the basin as necessary to achieve the goal of reducing, mitigating, and controlling hypoxia in the Gulf. In addition, basin states are called upon to take responsibility for increased monitoring and identification of sources of nutrient loads. There is not, however, a mandate for states to impose monitoring on permittees as stated in the Rationale.*

2. EPA believes that Section 308(a) of the Clean Water Act provides broad authority to require nutrient monitoring. *While Section 308 of the Clean Water Act authorizes EPA to furnish information, conduct monitoring, etc., this process is initiated by EPA issuing a 308 request letter. To our knowledge, such a letter has not been issued to dischargers in the Mississippi River Basin. Without a synchronized effort by all dischargers (who have common monitoring requirements), the stated goal of "assessing current point source loadings" will not be met. The City will participate, when required, in a basin-wide monitoring program. As such, the monitoring requirements of nutrients should be removed from the permit.*

References

Federal Register. 1998. 63 FR 18591.

Harrion, K. and Hoberg, G. 1994. *Risk, science, and politics – regulating toxic substances in Canada and the United States*. McGill-Queen's University Press, Montreal, Quebec.

Roberts, J.C. 1996. *The chemistry of paper*. Royal Society of Chemistry, Cambridge, 190 pp.

ATTACHMENT B

IMPOSITION OF NARRATIVE COLOR CRITERIA AS A PERMIT CONDITION IS INAPPROPRIATE AND WOULD BE "VOID FOR VAGUENESS"

The current National Pollutant Discharge Elimination System ("NPDES") permit for the City of Memphis' Stiles Wastewater Treatment Plant ("WWTP") issued March 31, 2000 contains a vague narrative standard for color and provides. "The wastewater discharge must not cause an *objectionable color contrast* in the receiving stream."[1] (Emphasis added.) In contrast, the underlying State water quality criteria for recreation uses provides: There shall be no color that … will result in any objectionable appearance to the water, considering the nature and location of the water. (Tenn. Code Ann. §1200-4-3-.03(4)(d)).

EPA has asserted, based upon their review of Google Earth pictures[2] and an on-site inspection of the discharge that the City of Memphis' discharge is in violation of the narrative color requirement in the NPDES permit. In discussions with EPA and TDEC, neither entity can identify a specific cut-off value for acceptable color (*i.e.*, in compliance) under the standard. The City of Memphis and its underlying industries, as such, do not have an objective standard for determining whether their actions would be in compliance with the underlying narrative standard.[3]

DISCUSSION

The Supreme Court has found a standard to be void for vagueness where it "fail[ed] to give a person of ordinary intelligence fair notice that his contemplated conduct is forbidden by the statute…." *Papachristou v. City of Jacksonville*, 405 U.S. 156, 162 (1972). *See also City of Chicago v. Morales*, 527 U.S. 41, 45-46 (1999) (Ordinance invalidated due to the "uncertainty about the scope of…[its]coverage."); *Kolender v. Lawson*, 461 U.S. 352, 361 (1983) (Ordinance invalidated as vague "because it encourages arbitrary enforcement by failing to describe with sufficient particularity what a suspect must do in order to satisfy the statute."); *Grayned v. City of Rockford*, 408 U.S. 104, 109 (1972) (A standard is deemed to be vague, and therefore void, when it, "trap[s] the innocent by not providing fair warning."); *U.S. v. Harriss*, 347 U.S. 612, 617

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[1] The existing NPDES permit for the T.E. Maxson ("Maxson") Wastewater Treatment Plant contains the same language.

[2] With color being the underlying issue, calibration of the underlying monitor used to view the Google Earth pictures would be essential. EPA, however, has not asserted that any calibrated equipment was used to assure that the color viewed was indeed representative of the color discharged.

[3] The August 30, 2010 draft permits for both the Stiles WWTP and the Maxson WWTPs propose to change the color permit condition to provide that "[t]he wastewater discharge shall not cause a distinct color contrast … in the receiving water." While such proposed approach also suffers from "void for vagueness" as further discussed in this Attachment, there are additional concerns associated with TDEC arbitrarily converting the regulatory narrative criteria into another more stringent narrative requirement in the draft permit. No appropriate basis has been identified for such changes.

(1954) ("The constitutional requirement of definiteness is violated by a criminal statute that fails to give a person of ordinary intelligence fair notice that his contemplated conduct is forbidden by the statute. The underlying principle is that no man shall be held criminally responsible for conduct which he could not reasonably understand to be proscribed.").

Additionally, the Tennessee Supreme Court and the United States Court of Appeals for the Sixth Circuit have overturned ordinances based on the "void for vagueness" standard. *See City of Knoxville v. Entertainment Resources, LLC*, 166 S.W.3d 650, 659 (Tenn. 2005) (Overturning a zoning ordinance for failing to provide an "articulable standard" and failure to specify the prohibited acts.);[4] *Leonardson v. East Lansing*, 896 F.2d 190, 197-198 (6th Cir. 1990) (Ruling that a portion of a City ordinance was void for vagueness as it did not "include sufficiently explicit and limiting standards."), *Belle Maer Harbor v. Charter Township of Harrison*, 170 F.3d 553, 559 (6th Cir. 1999) (Struck the terms "or as determined by the inspecting officer" from an ordinance as the terms were unconstitutionally vague as "a person of ordinary intelligence could [not] determine from this standard the proscribed conduct which could lead to criminal sanctions.")

As such, the determination to be made by one seeking to challenge a regulation as constitutionally void for vagueness is whether the rule warns individuals of the potential consequence of their conduct. *Jordan v. De George*, 341 U.S. 223 (1951). Where a statutory provision, regulation, or ordinance fails to do so, courts have held it to be invalid for vagueness. In this instance, the narrative permit condition, which fails to provide the City of Memphis (as well as industrial users subject to the "pass through" prohibition of 40 C.F.R. § 403.5(a)) with clear compliance instructions on their color discharge is void for vagueness.

APPLICATION OF THE VOID FOR VAGUENESS STANDARD

Provisions, involving environmental standards and where language similar to the "objectionable" language has been used, have been struck down as "void for vagueness."

In *Luna v. City of Ulysses*, 28 Kan. App. 2d 413 (Kan. Ct. App. 2000), the Kansas Court of Appeals held that the challenged City's noise standard, based upon "annoying or disturbing to others" (similar to the Tennessee "objectionable" standard), was constitutionally vague, and therefore, invalid. The ordinance read:

> It shall be unlawful for any person to make or cause or permit to be made upon any public or private property including public streets, alleys, thoroughfares or parks, any unnecessarily loud or excessive noise or sound which is physically or mentally *annoying or disturbing* to another person or persons or which disturbs the peace, quiet, or comfort of another person or persons. *Id.* at 414. (Emphasis added.)

[4] The Tennessee Supreme Court has also applied the "void for vagueness" standard in striking the terms "excess violence" from a criminal statute, as these terms were also found to be unconstitutionally vague. *Davis-Kidd Booksellers v. McWherter*, 866 S.W.2d 520, 532 (Tenn. 1993).

The Petitioner challenged the ordinance, claiming that the terms employed by the ordinance, "loud," "excessive," "mentally annoying," and "disturbing," were all lacking in objectivity, and therefore, void for vagueness. *Id.* In its determination that the standard failed for vagueness, the court applied a test much like that applied in *Harriss* and *Kolender*. The court held:

> In determining whether an ordinance is void for vagueness, the following two inquiries are appropriate: '(1) whether the ordinance gives fair warning to those persons potentially subject to it, and (2) whether the ordinance adequately guards against arbitrary and discriminatory enforcement.' *Id.* at 415.

After reviewing the ordinance in light of the aforementioned factors, the court concluded that the standard was unconstitutionally vague, as it did not "give fair warning" and failed to provide "objective standards." *Id.* at 416.

Courts have also applied the vagueness standard to narrative water standards. In *Simpson Tacoma Kraft Co. v. Dep't of Ecology*, 119 Wn.2d 640, 644 (Wash. 1992), the dischargers challenged the Washington Department of Ecology's ("DOE") implementation of a narrative water quality standard. The State's pertinent narrative criteria read:

> Toxic substances shall not be introduced above natural background levels in waters of the state which may . . . adversely affect public health, as determined by the department [of Ecology]. *Id.*

The Plaintiffs challenged the underlying standard as being void for vagueness, as well as the State's establishment of numerical limits for implementing the narrative requirement without undergoing applicable rulemaking procedures. It is noteworthy that the Superior Court found the state's narrative requirement to be unconstitutionally vague, as well as holding that the state needed to adopt its implementation procedures through rulemaking.[5] *Id.*

Like the Superior Court in *Simpson Tacoma*, the Kansas Supreme Court found a water statute to be unduly vague. *State v. Lackey*, 232 Kan. 478 (Kan. 1983). In *Lackey*, the State challenged the district court's determination to dismiss a criminal complaint against Petitioner for an alleged violation of Kan. Stat. Ann. § 55-904(a)(1) which provided that it is illegal to:

> Dispose of or cause the disposal of salt water or waters containing *minerals in an appreciable degree* produced in conjunction with the production of oil or natural gas except in the manner and locations prescribed by K.S.A. 55-1003 and K.S.A. 1980 Supp. 55-901 and rules and regulations adopted pursuant to such sections or as provided by K.S.A. 65-161 to 65-171(f), inclusive, and rules and regulations adopted pursuant to such sections. *Id.* (Emphasis added.)

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[5] On appeal, the Washington Supreme Court struck down the numerical standards due to DOE's failure to adopt implementation procedures through proper rulemaking, and, in light of such ruling, vacated the void for vagueness ruling as being gratuitous and unnecessary.

Petitioner had been found in violation of the statute as its tank truck operator had dumped salt water onto a county road. *Id.* The trial court voided the statute, as it was found vague and lacking in definition of "minerals in appreciable degree." Additionally, the Court held that the standard was too vague as "all water contains some salt and minerals in some degree." *Id.* at 480. The Court, primarily focusing on the term "appreciable," upheld the lower court's ruling that the standard violated the requirement of providing the regulated community with "fair notice of what is prohibited" because the terms employed in the statute were too vague. Furthermore, the Supreme Court held that "[f]undamental fairness is the touchstone" and that any such violation of fairness would render a statute void for its failure to provide the regulated community with a clear standard of required performance. *Id.* at 481.

Similarly, in *Hometown Properties, Inc. v. D.E.M.*, 1989 R.I. Super. LEXIS 132 (R.I. Super. Ct. 1989), the Petitioner challenged the Department of Environmental Management's ("DEM") denial of a permit renewal and request for expansion of their solid waste facility. After several years of successful and compliant operation, DEM denied Petitioners 1987 application for relicensing, claiming that Petitioner had violated the State's groundwater statute ("208 statute"). *Id.* at 15. The statute read in part:

> No person shall dispose of solid waste on or in the ground overlying groundwater reservoirs or groundwater recharge areas, as identified on a map entitled "State of Rhode Island '208' Area wide Water Quality Management Plan - Water Related Sensitive Areas" prepared by the Statewide Planning program. *Id.*

DEM denied the permit, claiming that the Petitioner's failure to demonstrate that the expansion of their facility would not affect any potential underlying groundwater sources was a violation of the 208 statute (the statute placed the burden of proof on the applicant). *Id.* at 12. The court held that the statute was unconstitutionally vague, as it was:

> [T]erminally ill, constitutionally speaking ... [and] the key terms of the 208 statute are defined neither explicitly nor by reference to other materials in a fashion that would permit a person of ordinary intelligence to do anything but guess as to whether a particular location falls within a groundwater recharge area as set forth in the act. *Id.*

Because of the statute's deficiencies, the court overruled DEM's denial of Petitioner's request for the permit, therefore, granting the permit.

These cases demonstrate that courts will find environmental laws and regulations which fail to adequately inform the public of the scope of the regulated activity void for vagueness. As such, rules, including those regulating water discharges, etc., which claim to regulate entities based on "objectionable criteria" and fail to provide regulated communities with more precise direction, will be overturned as unconstitutionally vague, as they fail to provide the "person of ordinary

intelligence fair notice that his contemplated conduct is forbidden." *Papachristou v. City of Jacksonville*, 405 U.S. 156 (1972).

CONCLUSION

In light of the cases discussed above, imposition of a narrative requirement in the City's NPDES permits will be found void for vagueness as it is lacking in preciseness, fails to adequately warn the City (as well as its industrial users that would be subject to the "pass through" prohibition of 40 C.F.R. § 403.5(a)) of the proscribed behavior, and fails to provide adequate standards, thereby failing to assure "enforce[ment] [of] the law in a non-arbitrary, non-discriminatory manner." *Kolender v. Lawson*, 461 U.S. 352, 357 (1983). Neither the existing nor proposed narrative color permit condition (or other narrative permit conditions) should be included in the City's final NPDES permit to be reissued.

ATTACHMENT C

PERMITTING REQUIREMENTS FOR COMPLIANCE WITH NARRATIVE WATER QUALITY CRITERIA

The City of Memphis' (the City) Stiles wastewater treatment facility ("WWTF") is subject to an NPDES permit which contains the following narrative requirement pertaining to color: "The wastewater discharge must not cause an *objectionable color contrast* in the receiving stream."[1] (Emphasis added). While the Environmental Protection Agency (EPA) and Tennessee Department of Environmental Conservation (TDEC) have alleged that the City is in violation of the Stiles NPDES permit color narrative standard, neither EPA nor TDEC have been able to identify how much color is acceptable and what controls must be achieved in order to be deemed in compliance with the vague narrative standard. This ambiguous limit is problematic as there is no clear way to gauge the City's compliance within the subjective boundaries.[2]

The August 30, 2010 draft NPDES permit for the Stiles WWTF proposes to change the narrative color permit requirement to: "[t]he wastewater discharge shall not cause a distinct color contrast . . . in the receiving water."[3] There is no basis for imposing a prohibition based upon a "distinct color contrast." The underlying water quality criteria for recreation uses provides: "There shall be no color that . . . will result in any objectionable appearance to the water, considering the nature and location of the water." (Tenn. Code Ann. §1200-4-3-.03(4)(d)). There is absolutely no basis for concluding that all distinct color contrasts would be objectionable considering the nature and location of the water. In other contexts, TDEC has undertaken a "color panel" and concluded that a certain amount of change or contrast in the receiving water due to a discharge is not objectionable. Furthermore, this draft permit condition would potentially penalize the City if its effluent was more natural in color than the receiving water. Surely, the City can not appropriately be deemed to be in violation for discharging water that is too clean!

Despite the inherent limitations of this vague limit, the City has been seeking to impose the same standard, through the "pass through" standard to its industries. Both the City and its industries are concerned that, in addition to any immediate actions undertaken to improve the quality of the color discharged from the Stiles WWTP (*e.g.*, construction of treatment at an industry discharging color or a change in materials used), they may later have to undertake additional actions due to the fact that the "subjective" nature of the standard can result in a "moving target." Consequently, the City has verbally requested (and in comments on the draft NPDES permit hereby requests) that TDEC issue a permit with numeric limitations or, in the

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[1] The existing NPDES permit for the T.E. Maxson ("Maxson") Wastewater Treatment Plant contains the same language.

[2] Void for vagueness issues associated with inclusion of the narrative standard in the NPDES permit is addressed by Attachment B. The draft narrative permit conditions for color in both the Stiles and Maxson draft NPDES permits would be subject to the same "void for vagueness" concerns as the existing NPDES permit language.

[3] The August 30, 2010 proposed NPDES permit for the Maxson plant similarly contains such language

alternative, impose best management practices ("BMPs") if numerical effluent limitations are infeasible. In either case, both the City and its industry should be provided with legal assurances that if activities are undertaken to meet the new permit requirements that their actions will not be second-guessed in subsequent permitting actions.

These comments provide that (1) the NPDES permit **must** contain numerical permit limits (or BMPs, if numerical limits are infeasible) and (2) TDEC, as the NPDES permitting authority, is the entity legally responsible for such work.

Numerical Limits Must be Established Unless Infeasible, in Which Case, BMPs May be Utilized

After imposing mandatory technology-based limits on dischargers, the Clean Water Act ("CWA") requires permitting authorities to issue permits with more stringent limitations, if such limits are needed to meet existing water quality standards.[4] This need-based permitting requirement is borne from the express language of the Act itself. Specifically, CWA § 301(b)(1)(C) states: "In order to carry out the objective of this Act there shall be achieved -- *any more stringent limitation, including those necessary to meet water quality standards*, treatment standards, or schedule of compliance, established pursuant to any State law or regulations, (under authority preserved by Section 510) or any other Federal law or regulation, or *required to implement any applicable water quality standard established pursuant to this act.*" (emphasis supplied).

These water-quality based effluent limitations ("WQBELs") apply regardless of whether the standard in question is numeric or narrative. *American Iron & Steel Inst. v. EPA*, 115 F.3d 979, 990-991 (D.C. Cir. 1997) ("Because narrative criteria do not specify numerical limitations on the concentration of a particular pollutant in the water, a problem arises when it comes to formulating discharge limitations in permits. We have already mentioned that permits must incorporate discharge limitations necessary to ensure that the water quality standards are met. This requirement applies to narrative criteria as well as to criteria specifying maximum amounts of particular pollutants."); *Pud No. 1 v. Wash. Dep't of Ecology*, 511 U.S. 700, 716 (U.S. 1994) ("Washington's Class AA water quality standards are typical in that they contain several *open-ended criteria* which…must be translated into specific limitations for individual projects."); 54 Fed. Reg. 23868, 23871 (Friday, June 2, 1989) (promulgation of amendments to 40 C.F.R. § 122.44(d)) ("Today's regulations amend paragraph (d)(1) to clarify that effluent limits established under paragraph (d) must achieve any state narrative water quality criteria as well as numeric water quality criteria.")

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[4] In opting not to include technological-based limitations and guidelines and standards for color, EPA noted that color is best dealt with on a local or waterbody-specific basis. 63 Fed. Reg. 18504, 18538 (April 15, 2008) ("The potential for significant aesthetic or aquatic impacts from color discharges is driven by highly site-specific conditions and is best dealt with on a case-by-case basis through individual permits . . . . ")

While the NPDES permit must contain an effluent limitation that will ensure the receiving waterbody meets the water quality standard in question, this "translation" process is more difficult when the water quality standard at issue is a narrative. As the D.C. Court opined in *American Paper Inst. v. United States EPA*, 996 F.2d 346 (D.C. Cir. 1993):

> When the standard includes numeric criteria, the process is fairly straightforward: the permit merely adopts a limitation on a point source's effluent discharge necessary to keep the concentration of a pollutant in a waterway at or below the numeric benchmark. Narrative criteria, however, present more difficult problems: How is a *state or federal NPDES permit writer* to divine what limitations on effluent discharges are necessary to assure that the waterway contains, for example, 'no toxics in toxic amounts'? Faced with this conundrum, some *permit writers* threw up their hands and, contrary to the Act, simply ignored water quality standards including narrative criteria altogether when deciding upon permit limitations.

Id. at 350 (emphasis supplied). Thus, in an effort to aid permit writers in translating narrative standards into effluent limitations, in 1989 EPA amended the Part 122 regulations to deal with the problem on a national basis. 54 Fed. Reg. 23868 *et seq.* (promulgation of amendments to 40 C.F.R. § 122.44(d)) (Friday, June 2, 1989). EPA clearly indicated that the regulation (*i.e.*, requiring the development of numerical effluent limits) applies to all pollutants, including nonconventional pollutants such as color[5] that are regulated by narrative requirements:

> The new paragraph clarifies that an NPDES permit must limit any pollutant or pollutant parameter (whether conventional, nonconventional, or toxic), including whole effluent toxicity, that is or may be discharged at a level that causes, has the reasonable potential to cause, or contributes to an excursion above any water quality criterion, including state narrative water quality criteria. The new language clarifies that paragraph (d) applies to any pollutant whether conventional, nonconventional, toxic, or whole effluent toxicity, and applies to excursions above *narrative water quality criteria*, not just numeric criteria in state water quality standards. (Emphasis added.)

54 Fed. Reg. 23872 (Friday, June 2, 1989) (promulgation of amendments to 40 C.F.R. § 122.44(d)). The revised regulations, pertinent portions found at 40 C.F.R. § 122.44(d)(1)(i) & (vi), were upheld as "reasonable, authorized attempts at necessary gap-filling in the CWA statutory scheme." *See American Paper Inst. v. EPA*, 996 F.2d 346, 348 (D.C. Cir. 1993). Specifically these regulations state:

> In addition to the conditions established under 122.43(a), *each NPDES permit shall include conditions meeting the following requirements* when applicable.

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[5] The Clean Water Act lists color to be a nonconventional pollutant. *See, e.g.*, CWA § 301(g)(1) ("Modifications for Certain *Nonconventional* Pollutants" lists color and other pollutants as examples of nonconventional pollutants.)

...

(d) Water quality standards and State requirements: any requirements in addition to or more stringent than promulgated effluent limitations guidelines or standards under sections 301, 304, 306, 307, 318 and 405 of CWA necessary to:

(1) Achieve water quality standards established under section 303 of the CWA, *including State narrative criteria for water quality.*

(i) Limitations must control all pollutants or pollutant parameters (either conventional, *nonconventional*, or toxic pollutants) which the Director determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any State water quality standard, *including State narrative criteria for water quality.*

* * *

(vi) Where a State has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above *a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits using one or more of the following options:*

(A) Establish effluent limits using a calculated numeric water quality criterion for the pollutant which the permitting authority demonstrates will attain and maintain applicable narrative water quality criteria and will fully protect the designated use. Such a criterion may be derived using a proposed State criterion, or an explicit State policy or regulation interpreting its narrative water quality criterion, supplemented with other relevant information which may include: EPA's Water Quality Standards Handbook, October 1983, risk assessment data, exposure data, information about the pollutant from the Food and Drug Administration, and current EPA criteria documents; or

(B) Establish effluent limits on a case-by-case basis, using EPA's water quality criteria, published under section 304(a) of the CWA, supplemented where necessary by other relevant information; or

(C) Establish effluent limitations on an indicator parameter for the pollutant of concern, provided: (1) The permit identifies which pollutants are intended to be controlled by the use of the effluent limitation; (2) The fact sheet required by 124.56 sets forth the basis for the limit, including a finding that compliance with the effluent limit on the indicator parameter will result in controls on the pollutant of concern which are sufficient to attain and maintain applicable water quality standards; (3) The permit requires all effluent and ambient monitoring necessary to show that during the term of the permit the limit on the indicator parameter continues to attain and maintain applicable water

> quality standards; and (4) The permit contains a reopener clause allowing the permitting authority to modify or revoke and reissue the permit if the limits on the indicator parameter no longer attain and maintain applicable water quality standards.

40 C.F.R. § 122.44(d)(1)(i) and (vi) (emphasis supplied).

Subsection (d)(1)(i) mandates that NPDES permits include more stringent "limitations" on pollutants (including nonconventional pollutants, *i.e.*, color) which have the potential to cause or contribute to an excursion of a narrative water quality criterion. Moreover, section (d)(1)(vi) instructs the permitting authority to use one of three different approaches for translating the narrative standard for any pollutant[6] into a more stringent effluent limitation.

Section 122.44(d), however, must be read in conjunction with the other permitting regulations as the CWA has some limited exceptions allowing for effluent limitations to be written in a form other than as a numeric concentration. Specifically, under 40 C.F.R. 122.44 (k), the permit may contain non-numeric effluent limitations in the form of BMPs[7] to control the discharge

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[6] The preamble to the amended regulation noted commenters' concerns associated with the reference to "specific chemical pollutants" in §122.44(d)(vi). In response, EPA noted that the standard applies to all pollutants that otherwise meet the threshold concerns, it was not intended to apply to a subset of pollutants meeting the threshold concern:

> Several commenters said the phrase '* * * for a specific chemical pollutant that is known to adversely affect or threaten human health or aquatic life * * *' in proposed (vi) could have been read to require an effluent limit for every priority pollutants, even if the pollutant is not present in the effluent. Other commenters said this language should apply to discharges that are 'known or suspected' to adversely affect aquatic life or human health. EPA agrees that these points needed clarification. As a result of these comments, EPA amended the introductory language of paragraph (vi) to clarify that water quality-based effluent limits are required only for pollutants that are '* * * present in an effluent at a concentration that causes, or has the reasonable potential to cause, or contribute to an excursion above a narrative criterion with an applicable state narrative water quality standards.' This language clarifies that water quality-based effluent limits are required only for pollutants present in an effluent at concentrations of concern to the permitting authority.

54 Fed. Reg. at 23875 (June 2, 1989). Moreover, the preamble to proposed § 122.44(d)(vi) (proposed at 122.44(d)(iv) at 54 Fed. Reg. 1300, 1304 (January 12, 1989), which also utilized the "specific chemical pollutant" language, reflects EPA's intent that such provision apply to a "toxic, conventional, or nonconventional pollutant." Nowhere does EPA manifest an intent that the use of the term "specific chemical pollutant" is somehow meant to be a subset of toxic, conventional or nonconventional pollutants.

[7] BMPs are defined as

> ...schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control

of pollutants, when numeric limits are infeasible.[8] Whereas the federal regulations would also allow the use of BMPs in other instances (*e.g.*, the practices are necessary to achieve effluent limitations and standards) the State regulations limit the use of BMPs to only those situations where "numeric effloent limitations are infeasible and the practices are reasonably necessary to achieve effluent limitations and standards or to carry out the purposes and intent of TWQCA." Rule 1200-4-5-.08(1)(i).

Thus, onless nomeric effloent limitations are infeasible (and the other conditions of Rule 1200-4-5-.08(1)(i) are met) TDEC must translate narrative standards into numeric limits.[9] Moreover, in making this translation, 40 C.F.R. § 122.44(d) limits the State to three options to conform to this mandate. If, however, numeric limits are infeasible, TDEC is not free to merely parrot the narrative standard into the permit for later interpretation (or to make arbitrary changes to the narrative requirement and include such changes in the permit). At a minimum, TDEC must interpret the narrative standard and impose BMPs which restrict the amount or concentration of the pollotant entering the receiving water. This need to interpret the standard narrative standard was discussed in *American Paper Institute*, where the federal Court of Appeals for the D.C. Circuit coort stated:

> The general language of narrative criteria can only take the permit writer so far in her task. Of course, that does not mean that the langoage of a narrative criterion does not cabin the *permit writer's* authority at all; rather, *it is an acknowledgement that the writer will have to engage in some kind of interpretation to determine what chemical-specific numeric criteria--and thus what effluent limitations--*

> plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

40 C.F.R. § 122.2.

[8] EPA regulations allow BMPs to control or abate the discharge of pollutants when:

> (1) Authorized under section 304(e) of the CWA for the control of toxic pollutants and hazardous substances from ancillary industrial activities; (2) Authorized under section 402(p) of the CWA for the control of storm water discharges; (3) Numeric effluent limitations are infeasible; or (4) The practices are reasonably necessary to achieve effloent limitations and standards or to carry out the purposes and intent of the CWA.

40 C.F.R. § 122.44(k).

[9] Furthermore, by rule, Tennessee's Water Quality Control Board is required to adhere to several considerations related to water quality. Tenn. Comp. R. & Regs. 1200-4-3-.01 "The following general considerations and criteria shall be used to determine... the corrective measures required to control pollution."). One of these considerations includes the reqoirement that Tennessee's Water Quality Control Board adhere to EPA's regolations and guidance related to the interpretation and application of narrative criteria (*e.g.*, § 122.44(d)(1)(i) and (vi)). Tenn. Comp. R. & Regs. 1200-4-3.02 (10) ("Interpretation and application of narrative criteria shall be based on available scientific literature and EPA guidance and regulations.")

> *are most consistent with the state's intent as evinced in its generic standard.* (Emphasis added.)

American Paper Inst. v. EPA, 996 F.2d 346, 351 (D.C. Cir. 1993). With respect to the city's narrative permit limit for color, it is clear that from the existing and proposed permit conditions for color that TDEC is not adhering to the statutory and regulatory obligations discussed above.

In a decision somewhat related to the issues discussed in this attachment, the Tennessee Water Control Board similarly recognized that, as a matter of law, numeric limits were not always required under the CWA or the Tennessee Water Quality Control Act (TWQCA). *In the Matter of Tennessee Clean Water Network*, Tennessee Water Pollution Control Board, Docket No. 04.30-105612A, April, 2010 at 15 (order granting in part and dismissing in part cross-motions for summary judgment). In this decision, Petitioner alleged that numeric violations must be included in a permit issued to curtail the stormwater runoff associated with a construction site. Although the facts in that case were distinguishable from the present -- the receiving waters were impaired for siltation and the temporary construction was expected to result in additional sediment into the watershed -- TDEC's defense of the non-numeric limits is enlightening. Specifically, in arguing that non-numeric limitations were appropriate, TDEC never argued for an approach which allowed the permit writer to merely recite a vague and subjective narrative standard back into the permit. To the contrary, TDEC stated, and the Board agreed, that it had authority to establish BMPs under several different state and federal provisions and that the BMPs, if complied with, would achieve the allocations set forth in the applicable TMDLs to restore the biotic integrity of the stream. *Id.* TDEC's Response in Support for CMMA's Motion for Summary Judgment, at 4-8.

In summary, the CWA, its implementing regulations, EPA's permitting guidance, federal case law, Tennessee rules, and TDEC's own averments to the Tennessee Water Pollution Control Board all require the City's NPDES requirements for color to contain more than a recitation of the State's narrative standard. Individually, and collectively, these authorities require the permit to include a limit or restriction which best interprets the state's general narrative standard. In fact, EPA's regulations set forth specific procedures for translating the narrative standard into a numeric standard in these situations. Moreover, if such a numeric limit is infeasible, EPA's and TDEC's regulations allow the permit to include BMPs to achieve compliance with the state's narrative standard. Nowhere do these authorities sanction a permit which merely restates (or worse yet, arbitrarily modifies) the subjective and ambiguous description contained in the narrative standard.

<u>TDEC, as The NPDES Permitting Authority Has the Legal Obligation to Develop Numerical Limits or, If Infeasible, BMPs</u>

In discussions, the issue has arisen as to whether the permittee or the NPDES permitting authority (*i.e.*, TDEC) has the legally responsibility for generating non-subjective numeric permit limits (or BMPs, if applicable). There is absolutely no support for the proposition that the permittee is somehow legally required to develop the applicable permit limits. The CWA expressly requires that EPA, or any approved state-permitting programs, draft and issue permits. Putting aside the obvious chaos that would result from allowing dischargers to interpret appropriate limits for their permits, EPA's guidance documents, preambles, and regulations are

replete with statements confirming that the permit writer is responsible for this conversion. See e.g., 40 C.F.R. § 122.44(d)(1)(i) referring to what each NPDES permit should include; 40 C.F.R. § 122.44(d)(1)(iv) referring to the permitting authority's responsibility; NPDES Permit Writer's Manual, EPA Docket # 833-K-10-001September, 2010 at section 6.4 ("*If a permit writer* has determined that a pollutant or pollutant parameter is discharged at a level that will cause, have reasonable potential to cause, or contribute *to an excursion above any state water quality standard, the permit writer must develop WQBELs for that pollutant parameter.*"); *American Paper Inst. v. United States EPA*, 996 F.2d 346, 350 (D.C. Cir. 1993) ("How is a *state or federal NPDES permit writer* to divine what limitations on effluent discharges are necessary to assure that the waterway contains, for example, 'no toxics in toxic amounts'? Faced with this conundrum, some *permit writers* threw up their hands and, contrary to the Act, simply ignored water quality standards including narrative criteria altogether when deciding upon permit limitations."); Clarifications Regarding Certain Aspects of EPA's Surface Water Toxics Control Regulations, M. Cook, EPA, OWEAC to Water Management Division Directors, August 14, 1992. ("When *a permit writer interprets* a narrative standard, the method of interpretation used will be available for public comment as a part of the permit and typically may be appealed through administrative and judicial procedures available for review of NPDES permit conditions."); *supra* at 9. *American Paper Inst. v. EPA*, 996 F.2d 346, 351 (D.C. Cir. 1993) (repeatedly referring to the permit writer's responsibility to translate narrative standards).

Furthermore, it is a basic tenet of the NPDES permitting program that in order for a State to obtain EPA approval of the State's NPDES permitting program, it must demonstrate that it has the requisite legal authority to issue permits and to apply and insure compliance with, among other things, water quality standards.[10]

As such, the idea that the City should be responsible for translating subjective narrative standards into tangible effluent limitations, let alone any permitting responsibilities, is legally unsupported. As the approved permitting authority, it is TDEC's responsibility, and TDEC's responsibility alone, to issue the City a permit containing the legally-required non-subjective numeric effluent limitations (or BMPs, if applicable) for color. Notwithstanding such approach, nothing prevents the City from voluntarily assisting TDEC in such endeavor, as the City deems appropriate, and otherwise coordinating with other interested parties to try and assure that the permit requirements (whether numerical or BMPs) address applicable concerns.

[10] States approved for NPDES permitting must also adhere to this fundamental Clean Water Act requirement. CWA § 402(b)(1) [33 U.S.C. § 1242(b)(1)] ("The Administrator shall approve each such submitted program unless he determines that adequate authority does not exist: (1) to issue permits which (a) apply, and insure compliance with, any applicable requirements of sections 1311, 1312, 1316, 1317, 1343 of this title,... ")

Attachment D
Comments on M.C. Stiles Draft NPDES Permit

City of Memphis
TENNESSEE

MYRON LOWERY - Mayor Pro Tem
JACK SAMMONS - Chief Administrative Officer
DIVISION OF PUBLIC WORKS
DWAN L. GILLIAM - Director

October 12, 2009

Mr. Vojin Janjic
Manager, Permit Section
Division of Water Pollution Control
Tennessee Department of Environment and Conservation
401 Church Street
L & C Annex 6th Floor
Nashville, Tennessee 37243-1534

Subject: Revised Draft of NPDES Permit No. TN0020711
M.C. Stiles Wastewater Treatment Plant (WWTP)
Memphis, Shelby County, Tennessee

Dear Mr. Janjic,

We would like to once again thank you and Gary Davis for your time and the opportunity to discuss the M. C. Stiles WWTP draft NPDES permit on September 30th. We believe the meeting was productive and allowed us as a group to talk through some of our concerns and questions about the proposed permit. Based on our discussions, we agreed to provide additional information on the proposed compliance schedules for both disinfection implementation and foam and color study and resolution.

***E. coli* Limit (Disinfection) Compliance Schedule**

As discussed, the City currently does not have the infrastructure in place to allow disinfection to be properly implemented at the effective date of the new permit. While a chlorine contact basin was constructed during the plant's initial construction and is still in place, there is no provision for chemical storage, chemical feed systems, nor control systems necessary to operate a disinfection process. Further, we continue to study options for disinfection, and chlorination may not ultimately be the preferred option.

Therefore, the City requests that a reasonable compliance schedule be added to the revised draft permit, and that the current limits be held in abeyance, to allow for:

- The first phase of the compliance schedule would allow for time to complete a study of alternative disinfectants. Please note that the original chlorination system designed for the Stiles WWTP assumed use of chlorine gas delivered by rail car. This potential use of chlorine gas as originally planned needs to be reconsidered for several reasons: safety, the fact that the

rail spur was never constructed, and the concerns about disinfection byproducts in the revised draft permit. Twelve months are requested to conduct and evaluate the results of a disinfection alternatives study; the results of which will be summarized in a report that will be submitted to TDEC, with a recommendation for the method of disinfection.

- If chlorine based disinfection is the recommended method, time is requested to determine if de-chlorination is also needed for compliance. This study would also examine the impact de-chlorination would have on the formation of disinfection byproducts. Three months are requested to conduct and evaluate the results of this study. The results of the study will be summarized in a report that will be submitted to TDEC.

- Once a disinfection alternative is selected based on the study, the design, bidding and construction of the required facilities needed to implement disinfection will be initiated. The City estimates that the following time would be needed to complete these steps based on past construction experience and the City's procurement requirements:

    - 4 months to award a design contract,
    - 12 months to design and advertise for bids
    - 4 months to process bid documents and contract and
    - 18 months to construct the facilities.

- The City also requests a reasonable period of time (3 months) be included in the compliance schedule to develop operational proficiency with the new disinfection system following handover of the facilities by the contractor.

Color and Foam Compliance Schedule

Page 2 of the revised draft permit includes the requirement that: "There shall be no distinctly visible floating foam, scum, oil or other matter contained in the wastewater discharge. The wastewater discharge must not cause a distinct color contrast in the receiving stream."

Sections 3.5 and 3.6 of the revised draft permit include studies focusing on foam and color associated with the M.C. Stiles effluent discharge. The City appreciates that TDEC understand that studies (and possibly design and construction) will be necessary to bring the discharge into compliance with the permit requirements cited above. Accordingly, the City requests that a reasonable compliance schedule be added to a revised draft permit to allow the City (and potentially its contributing industries) to have a reasonable amount of time to address these issues.

The City has voluntarily taken steps to reduce foaming in its effluent in the short-term utilizing de-foaming agents, but needs additional time to investigate possible long-term solutions other than addition of de-foamer that would address the source of the problem. Information on the City's actions to date is provided below, followed by proposed activities to be included in a compliance schedule.

Compliance Schedule for Foam and Color Control

The compliance schedule that the City is requesting would include the following actions to eliminate foaming and visible color after initial mixing in the river associated with its discharge. The City requests that during this period of time, the narrative requirements of the permit cited above be held in abeyance. The City will commit to more aggressive use of de-foaming agents to minimize potential foaming during the duration of the compliance schedule and to demonstrate good faith in this regard has recently increased the strength of the de-foaming agent as noted below. The City proposes the following schedule and tasks:

- A study to optimize the application location and dose of de-foaming agent for both the short-term and possibly long-term solutions. The City has already begun these efforts by starting to use a double strength de-foaming agent (i.e., a 20% polydimethylsiloxane solution) for injection into the plant's effluent at the chlorine contact basin.

- A study to investigate the causes of the foam and to make recommendations for mitigating the foam. The City has engaged a consultant to assist with this effort and is currently working cooperatively with the consultant on a sampling and testing program of the plant process, influent sewer interceptors, and Industrial Users (IU), and conducted an IU surfactant survey to gather data for determining the possible causes of the foam. This program is on-going with the consultant continuing to analyze the data generated and being generated by this program.

- A study of the plant process has been initiated to determine whether surfactant compounds are accumulating in the plant to contribute to foam production.

- An evaluation is being made of potential need to modify the outfall pipe downstream of the chlorine contact chamber with a focus on eliminating the existing 19-foot vertical free fall in the drop structure near the terminus of the primary outfall to reduce the potential for foam formation.

- An evaluation will be conducted of how modifying the outfall terminus (deeper, slightly longer etc.) could diminish foam production.

- A study will be conducted of sources of color in the industrial discharges to the WWTP and their possible reduction and/or elimination. The City staff will work with the applicable industrial dischargers to reduce the color loading to the WWTP.

The studies proposed above would be performed concurrently and at the end of the 12-month study period, the City will submit a report to TDEC identifying the next steps that are necessary to address the color and foam issue.

The corrective actions that will be identified by the above studies are difficult to forecast and could be either (1) a collection of changes in the plant processes or (2) require construction of pre-treatment facilities either by the industries or city in partnership with the industries. These two approaches have different timelines and thus we request a conditional time frame based on the findings of the study, specifically:

- If the study finds that foam and color can be addressed by changes to the existing processes used by the industry, then the City would request 18 months to implement these recommendations and work with the applicable industries on color process reduction.

- If it is necessary to construct pre-treatment facilities, then we request that the compliance schedule that would accommodate the City's past construction experience and the City's procurement requirements:

    - 4 months to award a design contract,
    - 12 months to design and bid the remaining facilities,
    - 4 months to process the contract award and
    - 18 months to construct the facilities.

We also appreciate the discussion on the other issues raised by the City and related to the draft permit as identified in our original response. Based on our meeting discussions, we have listed what we understood to be the resolution of each of the 33 items that we discussed on September 30th. As shown, a couple of the minor items were not specifically discussed, but are included in table. We will be happy to discuss any of these items more specifically if needed.

Item	Item Description	Resolution
A1		Not discussed during our meeting
A2	E. coli limits should apply instream (with dilution) rather than end-of-pipe concentrations	No dilution due to only primary recreation standard
A3	Change E. coli permit limits - Drop max day E. coli limit - Change average day E. coli limit to include receiving water dilution	Not discussed during our meeting
A4	Allow 18-month compliance schedule for E. coli limits and possible generation of disinfection byproducts to include:	See compliance schedule included above
A5	Drop permit limits for AOX as parameter is not relevant	Agreed that the City will develop list of possible DBPs of concern as part of the disinfection study. Agreed AOX not a good measurement of chlorinated by-products
A6	Drop permit limits for heptachlor and chlordane	Limits to remain
A7	Drop permit limits for dieldrin as value incorrectly read on TDEC's own graph	TDEC to confirm permit limits for dieldrin
A8	Drop monitoring requirement for PCBs	PCBs to be monitored 1/year
A9	Drop monitoring requirement for methyl mercury due to unproven/ unsupported hypothesis that this forms during anaerobic digestion	Sampling to be conducted 1/year
A10	Drop monitoring requirement for nonylphenol and nonylphenol ethoxylates	No monitoring required

A11	Make conditional monitoring for TRC in footnote b for consistency with other permit provisions	TDEC to revise
A12	Drop monitoring requirements for dioxin, organic pesticides, DDT, dieldrin, heptachlor, chlordane in MS river upstream of discharge – "research program"	Requirement to be removed from permit
A13	Refine language on TRC monitoring when "other oxidants" used.	TDEC to revise
A14	Modify permit language on narrative standards (visible pollutants & toxics in hazardous amounts) to match underlying regulations	TDEC to revise
A15	Drop permit language about monitoring when industries at "normal to maximum contaminant levels" as this is not representative	Remove "normal to maximum" and replace with "representative" in permit
A16	Refine permit language on BOD sampling location	This was not discussed during our meeting
A17	Drop Section 1.2.3.d on best available analytical methods as potential onerous and redundant	TDEC to address
A18	Drop 1.3.5.2 on anticipated bypass notification as redundant and confusing	TDEC to address
A19	Change permit language to remove" to properly operate/maintain collection system" as not supported by TN regulations	Agreed to keep as currently written
A20	Drop sentence on prohibiting new IPP-regulated discharges that require permit modification until TDWPC gives authorization	TDEC to address
A21	Drop requirement for survey of industrial users because nutrient mgt plan (A31) should be dropped	To be dropped from permit
A22	Clarification needed for IPP reporting requirements	IPP reporting to be clarified
A23	Clarification on # of acute WET needed and why if really 4 separate tests.	4 individual tests to remain in the permit
A24	Drop permit requirement for chronic WET testing	No chronic WET testing in permit, but will be required as part of the permit application process
A25	Allow option of use of MS River water as control water for WET tests OR use of "hard" synthetic water	Not discussed
A26	Add permit provision to decrease frequency of WET testing if 4 consecutive tests pass	Not discussed
A27	Drop Section 3.5 - requirements for monitoring in the river for dilution to meet coliform limits and disinfection byproducts because of	Requirements to be removed

	compliance schedule request in A4	
A28	Drop Section 3.6 - requirements for source identification and control plan for banned organic chemicals	Requirements to be removed
A29	Drop requirement for daily photographs of effluent discharge and "foam" plume.	Discussed the need for documentation after the completing the items in the compliance schedule on foam. Documentation could be photos or a check sheet.
A30	Allow 18-month compliance schedule for color and foaming to include	See compliance schedule included above
A31	Drop Section 3.7 - requirement for nutrient management plan due to lack of legal authority or other established basis (e.g., IPP) for inclusion	Requirement to be removed
A32	Fix typo on PCB units	TDEC to acknowledge the revised units in the response to comments
A33	Provides clarification on TDEC response on dilution available from two existing outfalls	Fact sheet will not be changed but TDEC to address clarification

Please let us know if there are any questions and/or comments regarding any of these resolutions or any additional information that is needed from the City at this time. Thanks again for your time and willingness to discuss these issues and for working toward a permit that is acceptable to all parties. We look forward to hearing from you in the near future in regarding to this revised draft permit.

Sincerely,

[redacted]

Paul Patterson
Administrator of Environmental Engineering

Dwan Gilliom, Director of Public Works
Don Hudgins, City of Memphis
Chris Provost, CDM
Gary Davis, TDEC

Appendix AD-B1
EPA's Written Comments

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

JUL 1 6 2011

Mr. Vojin M. Janjic
Manager, Permit Section
Division of Water Pollution Control
Tennessee Department of Environment and Conservation
L & C Annex - 6th Floor
401 Church Street
Nashville, Tennessee 37243-1534

Dear Mr. Janjic:

In accordance with the Environmental Protection Agency-Tennessee Department of Environment and Conservation (TDEC) Memorandum of Agreement (MOA), we have completed our review of the draft National Pollutant Discharge Elimination System (NPDES) permits for two Sewage Treatment Plants (STPs) in Memphis: Maynard C. Stiles STP (NPDES permit number TN0020711) and T. E. Maxson STP (NPDES permit number TN0020729). The draft permit and supporting materials that went to public notice on May 16, 2011, were received electronically on May 18, 2011. On June 16, 2011, the EPA requested a full 90-day review of these draft permits. At this time, the EPA is formally submitting its comments. It is noted that on December 1, 2010, the EPA submitted comments to draft permits submitted last year.

In regards to the permits and rationales, the EPA has several areas of general concern which are presented here. Our comments are as follows:

> For both facilities, a schedule of compliance for *E. coli* and total residual chlorine (or total residual oxidents) has been included. Previously, the EPA recommended that the rationales for both permits document the appropriateness for the inclusion of the compliance schedule and to establish interim requirements and dates if the schedule is more than one year; this has not been presented in the draft permits and rationales. Please refer to 40 Code of Federal Regulations (CFR) Section 122.47(a). The referenced memo dated May 10, 2007, from James A. Hanlon regarding Compliance Schedules (see this website: http://www.epa.gov/npdes/pubs/memo_complianceschedules_may07.pdf) provides additional guidance on how permit writers can justify compliance schedules consistent with 40 CFR Section 122.47. More detail is provided in the enclosures.
>
> As previously discussed in our letter dated December 1, 2010, another concern is whether the Tennessee Valley Authority - Allen Steam Plant's cooling water, which T. E. Maxson discharges to, would be considered "waters of the U.S.," the EPA asks that TDEC clarify this designation. See the enclosure for additional information on this facility.

Per the MOA, Section B.5., please consider these comments. As per the MOA, Section B.6., please provide the EPA the opportunity to review the "proposed final" permits prior to issuance if they differ significantly from these drafts, if significant public comments objecting to the draft have been received by TDEC, or if there are significant issues raised by other states which may be affected by the discharges. If you have any questions, please contact Ms. Connie Kagey of my staff at (404) 562-9300.

[redacted]
Mark J. Nutter, Chief
Municipal and Industrial NPDES Section
Pollution Control and Implementation Branch
Water Protection Division

Enclosures

cc: Mr. Dwan L. Gilliom
Director, City of Memphis
Division of Public Works

TN0020711 Memphis – Maynard C. Stiles STP (Comments on 5/17/2011 Draft NPDES Permit)			
PAGE	**SECTION**	**DESCRIPTION**	**COMMENT**
2 *	1.1	Organic Pesticide Chemicals; Heptachlor and Total Chlordane monitoring	The EPA recommends establishing composite monitoring for these pollutants instead of an instantaneous grab sample. Organic chemicals should be monitored by composite samples.
2 *	1.1	Mercury and Methyl Mercury monitoring	The EPA recommends clarifying the reason that the Total Mercury monitoring requires a composite sample, whereas the Methyl Mercury monitoring requires a grab sample.
2	1.1	Mercury monitoring frequency	The table for pre-treatment requirements on page 20 (Section 3.2.d.ii.) shows that metals, including total mercury, are to be monitored semiannually, thus, the EPA recommends that total mercury in the limits table should also be monitored semiannually.
2	1.1	Typo	Total chlordane is listed in the table, but the footnote reads "technical" chlordane. Please correct, as needed.
5 *	1.2.3.a	Typo	3rd Sentence: This references PCBs (not "PBCs"). Please correct.
20	3.5	Compliance Schedule	Any compliance schedule must be justified as per 40 CFR Section 122.47(a). When a compliance schedule is given, the permittee should be required to notify the Permitting Authority in writing whether compliance dates have been met. (40 CFR § 122.47(a)(4). The EPA recommends that the permit require the permittee to report progress of compliance (within 14 days of each interim or final date of compliance) for each step as required by the regulation.
26	3.5.1	Additional Permittee Submittals	This section does not give specific dates when the various reports are due. The EPA recommends inclusion of specific dates when the permittee is to submit each report referenced in this section.
R-4	6.3.4.	Biomonitoring	The second paragraph states that the discharge demonstrates some chronic toxicity. The EPA recommends that TDEC clarify whether reasonable potential exists for chronic toxicity and include a chronic toxicity limit, as appropriate.

TN0020711 Memphis – Maynard C. Stiles STP (Comments on 5/17/2011 Draft NPDES Permit)

PAGE	SECTION	DESCRIPTION	COMMENT
R-13	8.10.	Chlorinated Byproducts	Neither the permit, nor the rationale has the date that the permittee is to provide the information to Tennessee. The EPA recommends that the permit include the date this report is due.
R-15	9.1.	Treated Effluent Transport/Dispersion Within Receiving Stream	Neither the permit, nor the rationale has the date that the permittee is to provide the information to Tennessee. The EPA recommends that the permit include the date this report is due.
R-17 *	10.	Receiving Stream WQ Status/Antidegradation	The last sentence of the 3rd paragraph reads as if it were a placeholder. The EPA recommends deleting and/or rewording to clarify.
R-18 *	10.	Receiving Stream WQ Status/Antidegradation	The rationale has indicated that a TMDL has been established for chlordane, dioxins, and PCBs, yet no justifications have been made in the discussion on how the limits that have been established are consistent with the assumptions and requirements of the TMDL wasteload allocations as per 40 CFR Section 122.44(d)(1)(vii)(B). The EPA recommends discussing how these limits are consistent with the wasteload allocation.
R-25 *	App. 2e	Treated effluent – Biomonitoring	The EPA's 2A application requires that effluent data be no more than 4.5 years old. The EPA recommends that TDEC request and present more recent results for each of these sections.
R-26 *	App. 2f	Landfill groundwater monitoring results (Mercury)	
R-27 *	App. 2g	M.C. Stiles Sludge mercury content	

* A similar comment (or question) was previously made by the EPA in the enclosure to its December 1, 2010, letter.

Appendix AD-C1
TCWN/Sierra Club's Written Comments

August 10, 2011

Mr. Vojin Janjić
Tennessee Department of Environment & Conservation
Water Pollution Control
6th Floor L & C Annex
401 Church Street
Nashville, TN 37243-1534

Subject: Draft NPDES Permit TN0020711 (Memphis - Maynard C. Stiles STP)
Draft NPDES Permit TN0020729 (Memphis - T.E. Maxson STP)

Dear Mr. Janjić:

The Tennessee Clean Water Network ("TCWN") and the Sierra Club are pleased to submit these joint comments regarding the draft National Pollutant Discharge Elimination System ("NPDES") permits for the above-referenced sewage treatment plants in Memphis, TN. Unless otherwise specified, each comment addresses both permits.

Given the very substantial delays in issuing these permit renewals, TCWN and the Sierra Club urge you to finalize these permits as soon as possible. These plants are operating under permits that are more than 11 years old and that contain outdated terms. This is the third draft permit for the Stiles plant, and the second for Maxson. Further delay is unwarranted.

1. References to Administrative Actions

TCWN and the Sierra Club appreciate the Division's elimination of references to administrative actions that were contained in the prior draft permit.

2. Foam and Color

Commenters request the Division to specifically address foam in these permits. We request the narrative limit on page 3 of each permit be modified slightly to read: "There shall be no distinctly visible floating scum, oil, foam, or other matter contained in the wastewater discharge." Several applicable narrative water quality criteria list foam (e.g., for recreation, the standard is "[t]here shall be no distinctly visible solids, scum, foam, oily slick…that may be detrimental to recreation." Tenn. Comp. R. & Regs. 1200-4-3-.03(4)(e)). Both EPA and TDEC have observed the discharge of foam from both plants. These observations indicate the reasonable potential to violate these instream water quality criteria and call for the imposition of a water quality-based effluent limit ("WQBEL").

Commenters support this draft permit's terms related to color. The narrative color limit in the current draft permits is derived directly from the applicable water quality criterion, is consistent with the language in other permits issued by the Division, and is not unduly vague.

3. E. Coli/Disinfection

Commenters appreciate the Division's proposal to impose numeric limits for E. coli. As demonstrated in the Rationale, these limits are required because the reasonable potential exists to cause or contribute to instream water quality violations for E. coli. Imposing E. coli limits represents a substantial step toward protecting human health and the environment, and is long overdue.

However, Commenters request that the final permits be issued without compliance schedules for E. coli. The Division may choose to exercise its enforcement discretion as it sees fit, but the compliance schedules are not permissible in these permits because the instream water quality standard for E. coli has been in place since September 30, 2004. Maxson at R-10, Stiles at R-9. Compliance schedules are not permissible for WQBELs based on water quality standards that are more than three years old. 40 C.F.R. § 122.47(a)(2) ("a schedule of compliance shall be available only when necessary to allow a reasonable opportunity to attain compliance with requirements issued or revised less than three years before recommencement of discharge"). Instead, these permits must require immediate compliance with WQBELs based on these water quality criteria. 33 U.S.C. § 1311(b)(1)(C); *In the Matter of Star-Kist Caribe, Inc.*, 3 E.A.D. 172, 175, 177 (1990); Memorandum from James Hanlon to Alexis Strauss (May 10, 2007) ("Hanlon Memo") (attached to prior permit comments and available upon request).

Even if compliance schedules were allowed, they must be designed to bring the permittee in compliance as soon as possible. Hanlon Memo. TCWN and the Sierra Club appreciate the shortening of the compliance schedule from 56 months in the prior drafts to 36 months from the permit effective date in the current drafts. However, given the substantial delay in issuing the permits, the uncertainty of even this schedule,[1] and the known presence of recreational activity in the area, a three-year schedule remains too lengthy.

Finally, the Rationales for both permits appear to be procedurally defective because they do not make findings, reasonably supported by the record, of the following:

- That the compliance schedules will lead to compliance with an effluent limitation to meet water quality standards by the end of the compliance period. 33 U.S.C. §§ 1311(b)(1)(C) (WQBELs are required not later than July 1, 2977) and 1362(17); *see also* 40 C.F.R. §§ 122.2, 122.44(d)(1)(vii)(A); Hanlon Memo.
- That a compliance schedule is "appropriate" and that compliance with the final WQBEL is required "as soon as possible." 40 C.F.R. § 122.47(a) & (a)(1); Hanlon Memo.
- That the discharger cannot immediately comply with the WQBEL on the effective date of the permit. 40 C.F.R. § 122.47(a)(1); Hanlon Memo.

[1] The rationale for Maxson indicates that its schedule may be extended even further. Maxson at R-10.

4. Total Nitrogen and Total Phosphorus

The draft permits appear to violate Sections 402 and 302 of the federal Clean Water Act, 33 U.S.C. §§ 1342(b)(1)(A) and 1312(a), and Tenn. Comp. R. and Regs. 1200-4-5-.04(1) by failing to impose effluent limits sufficiently stringent to attain applicable water quality criteria for nutrients. *See also* 40 C.F.R. §§ 122.44(d)(1)(vi)(A) & 123.25. Issuance of the draft permits as proposed would also violate Tenn. Code Ann. § 69-3-108(g) because they fail to include the most stringent effluent limits necessary to implement applicable water quality standards for nutrients.

As the draft permits acknowledge, both plants are discharging high concentrations of nitrogen and phosphorus compared to typical sewage treatment plants. It is our understanding the Mississippi River is no longer on Tennessee's Section 303(d) List as impaired by nitrate or phosphorus. This is not, however, because pollution problems in the Mississippi and the Gulf of Mexico have been cured, but only because of changes in listing methodology. Nitrate levels in the river are high, and the Memphis watershed is a significant contributor to the Gulf of Mexico hypoxic zone.

Commenters request that the final permits impose numeric WQBELs for nutrients, which should be determined through a reasonable potential analysis as required by 40 C.F.R. § 122.44(d)(1)(ii) and based upon the assessment of the receiving waters using the Division's *Development of Regionally-Based Interpretations of Tennessee's Narrative Nutrient Criterion* for Ecoregion 68a at the 75th percentile for nitrate + nitrite. Once the receiving waters are adequately assessed, the appropriate nutrient limit should be included in this permit.

5. Mercury

Commenters request that the Division impose numeric WQBELs for mercury in both permits. Mercury is extremely toxic, persistent, and bioaccumulative. The permits acknowledge the elevated presence of mercury at both plants, and identify the receiving waters as impaired due to excessive mercury in fish tissue. Maxson R-14 to R-15; Stiles R-14 to R-15.

It appears that there is a reasonable potential for the discharges from these plants to cause or contribute to water quality violations for mercury, particularly if the analysis is conducted without using mixing zones (see below).[7] Accordingly, the permits should impose WQBELs for mercury. Tenn. Comp. R. & Regs. 1200-4-3-.03(4)(j). These limits should be based on EPA's 2001 methylmercury rule and 2009 guidance. EPA, *Guidance for Implementing the January 2001 Methylmercury WQ Criterion*, EPA 823-R-09-002, at 25 (2009) ("EPA 2009 Guidance"). The Division has previously acknowledged that there is no correlation between the Division's existing in-stream numeric standard and fish tissue concentration. TDEC Regulatory

[7] Whether there is actually a reasonable potential to exceed instream criteria for mercury depends on stream background concentration. The draft permits appear to be using two different figures as the background concentration – .729 ng/L (Stiles R-41, Maxson R-40) and .906 ng/L (Stiles R-45, Maxson R-44). If the higher number is correct, then pretty much any measurable amount of total mercury in the discharge would require a limit at the WQC (.051 ng/L) end-of-pipe.

Approaches to Mercury Effluent Limits. Bob Alexander, at 11, found at http://www.em.doe.gov/PDFs/Mercurysummit09/04Alexander%20Mercury%20Regulatory%20Issues.pdf. However, if the Division is unable to apply this methodology at this time, at a minimum it should impose an end-of-pipe limit of .051 µ/L. Tenn. Comp. R. & Regs. 1200-4-3-.03(4)(j).

The Division should not allow mixing zones for mercury. In the draft permits the Division is effectively allowing immense mixing zones by using stream allocation factors[1] based on the entire flow of the Mississippi River in its reasonable potential analyses. This is inappropriate for mercury, given that the in-stream impairment is due to the Division's fish tissue advisory. Tennessee rules prohibit mixing zones that "adversely affect the reasonable and necessary uses of the area" or that "endanger the public health or welfare." Tenn. Comp. R. & Regs. 1200-4-3-.05(2). Here, the recreational use of the waters for fishing is impaired, and there may be a public health risk to people who consume fish from the area. Moreover, EPA has stated that a mixing zone is not applicable "when applying the fish tissue-based criterion" for methylmercury. EPA 2009 Guidance at 65. Even if the Division uses its existing in-stream mercury criterion, it should do so without a mixing zone.

While we appreciate the requirement that the permittee conduct more sensitive mercury testing in the future, it is no longer sufficient to merely monitor mercury discharges. The Division first issued a fish tissue advisory in April 2007. Commenters' comments on a prior draft of the Stiles permit - submitted in April 2009 - noted that the mercury sampling method was insufficiently sensitive. TDEC itself acknowledges that the permit renewal applications provided insufficient data to quantify mercury in the effluent. Maxson at R-14, Stiles at R-15. It is the permittee's obligation to provide the information required for the Division to issue a NPDES permit. Tenn. Comp. R. & Regs. 1200-4-5-.05(2). There has been ample time for the permittee to have done so.

6. Overflows

Commenters request a minor clarification of Parts 2.3.3(d) of the permits so that the first sentence begins, "The permittee is relieved of the prohibition on new or additional flows after…." As the provision is currently drafted, it is unclear what "this requirement" means, and this phrase could be interpreted to include the requirements that "overflows are prohibited" and/or that the "permittee shall operate the system so as to avoid overflows."

7. Dieldrin and DDT at Stiles

Commenters request clarification of the basis for eliminating limits on dieldrin and DDT at Stiles, and, if appropriate, the retention of these limits as set forth in the current permit. The Rationale does not adequately document how the elimination of these limits fits one of the exceptions to the anti-backsliding rule set forth at Tenn. Comp. R. & Regs. 1200-4-5(1)(j). The permittee's failure to install treatment equipment is hardly something to be rewarded by eliminating a limit that has been in place for over a decade. The Division's assertion that there is

[1] Commenters note that the stream allocation factors applied to the two permits differ significantly. *Compare* Maxson at R-38 (90%) *with* Stiles at R-39 (50%). The Rationales do not explain this difference

no reasonable potential to exceed water quality criteria is not sufficient, on its own, to justify elimination of the limit. In the response to comments, please explain precisely which exception to the anti-backsliding rule applies, and how each element of that exception has been satisfied.

We appreciate the Division's consideration of these comments. Do not hesitate to contact me at 865-522-7007 x 102 or at [redacted] if you have any questions.

Sincerely,

[redacted]

Stephanie D. Vaughn
Staff Attorney
Tennessee Clean Water Network

Axel Ringe
Chair of the Water Committee
Tennessee Chapter of the Sierra Club

cc: Mark Nuhfer, EPA
Connie Kagey, EPA

Appendix AD-D1
Buckeye Technologies Written Comments (Submittal By Bass, Berry and Sims)

BASS
BERRY • SIMS

J. Andrew Goddard
PHONE: (615) 742-6224
FAX: (615) 742-2724
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150 Third Avenue South, Suite 2800
Nashville, TN 37201
(615) 742-6200

August 16, 2011

AUG 1 2011

VIA EMAIL AND U.S. MAIL
Mr. Vojin Janjic
Manager, Permit Section
Tennessee Division of Water Pollution Control
L&C Annex, 6th Floor
401 Church Street
Nashville, TN 37243

Re: Draft NPDES Permit No. TN0020711 Issued May 17, 2011
Memphis – Maynard C. Stiles STP
Memphis, Shelby County, Tennessee

Dear Mr. Janjic:

This firm represents Buckeye Technologies, Inc. ("Buckeye") on certain matters. On behalf of Buckeye, the following comments are submitted with respect to the referenced draft NPDES permit (the "Draft Permit") proposed to be issued by TDEC to the City of Memphis (the "City") with respect to its Maynard C. Stiles Sewage Treatment Plant (the "Stiles Plant").

Comments on Color Limit

The color standard has been changed to "The wastewater discharge must not cause an objectionable color contrast in the receiving stream." This necessarily should be interpreted to be consistent with applicable Tennessee Rules, including in particular Rule 1200-4-3-.03(4)(d) and Rule 1200-4-3-.05. The former prohibits, in relevant part, "color in such amounts or character that will result in any objectionable appearance to the water, *considering the nature and location of the water.*" (Emphasis added). The latter requires that the effective discharge on receiving streams "*shall* be considered beyond the mixing zone" (emphasis added), as more fully described in the comment letter Buckeye previously submitted on December 10, 2010. Buckeye suggest that either this permit language or the Rationale be modified to make it clear that this permit condition is to be interpreted consistent with the requirements of these two Tennessee Rules.

Section R8.14 of the Rationale states in part that "Distinct in-stream plumes (due to discharge turbidity/color and/or foam are not allowed pursuant to Tennessee's narrative water

quality requirements (1200-4-3-.03(4)(d))." (Parentheticals as in original.) This is consistent with the color standard in the previous draft permit (which, as noted in Buckeye's previous comment letter, is not consistent with the Tennessee water quality criteria for color) but is not consistent with the color limit in this Draft Permit. For example, a plume with a slight color contrast would not necessarily be objectionable. Buckeye suggests that this sentence be deleted.

Incorporation of Prior Comments

Buckeye hereby incorporates herein by reference the comments in its previous comment letter, except for those that have been accepted, or rendered moot, by changes in this Draft Permit.

Incorporation of American Yeast Comments

Buckeye has reviewed the comments on the Draft Permit submitted by Michael E. Scott, on behalf of American Yeast Corporation, dated August 15, 2011. Buckeye is fully supportive of those comments, and they are incorporated herein by reference as well.

We thank you for your consideration of these comments. Please include me, as counsel for Buckeye, on the mailing list for this permit and copy me on any future correspondence on this, including any mailings or emailings of draft or final permits or notices with respect thereto. Email mailing is preferred.

Thank you very much.

Sincerely,

J. Andrew Goddard

Cc by email:
Saya Qualls
Patrick Parker
Gary Cohen
Michael Scott

Appendix AD-E1
American Yeast Written Comments (Submittal Nutter McClennen & Fish LLP)

Gary Davis - RE: Comments to Draft NPDES Permit No. TN0020711

From: Michael Scott <MScott@nutter.com>
To: 'Gary Davis' <Gary.Davis@tn.gov>, Ask Tdec <Ask.Tdec@tn.gov>
Date: 8/16/2011 5:34 PM
Subject: RE: Comments to Draft NPDES Permit No. TN0020711
CC: Vojin Janjic <Vojin.Janjic@tn.gov>

Mr. Davis,

I want to clarify that American Yeast incorporates by reference into the comments submitted on August 15, 2011, its comments in its previous comment letter dated November 29, 2010, except for those that have been accepted, or rendered moot, by the changes in this draft permit

Thank you Mr Davis

Michael Scott

From: Gary Davis [mailto:Gary.Davis@tn.gov]
Sent: Monday, August 15, 2011 3:39 PM
To: Michael Scott; Ask Tdec
Cc: 'Edwards Gary'; Kolano Tom; Vojin Janjic
Subject: Re: Comments to Draft NPDES Permit No. TN0020711

Mr. Scott
We appreciate your attached comments.
Thanks
Gary Davis

>>> Michael Scott <MScott@nutter.com> 8/15/2011 2:31 PM >>>

Mr. Davis,

On behalf of American Yeast Corporation, I have attached comments on the draft NPDES Permit No. TN0020711. I would appreciate it if you would acknowledge receipt by sending me a reply to this email.

Thank you

Michael Scott

Circular 230 Disclosure: To ensure compliance with IRS Circular 230, we inform you that any federal tax advice included in this communication (including attachments) is not intended or written to be used, and it cannot be used, for the purpose of (i) avoiding the imposition of federal tax penalties or (ii) promoting, marketing or recommending to another party any transaction or matter addressed herein.

Circular 230 Disclosure: To ensure compliance with IRS Circular 230, we inform you that any federal tax advice included in this communication (including attachments) is not intended or written to be used, and it cannot be used, for the purpose of (i) avoiding the imposition of federal tax penalties or (ii) promoting, marketing or recommending to another party any transaction or matter addressed herein.

Nutter

Michael F. Scott
Direct Line: 617-439-2811
Fax: 617-310-9811
E-mail: mscott@nutter.com

August 15, 2011
19188-60

By Electronic Mail (Gary.Davis@tn.gov) &
By Certified Mail, Return Receipt Requested

State of Tennessee
Department of Environment and Conservation
Attn: Mr. Gary Davis
401 Church Street
L&C Annex, 6th Floor
Nashville, TN 37243

Re: Comments to Draft of NPDES Permit No. TN0020711

Dear Mr. Davis:

I am writing on behalf of American Yeast Corporation ("AYC") with respect to the draft of NPDES Permit No. TN 0020711 that was issued by the Tennessee Department of Environment and Conservation ("TDEC") on May 17, 2011(the "May 2011 Draft Permit") for discharges from the Maynard C. Stiles wastewater treatment plant (the "WWTP"). As noted in our November 29 2010 letter to TDEC regarding the August 30, 2010 version of this permit (the "August 2010 Draft Permit, AYC operates a yeast plant at 2405 North Street, Memphis, and is an industrial discharger to the WWTP. The following observations are based on our review of the May 2011 Draft Permit and other materials described below.

While the August 2010 Draft Permit, at page 5, stated that "[t]he wastewater discharge shall not cause a distinct color contrast . . . in the receiving stream[.]" it appears that TDEC, in the May 2011 Draft Permit, has chosen to return to the color standard contained in the current NPDES permit for the WWTP, which prohibits "objectionable" color contrast in the receiving stream. Our November 29, 2010 letter to TDEC set forth several reasons why AYC believes the "objectionable" color contrast was the correct method for measuring color.

Under the May 2011 Draft Permit, color (Pt Co Units) True and Apparent is required to be monitored on a weekly basis. In addition, the May 2011 Draft Permit requires visual Outfall Observations on a daily basis. The May 2011 Draft Permit, however, does not authorize the establishment of a mixing zone for monitoring color, which AYC believes may aid in monitoring of and compliance with the objectionable color standard.

As noted in our November 2010 letter, there are color contrasts throughout the waters of the Mississippi River, making it difficult to accurately determine compliance with the applicable Water Quality Criteria. One way to assist in measuring such compliance is to institute a mixing zone for color at the outfall location. Section 1200-4-3-.05(2) of the Tennessee Water Quality Criteria states that

"[t]he effect of treated sewage or waste discharge on the receiving waters shall be considered beyond the mixing zone except as provided in this paragraph." The relevant paragraph provides for restrictions in the implementation of a mixing zone in certain instances, none of which would apply in the case of a color standard. Given this directive within the Water Quality Criteria, and given that a mixing zone would aid in monitoring compliance with the standard in the Water Quality Criteria, it may be helpful in the development and imposition of color standards for the May 2011 Draft Permit to provide for a mixing zone for color. This has been done within other NPDES permits issued by TDEC[1], and would provide meaning to the phrase "considering the nature and location of the water" in the Water Quality Criteria when determining whether there exists an objectionable color appearance.

Specifically, AYC requests the following changes to the May 2011 Draft Permit: Pages 4 and 5 of the May 2011 Draft Permit describe the monitoring procedures for the WWTP's effluent. It states that effluent samples must be collected prior to mixing with any other discharge or the receiving stream. The measure of an "objectionable" color standard requires observation of a color contrast. Color contrast cannot be evaluated until the effluent has entered the mixing zone. Color observations, therefore, should instead be made immediately downstream of the mixing zone in the receiving stream to most effectively measure any color contrast.

Please contact me with any questions or concerns regarding the above. Thank you for your consideration of our comments.

Very truly yours,

Michael E. Scott

cc: Mr. Vojist Janjic, Manager, Permit Section, Division of Water Pollution Control
Mr. Gary Edwards, President, American Yeast Corporation
Mr. Tom Kolano, Plant Manager, American Yeast Corporation

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[1] See, for example, NPDES Permit No. TN0002356, issued by TDEC for Bowater Newsprint Calhoun Operations (allowing for a 2,000 foot mixing zone), and NPDES Permit No. TN0002232, issued by TDEC for Packaging Corporation of America, Counce Mill (allowing for a 1,000 foot mixing zone).

Appendix AD-F1
Ms. Mary Wilder Comments

Dear Jane:
Tennessee Department of Environment and Conservation
Manager, Permit Section
Division of Water Pollution Control
401 Church Street
L&C Annex 11th Floor
Nashville, TN 37243

August 18, 2011

Dear Ms. [illegible]

Re: [illegible] NPDES Permit No. TN0020711 [illegible] comments regarding the permit

The draft permit is a positive step in maintaining water quality in West Tennessee. The permit needs to be approved and become the permit under which the City of Memphis operates. The current permit has not been adopted for almost years.

The language in the RR.15 section is very helpful. [illegible] to suggest that sanitary overflows or backups are unusual resulting. The events need to be reported to TDEC by process and more accurate [illegible] information on overflows should be more available within days of a sanitary overflow incident.

Additionally, The City of Memphis Public Works sought to requested to test the sanitary system and report a repair and maintenance plan to TDEC when there is more than three events in a calendar year in which sanitary flows are subject to home owner [illegible]. The [illegible] are needed to be available to the public.

Thank you for the public comment process. We hope citizens be involved in keeping our water clean and our income rate.

Sincerely,

[redacted]

Ms. Wilder
[illegible]
Memphis, TN 38127

RATIONALE

Memphis-Maynard C. Stiles STP
NPDES Permit No. TN0020711
Permit Writer: Gary Davis

R1.0 FACILITY INFORMATION

Memphis-Maynard C. Stiles STP
Memphis, Shelby County, Tennessee
Treatment Plant Average Design Flow: 135 MGD
2010 Percentage Industrial Flow: 18.1 % (based on design flow)
Treatment Description: Contact - Stabilization Activated Sludge

R2.0 RECEIVING STREAM INFORMATION

Mississippi River at Mile 738.8
Watershed Group: Mississippi

Hydrocode: 8010100
Low- Flow: 7Q10 = 70,500 MGD (109,000 CFS)
30Q5 = 89,900 MGD (139,000 CFS)

Receiving Waters: Outfall 001 Discharges to the Mississippi River
The Mississippi River is classified as
an Exceptional Tennessee Waters, (Due to the
Federal Endangered Pallid Sturgeon and
Tennessee Threatened Blue Sucker Fish Species)

Receiving Stream Usage Designations:

Domestic Wtr Supply	Industrial	Fish & Aquatic	Recreation
	X	X	X
Livestock Wtr & Wlife	Irrigation	Navigation	
X	X	X	

R3.0 CURRENT PERMIT STATUS

Permit Type:	Municipal
Classification:	Major
Issuance Date:	3/31/2000
Expiration Date:	3/31/2005
Effective Date:	4/1/2000

R4.0 DIVISION'S PROPOSED NEW PERMIT AND REFERENCES FOR PREVIOUSLY SUBMITTED WRITTEN COMMENTS REGARDING PRIOR DRAFT PERMITS

For developing the M.C. Stiles STP's (TN0020711) new proposed permit, the division received/evaluated numerous written comments for the following previously-issued draft permits.

- Draft Permit (August 28, 2007) – Public Noticed (August 20, 2007)
- Revised Draft Permit (March 11, 2009) – Public Noticed (February 23, 2009)
- Draft Permit (August 30, 2010) – Public Noticed (October 11, 2010)

The above drafts and comments are in division's Water Pollution Control (WPC) permit file.

R5.0 PERMITTEE'S PERMIT MODIFICATIONS REQUESTED IN NPDES PERMIT RENEWAL APPLICATION

The permittee's current NPDES permit limitations and monitoring requirements are presented in Attachment R-1.

In its NPDES permit renewal application submittal the permittee requested that the division consider the following items:

- Increased treated effluent BOD_5 and TSS limits due to its relatively large industrial contribution. Based on the permittee's supplemental permit renewal information, the division has included a variance from federal secondary treatment standards for the permittee's treated effluent.

- Allow higher-than-design monthly flow rates to be used for calculating treated effluent weekly effluent mass loadings. No change in the new permit is appropriate. For municipal wastewater treatment facilities renewed permits, the division determines treated effluent limitations, including maximum weekly concentrations and uses the permittee's design not an actual flow, to establish corresponding weekly mass loadings discharge requirements.

- Pesticide monitoring requirements be eliminated or frequency reduced to once per permit term. Based on the continued wastewater input from a pesticides manufacturers, the permittee's pesticides DMR monitoring results, and the July 25, 2008 Total Maximum Daily Loads (TMDLs) for chlordane, dioxins, and polychlorinated biphenyls in the Mississippi River, the division considers the permittee's treated effluent to contain pesticides that may possibly violate water quality standards and/or contribute to the receiving stream impairments. Thus, no reduction in monitoring frequency is included in the new permit.

R6.0 EVALUATION OF CURRENT NPDES PERMIT COMPLIANCE AND PERMIT RENEWAL APPLICATION INFORMATION

Treated effluent monitoring results are provided in Appendices R-2A through R-2F. TDEC personnel completed numerous compliance evaluation inspections since the

current permit's effective date. The following types of treated effluent monitoring results were evaluated during this permit renewal process:

- Discharge Monitoring Report (DMR)
- Fecal Coliform (provided in NPDES permit renewal application)
- Organic Pesticides, DDT, Dieldrin, and PCBs
- Total Dioxin
- Whole Effluent Toxicity – LC_{50} and NOEL (DMR) and IC_{25} (data provided in NPDES permit renewal application)
- Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus (data provided in NPDES permit renewal application)
- Other Parameters (data provided in NPDES permit renewal application)

R6.1. COMPLIANCE EVALUATION INSPECTION (CEI) RESULTS

Mr. Eddy Bouzeid (TDEC Memphis Environmental Field Office) completed CEIs on (June 19, 2001, October 20, 2003, October 24, 2005, April 10, 2006, June 20, 2008, and June 3, 2010) and rated the permittee's permit compliance as "Satisfactory". Effluent foam was noted during the June 3, 2010 on-site inspection.

R6.2. DISCHARGE MONITORING REPORT (DMR) RESULTS

The DMR results for the months ending April 2000 through March 2011 are provided in Appendix R-2A. As shown in the Appendix R-2A, the permittee has had consistent sanitary sewer overflows and some effluent BOD_5 and TSS permit exceedances.

R6.3 ADDITIONAL MONITORING RESULTS FOR TREATED EFFLUENT

This section includes monitoring results submitted pursuant to the permittee's current permit and data included in its NPDES permit renewal application, as supplemented. The basis for applying monitoring requirements and limitations in the new permit is provided subsequently in Sections R7.0 and R9.0

R6.3.1. Fecal Coliform

The permittee's current permit does not require fecal coliform monitoring. However, in the permittee's NPDES permit renewal application fecal coliform results were provided for three treated effluent samples. The maximum fecal coliform result was 660,000 cfu/100 ml, with an average of 507,000 cfu/100 ml. These are high values because effluent disinfection is not being used. As illustrated by the recent *E. coli* results presented in Appendix R-2B, it appears that elevated *E. coli* levels exist near the Tennessee bank downstream of Outfall 001, including in the Wolf River Harbor. As such, an *E. coli* compliance schedule for the design/installation and operation of end-of-pipe disinfection system is presented in the new permit's Section 3.5.

R6.3.2. Organic Pesticides Chemicals (including DDT, Dieldrin, and PCBs)

The permittee's treated effluent organic pesticide chemicals, (including DDT, dieldrin, PCBs) monitoring results summary is presented in Appendix R-2C.

R6.3.3. Total Dioxin

The annual total dioxin results for the permittee's treated effluent are provided in Appendix R-2D. From these results it is apparent that the treated effluent contains some total dioxin.

R6.3.4. Biomonitoring – LC_{50}, NOEC and IC_{25}

As shown in Appendix R-2E, the permittee submitted its biomonitoring LC_{50} and NOEC results for its treated effluent consistent with its current permit. Some acute aquatic toxicity was demonstrated, with 96-hour LC_{50} values of 70.7% for water fleas, and 45.1% for fathead minnows. Due to the type of treatment system used and the large amounts of diverse industrial wastewaters treated, more acute toxicity was expected.

For its permit renewal application the permittee completed the four treated effluent IC_{25} tests shown in Appendix R-2E. The permittee's treated effluent IC_{25} results demonstrated some chronic toxicity, with IC_{25} values reported ranging from 30.3 to 36.4% for water fleas to 11.2 to 47.7% for fathead minnows.

R6.3.5. Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus Results

The permittee reported a daily maximum ammonia-nitrogen value of 40.9 mg/l and total Kjeldahl nitrogen of 45.9 mg/l in its treated effluent. Relative to domestic sewage, these results are relatively high values and probably partially due to the facility's large industrial input.

The permittee reported an average total phosphorus result of 7.56 mg/l for three treated effluent samples. This total phosphorus is relatively high compared to domestic sewage, and is probably due to the treatment plant's large industrial input.

R6.3.6. Other Parameters and Toxics and Metals Results

The permittee's permit renewal application indicated the treated effluent mercury at less than 0.2 ug/L for three samples. However, as shown in Appendix R-2F, mercury was present in the permittee's on-site Old and New Landfills groundwater samples and sludge samples. The permittee reported 2009 influent and effluent mercury values of <0.2 ug/L, with the exception of two influent results (0.30 ug/L for 7/1-2/2009 and 0.20 ug/L for 9/15-16/2009). Based on these results, sampling frequency, and the large/diverse industrial wastewater input to the permittee's M.C. Stiles STP facility, the division considers that some mercury probably is present in the Outfall 001 discharge. Therefore, the new permit requires mercury monitoring using a more sensitive method.

R6.4. DIVISION'S DETERMINATIONS AND MAJOR CHANGES INCLUDED IN THE NEW NPDES PERMIT

The following major changes from the current permit have been incorporated into the new permit:

a. The permittee requested a variance from the minimum BOD_5 and TSS wastewater federal secondary treatment standards for POTWs (technology-based) as defined in 40 CFR 133.102. The federal secondary treatment standards are technology-based and variance changes for the proposed new permit are not subject to antibacksliding.

The permittee requested a variance from the minimum BOD_5 and TSS wastewater secondary treatment standards for POTWs as defined in 40 CFR 133.102. As shown in Appendix R-3, the division has determined that the provisions of 40 CFR 133.103(b) have been met by the permittee, and the calculated limits for treated effluent BOD_5 and TSS concentration limits have been determined. As such, the BOD_5 concentration limits per variance follows:

	BOD_5 Limits (mg/L)		
	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	45	68	90
Per Variance	**43.1**	**64.7**	**86.1**

	TSS Limits (mg/L)		
	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	**52**	**78**	**104**
Per Variance	53.2	79.8	105.8

Since the Mississippi River designation is an "Exceptional Tennessee Waters" and the permittee has not provided the division with antidegradation documentation (including alternative analyses with social/economic evaluations for the above increased Outfall 001 BOD and TSS concentrations per the variance), the new permit includes the most stringent discharge limits (current permit versus per variance values). The values included in the new permit are shown in bold font.

b. Pursuant to the elements/timing presented in the permit's Section 3.5, the permittee must install/operate an end-of-pipe treated effluent disinfection system to demonstrate that its M.C. Stiles STP Outfall 001 discharge does not cause nor contribute to any non-attainment of the state of Tennessee's recreation *E. coli* requirements (maximum monthly geometrically mean of 126 cfu/100 ml with a maximum sample of 487 cfu/100 ml required by Tennessee's recreation water quality standards, Rule 1200-4-3.03(4)(f)).

c. Since contaminants (e.g., newly-generated chlorinated byproducts, if chlorination is used for Outfall 001 disinfection) in the permittee's treated effluent discharge mixing zones within the Mississippi River must not exceed the division's human health criteria or adversely impact reasonable uses of the area, per Rule 1200-4-3-.05(2), the new permit's Section 3.5 defines an *E. coli* compliance schedule with associated

requirements. For example, as warranted. the permittee must post signs noting the hazards associated with the Outfall 001 discharge's potential human health hazards, including those associated with the discharges' immediate instream mixing zone. The division has concern that the Mississippi River flow transports the permittee's Outfall 001 discharge toward the Mud Island shoreline and into the Wolf River Harbor. Also, when the Mississippi River is at high flow the permittee's Outfall 001 discharge may actually be transported into the Wolf River.

R7.0. REPORTS SUBMITTAL REFERENCES

The following summary provides references for selected reports that the permittee must submit to the division:

Selected Reports	Section in Permit
Discharge Monitoring Reports (DMR) (a)	1.2.1
Monthly Operational Reports (MOR)	1.2.4
Bypass and Overflow Summary Reports	1.2.5
Industrial Pretreatment Reports	3.2.
Sludge Reports	3.3.
Biomonitoring Reports	3.4
Influent Flow Assessment Report	1.2.1
E. coli Compliance Elements/Timing Reports	3.5

R8.0. REGULATORY BASIS FOR NEW NPDES PERMIT'S MONITORING/LIMITATIONS REQUIREMENTS

Parameter	Regulatory Basis/Rationale Reference
BOD_5	Refer to Section R8.1 T.C.A. 1200-4-5-.09 (for BOD_5)
Total Suspended Solids (TSS)	T.C.A. 1200-4-5-.09 Refer to Section R8.2
Ammonia-Nitrogen (NH_3-N)	Refer to Section R8.4
Total Nitrogen (TN)	T.C.A. 1200-4-3-.03, Refer to Section R8.5
Total Phosphorus (TP)	Refer to Section 8.5
E. coli	T.C.A. 1200-4-3-.03, Refer to Section R8.3
Total Residual Chlorine (TRC)	Refer to Section R8.4
Chlorinated Byproducts	Refer to Section R8.10
Settleable Solids	T.C.A. 1200-4-5-.09 Refer to Section R8.12
Dissolved Oxygen (D.O.)	D.O. protection, Refer to Section R8.1
pH	Refer to Section R8.13
Organic Chemicals Pesticides (Including DDT,	
Dieldrin, and Heptachlor) and PCBs	Refer to Section R8.8
Total Dioxin	Refer to Section R8.9
Total Mercury and Methyl Mercury	Refer to Section R8.11
Visual Observations	Refer to Section R8.14
Whole Effluent Toxicity:	
Acute Toxicity - LC_{50}	Refer to Section R8.6
Chronic Toxicity - IC_{25}	Refer to Section R8.6 (Permit Renewal Scans)
Flow (MGD): Influent and Effluent	Used to quantify pollutant load and percentage removals (a)
Sanitary Sewer Overflows, Total Occurrences	Refer to Section R8.15
Dry Weather Overflows, Total Occurrences	Refer to Section R8.15
Bypass of Treatment, Total Occurrences	Refer to Section R8.15

Additional Permit Criterion:

Weekly limitations on BOD_5 and TSS concentrations are given as required per 40 CFR 133.102(a)(2) or 133.102(a)(4)(2) & 133.102 (b)(2) respectively; daily BOD_5 and TSS limitations are authorized by T.C.A. 1200-4-5-.09; monthly and weekly mass loads are limited per 40 CFR 122.45(f) and based on the design flow as per 40 CFR 122.45(b); monthly average percent removal rates for BOD_5 and TSS are required per 40 CFR 133.102(a)(3) or 133.102(a)(4)(iii) and 133.102 (b)(3) respectively. A minimum 40% daily removal rate is required as equivalent to a daily mass load limitation. Additionally, the permittee must also use the following provisions in achieving its new permit monitoring/limitations requirements:

(a) Since the permittee's treatment facility has multiple input streams the influent flow and resulting characteristics must be estimated. The estimated values must be used for calculating loadings and percentage removals.

(b) All sampling shall be representative.

(c) Facility-specific influent monitoring is incorporated into this new permit, since the sludge lagoon supernatant is discharged into an interceptor ahead of the wastewater treatment plant. Accordingly, this new permit specifically acknowledges that the

influent sampling shall occur downstream of the sludge lagoon supernatant return. However, the influent monitoring location must be upstream of any other wastestreams returned to the front of the plant. As such, the influent monitoring must require concurrent monitoring and reporting of both the quantity and quality of the sludge lagoon supernatant. As noted in the new permit's Section 1.2.1., within 60 days from the new permit's effective date the permittee must submit to the division's Memphis Environment Field and Nashville Central Offices, an updated Influent Flow Assessment Report which relates the quality and quantity of contributory influent wastestreams. Based on the updated submittal, the division will notify the permittee in writing if additional influent monitoring requirements are necessary.

R8.1. CONTROL REQUIREMENTS FOR BOD_5, DISSOLVED OXYGEN, AND BOD_5 REMOVAL

a. Biochemical Oxygen Demand (BOD) is a measure of dissolved oxygen used when biological processes breakdown wastewater organic pollutants. The five-day biochemical oxygen demand (BOD_5) is typically used for monitoring both the wastewater's strength and treatment facility's performance.

   Limiting the treated wastewater BOD_5 (oxygen demand) is necessary to prevent pollutants in the discharge from driving oxygen in the receiving stream down below levels necessary to support fish and aquatic life. Additionally, the biological oxidation of ammonia requires dissolved oxygen and therefore, exerts an oxygen demand on receiving stream. Due to the large dilution provided by the Mississippi River, estimated at 522:1 (for 7Q10 flow: STP design flow), no adverse dissolved oxygen impacts are anticipated. The Outfall 001 discharge mixing characteristics with the Mississippi River flow should be determined pursuant to the proposed permit's Section 3.5 requirements, should a chlorination-based disinfection system be selected by the permittee.

   For this facility, a monthly average BOD_5 limit of 30 mg/l is the federal secondary treatment standard technology-based effluent limitation pursuant to Rule 1200-4-5-.09. However, due to the permittee's large input from major industries, the permittee has requested a federal secondary standards variance pursuant to 40 CFR 133.102. As shown in Appendix R-3 and Section 6.4(a), a variance has been approved and applicable BOD_5 limitations were included in this new permit. Sample type will be composite.

   The dissolved oxygen (D.O.) effluent limitation of 1.0 mg/l (daily minimum on an instantaneous basis) from the current NPDES permit is retained in the new permit. The new permit requires that grab samples be taken to check for D.O. compliance.

b. The current and new permits include BOD_5 and TSS percent removal requirements, based on the facility influent characteristics. This is part of the minimum requirements for all municipal treatment facilities as referenced at 40 CFR Part 133.102. The reasons stated by the U.S.E.P.A. for these requirements are to achieve these two basic objectives:

(1) To encourage municipalities to correct excessive inflow and infiltration (I/I) problems in their sanitary sewer systems, and
(2) To help prevent intentional dilution of the influent wastewater as a means of meeting permit limits.

The treatment facility is required to achieve 85% BOD_5 and TSS removals, based on monthly averages. The number of excursions (days when BOD_5 and/or TSS removal is less than 40%) must be reported on the Discharge Monitoring Report.

R8.2. TOTAL SUSPENDED SOLIDS (TSS) AND TSS REMOVAL REQUIREMENTS

The rationale for defining new permit TSS limitations is similar to that presented in Section R8.1 for BOD_5. The TSS technology-based effluent limit is also 30 mg/l, pursuant to federal secondary standards (Rule 1200-4-5-.09). As shown in Appendix R-3 and Section R6.4.(a), alternative TSS limitations were calculated based on secondary TSS variance due to the permittee's inputs from its major industries, per 40 CFR Part 133.102.

R8.3. *E. coli* CONTROL REQUIREMENTS

Due to the recreational activities occurring in the Mississippi River, achieving the *E. coli* limits for protecting human health (per Rule 1200-4-3-.05(2)) is an integral new permit requirement. The new proposed permit requires that the permittee disinfect its treated wastewater end-of-pipe according to provisions included in the permit's Section 3.5. As of September 30, 2004, the criterion for fecal coliform was removed from the state of Tennessee's Water Quality Standards. The division now imposes an *E. coli* limit on discharges of treated sewage for the protection of recreational use of the stream in lieu of the fecal coliform limit. For example, the *E. coli* daily maximum limit of 487 cfu per 100 ml applies to Tennessee Exceptional Waters.

In anticipation of treated effluent disinfection requirements, the permittee had installed a chlorine contact chamber when its contact-stabilization activated sludge plant was built. However, the permittee has indicated to the division that its chlorine contact chambers have been not been used for end-of-pipe disinfection and has noted that its facility has no provisions for chemical storage/feed and controls. Since the division recognizes that chlorine usage for disinfection may generate deleterious chlorinated byproducts with adverse water quality potential, additional investigations are warranted as presented in R8.10.

As referenced in the new permit's Section 3.6, until end-of-pipe disinfection system is functional, the permittee must post signs which warn recreational users of human health hazards associated with the Outfall 001 discharge.

Treated wastewater disinfection is generally required in NPDES permits to provide for the receiving stream designated usages, with a focus on protection from pathogenic microorganisms. Fecal coliform and *E. coli* bacteria serve as indicator organisms for assessing a receiving stream's bacteriological characteristics and disinfection effectiveness. Monitoring the *E. coli* in its treated effluent allows a permittee to document that elevated *E. coli* in a receiving stream is not due to the permittee's discharge.

R8.4. AQUATIC TOXICITY POTENTIAL DUE TO AMMONIA NITROGEN AND/OR TOTAL RESIDUAL CHLORINE/OXIDANTS (TRC/TRO)

The potential for aquatic toxicity within the Mississippi River due to the permittee's treated effluent ammonia-nitrogen and residual oxidants (e.g., total residual chlorine) from treated effluent disinfection is discussed subsequently and in Appendix R-4. The results from the *E. coli* control evaluations shown in the permit's Section 3.5 (e.g., instream dispersion) will be used to determine if permit changes in the discharge requirements for the Outfall 001 discharge ammonia-nitrogen and/or TRC/TRO are needed.

Ammonia-Nitrogen Aquatic Toxicity Considerations

Based on the evaluation results shown in Appendix R-4 the new permit includes weekly Outfall 001 discharge monitoring with report-only requirements for the treated effluent ammonia nitrogen concentration. Based on the permittee's DMR data and results from the proposed permit's Section 3.5 Outfall 001 discharge transport/dispersion within the Mississippi River, the permit may be reopened to include ammonia toxicity limits, if applicable.

Total Residual Chlorine (TRC) and Total Residual Oxidants (TRO) Aquatic Toxicity Considerations

The treatment plant does not currently use chlorination for disinfection of its treated effluent. Since total residual chlorine (TRC) from a chlorination-based disinfection process can be toxic to aquatic life, the new permit includes a treated effluent TRC limit. The TRC limit would only be applicable if ba chlorination-based disinfection system were used. As shown in Appendix R-4, TRC limits can be derived using the mass balance formula and the EPA instream protection for fish and aquatic life values of 0.019 and 0.011 mg/l for acute and chronic exposure, respectively.

As shown in Appendix R-4, even if the Outfall 001 discharge were fully dispersed, the calculated water quality treated effluent values exceed the maximum TRC concentration of 2.0 mg/l industrial practice value used municipal treatment facilities. However, as discussed elsewhere in this rationale, the Outfall 001 discharge is transported to the Mud Island shoreline and potentially into the Wolf River Harbor. Also, under certain Mississippi River conditions the Outfall 001 discharge may actually be transported into the Wolf River. It is expected that the permittee's *E. coli* investigation results (per the new permit's Section 3.5) will provide the actual treated effluent transport/dispersion, which should be useful in establishing site-specific discharge TRC limits, and reasonableness of the division's 2.0 mg/l value. Dechlorination processes are typically used to insure that excess TRC concentrations

are not discharged. As such, the new permit includes a TRC limit of 2.0 mg/l. Based on additional effluent transport/dispersion information, the division may decide that an alternative TRC limit is applicable, and if so the division will reopen the permit for modification.

The new permit includes total residual oxidant (TRO) monitoring requirements, as applicable. As such, TRC and/or TRO limits are presented in the permit's Section 1.1. Depending on the specific TRO to be used, the division may reopen the permit to include the relevant aquatic toxicity limitations and change the monitoring frequency. The results from the proposed permit's Section 3.5 will be used to make permit modifications, if warranted for Outfall 001 TRC or TRO.

R8.5. TOTAL NITROGEN AND PHOSPHORUS MONITORING REQUIREMENTS

The permittee's Outfall 001 treated effluent monitoring required in the new permit for total nitrogen and total phosphorus is imposed pursuant to the joint State/Federal Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico. The monitoring results from major municipal and industrial facilities discharging within the Mississippi River Basin will help assess current point source loadings to the Gulf and enable the task force to track changes in loadings across the basin with time. EPA believes that Section 308(a) of the Clean Water Act provides broad authority to require nutrient monitoring. No ecoregion reference streams exist for the Mississippi River. Thus, references for the application of the state's narrative nutrients criteria are not available. Even where there is no reasonable potential for a particular facility to cause or contribute to excursions of criteria within the immediate receiving waterbody, nutrient monitoring is being included in permits. Additionally, the corresponding influent monitoring is incorporated by the state for use in evaluating the ability of existing technologies to remove nutrients. As such, treated effluent nutrient monitoring data is needed and included in the new permit.

R8.6. BIOMONITORING – LC50 AND IC25 MONITORING REQUIREMENTS

The acute and chronic biomonitoring requirements for the new permit are addressed in Appendix R-5. Assuming complete-mixed conditions, the critical 7Q10 low-flow instream waste concentration (IWC) is 0.19. Therefore, under full effluent dispersion, the reasonable potential for the permittee's discharge to exceed the narrative water quality criterion, "no toxics in toxic amounts" is dramatically decreased. However, as discussed subsequently in Section 9.2, the actual transport/dispersion characteristics within the receiving stream is not well defined and pursuant to the new permit's Section 3.5 investigation results, further mixing information should be available. As such, the new permit includes acute (48-hour LC_{50}) monitoring requirements, with chronic (IC_{25}) biomonitoring being required pursuant to the permittee's permit renewal application process.

R8.7. WATER-QUALITY BASED EFFLUENT CALCULATIONS – OTHER PARAMETERS, ANTIDEGRATION CONSIDERATIONS

As shown in Appendix R-6, pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit reissuance process and/or

due to changes in industrial waste contribution. The proposed new permit requires the permittee to maintain its pretreatment program. Based on the water quality reasonable potential calculations shown in Appendix R-6, the new permit includes annual monitoring requirements for Outfall 001 benzidine and hexachlorobenzene. For its permit renewal application the pemittee did not use sufficiently sensitive analytical procedures to demonstrate that no reasonable potential to violate water quality exists. The permittee treats industrial wastewaters from numerous dischargers that manufacture or use organic chemicals, therefore Outfall 001 monitoring for these contaminants is included in the new permit. The permit reopener clause provides for modification based on the permittee's Outfall 001 benzidine and hexachlorobenzene DMR results.

R8.8. ORGANIC PESTICIDE CHEMICALS, DDT, DIELDRIN, HEPTACHLOR, AND PCB DISCHARGE REQUIREMENTS

The permittee's organic pesticide chemicals, DDT, dieldrin, heptachlor and PCBs monitoring results are presented in Appendix R-2C. The current permit includes monitoring requirements for the specific list of organic pesticide chemicals. Since the permittee continues to accept wastewater from pesticides manufacturers, the Mississippi River is now classified as Tennessee Exceptional Waters, and some treated effluent pesticide values were reported, the new permit will retain the current permit's annual Outfall 001 discharge monitoring for the organic pesticide chemicals. Since the permittee has not installed wastewater treatment facilities for compliance with the current permit's Outfall 001 DDT and dieldrin limits, and as shown in Appendix R-6 the new permit will not include the limits. This will not trigger antibacksliding provisions, since the DDT and dieldrin discharge values do not present a reasonable potential for violating water quality standards.

As noted in the Section R10.0, based on the 2008 Mississippi River TMDL requirements for PCBs and chlordane, dischargers having these chemicals in their treated wastewater must be limited discharges to the water quality criterion. As such, the new permit includes the water quality criterion as monthly average and daily maximum values, for the Outfall 001 treated effluent PCBs and chlordane. The permittee must demonstrate compliance with the new permit PCBs using EPA Method 1668B.

The division has the ability to reopen and modify the permit for parameters presented in this section.

R8.9. TOTAL DIOXIN DISCHARGE REQUIREMENTS

"Total dioxin" is defined by the Tennessee Water Quality Criteria as the sum of the concentrations of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs) specified in the criteria.

The current permit requires that treated effluent total dioxin be monitored annually to determine if the discharge contributes to further Mississippi River degradation. As shown in Appendix R-2D the Outfall 001 treated effluent total dioxin values ranged from 0.0000 to 6.9745 picograms/liter (pg/L). These results demonstrate that total dioxin is present in the discharged Outfall 001 treated effluent. The 2008 Mississippi River TMDL document referenced in Section R10.0, notes that dischargers of dioxins must have their treated wastewater limited to the water quality criterion. As such, the

new permit includes the water quality criterion as monthly average and daily maximum values, for the Outfall 001 treated effluent total dioxins.

For the new permit the total dioxin monitoring frequency will be detained at annually from the current permit.

R8.10. CHLORINATED BYPRODUCTS

The division considers the permittee's Maynard C. Stiles STP and T. E. Maxson STP treatment facilities to be unique within the state of Tennessee, since these facilities treat a higher proportion of industrial wastewater flows/contaminant loadings from numerous/diverse sources. As such, the division is concerned that disinfection of the wastewater using chlorination based system could result in high effluent concentrations of chlorinated byproducts (both inorganic and organic), which may pose a human health risk. The identification/characterization (including types and amounts) of chlorinated organics generated via a chlorination-based disinfection system must be addressed, per the proposed permit's Section 3.5. The permittee must provide the division with sufficient treated effluent chlorinated byproducts characterization (including a list of specific chemicals) and the discharge's instream transport/dispersion information, such that the division may define applicable treated effluent limits for obtaining receiving stream water quality standards. The permit may be reopened to include applicable chlorinated byproducts limits.

Based on information to be provided by the permittee relative to chlorinated organics generated (via the proposed permit's Section 3.5 requirements), the new permit includes reopener provisions to modifying the permit to include Outfall 001 numerical limits (e.g., monthly average and daily maximum for identified harmful organic chlorinated byproducts, which may/will be generated due to chlorination for disinfection). The permittee had initially indicated to the division that if disinfection is required, chlorination would be used. However, recently, the permittee indicated that non-chlorination processes are being evaluated for Outfall 001 treated effluent disinfection also.

R8.11. TOTAL MERCURY AND METHYL MERCURY

The division added mercury as a fish-consumption advisory for the Mississippi and Wolf Rivers and McKellar Lake on April 26, 2007. The division's fish tissue trigger point for the mercury advisory is 0.3 ppm. As such, the division is including discharge limitations and/or monitoring requirements for permitted potential sources.

The permittee's permit renewal application included three treated effluent mercury results each < 0.2 ug/L. As such, the mercury in the permittee's Outfall 001 can not be specifically quantified. As shown in Appendix R-2F, the permittee's landfill groundwater monitoring data (also provided with the permit renewal application), included numerous mercury results greater than 0.2 ug/L, with a median value of 0.3 ug/L, and range of <0.2 to 0.91 ug/L. As noted in this R6.3.6., measureable mercury was reported for the permittee's influent in 2009. Therefore, mercury is present in the permittee's wastewater, and as such the new permit includes annual monitoring requirements for total mercury and methyl mercury. The treated effluent total mercury

must be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630.

The permittee uses covered lagoons for sludge handling/stabilization. As such, under the anaerobic conditions within the lagoons, the division considers an increased potential exists for the generation of methyl mercury. The supernatant from the sludge lagoons is returned to the wastewater treatment system, and the methyl mercury would be discharged via Outfall 001. Methyl mercury is the form that is bioaccumulated in fish tissue. As such, methyl mercury monitoring is included in the new permit.

R8.12. SETTLEABLE SOLIDS

Settleable solids results provide an indication of the treatment system performance. The treated effluent settleable solids limitation (1.0 ml/L) included in the permittee current permit will be used for the new permit.

R8.13 pH

The permittee must comply with secondary treatment technology pH limitations (6.0 to 9.0 s.u.) for its treated effluent. Major variations in effluent pH can provide the permittee with an indication of industrial user spills.

R8.14 VISUAL OBSERVATIONS

Historically, the permittee's Outfall 001 discharge has resulted in turbidity/color contrast (distinct plume) within the Mississippi River extending at times to and downstream of the Mud Island shoreline. Floating foam downstream from the Outfall 001 discharge has also been observed. Distinct instream plumes (due to discharge turbidity/color and/or foam are not allowed pursuant to Tennessee's narrative water quality requirements (Rule 1200-4-3-.03(4)(d)). The permit's current permit does not allow the discharge of visible matter or causes an objectionable color contrast. For example, due to instream color contrast from treated pulp and paper wastewater, the division has required other permittee's to install effluent diffusers, even for dischargers to very large receiving streams. As such, the permittee will be conducting a color investigation to identify control requirements.

Pursuant to the proposed permit Section 1.1 the permittee must monitor and report its Outfall 001 color in terms of both apparent and true color. Additionally, the proposed permit requires the permittee to monitor/document/report the character of the Outfall 001 discharge and resulting impacts (including color, foam characteristics, extent) on the Mississippi River via visual observations.

R8.15 OVERFLOW AND BYPASS REPORTING

For the purposes of demonstrating proper operation of the collection, transmission, and treatment system, the new permit defines overflow as any release of sewage other than through permitted outfalls. This definition includes, but is not necessarily limited to, sanitary sewer overflows and dry weather overflows. For example, a collection system blockage or hydraulic overload that causes backup and sewage

release into a building during a wet weather event may not clearly fit either the definition of a sanitary sewer overflow or a dry weather overflow. The permittee must also account for overflows that result in sewage flow into buildings. Any unpermitted release potentially warrants permittee mitigation for human health protection and/or water quality impacts via direct or indirect contact and demonstrates a hydraulic problem in the system that warrants permittee consideration as part of proper system operation and maintenance.

For the more typical, unpermitted, releases into the environment, the new permit uses interchangeablely the terms, "overflow" and "sanitary sewer overflow" for compliance reporting purposes. Sanitary sewer overflows can have an adverse impact on the permittee's overall *E. coli* control program. The permittee routinely has had sanitary sewer overflows. The permittee provides a summary of its sanitary sewer overflow sources, amounts, causes and mitigation measures taken, are submitted monthly to the division with its DMRs.

R9.0 OTHER NPDES PERMIT REQUIREMENTS AND CONDITIONS

The division retains the right to reopen this new permit, e.g., for modifications as warranted.

R9.1. TREATED EFFLUENT TRANSPORT/DISPERSION WITHIN RECEIVING STREAM

Should chlorination be selected by the permittee for Outfall 001 disinfection, as presented in the proposed permit's Section 3.5 *E. coli* compliance program, the permittee must provide the following information to the division:

a. Define the lateral, vertical, and longitudinal extent of the Outfall 001 treated effluent plume within the Mississippi River. The assessment must be completed for varying conditions of stage, flow, and velocities within the Mississippi River.
b. Develop, or utilize an existing, mathematical model to predict the Outfall 001 treated effluent transport/dispersion characteristics within the Mississippi River.

The permittee's treated effluent transport/dispersion summary shall also include the evaluation objectives, investigation procedures/protocols, data (monitoring and calculated results), mitigation measures, implementation plans, schedules, conclusions, and recommendations. Based on this information the division may determine that the permit must be reopened to make changes to its limitations and monitoring conditions and/or make other adjustments.

R9.2. WASTEWATER TREATMENT OPERATOR AND COLLECTION SYSTEM CERTIFICATIONS

The wastewater treatment facilities shall be operated under the supervision of a certified wastewater treatment operator. Also, the permittee's wastewater collection system shall be operated under the supervision of a certified collection system operator. These certifications must be in accordance with the Water Environmental Health Act of 1984.

R9.3. PRETREATMENT PROGRAM

The Memphis-Maynard C. Stiles STP has an approved pretreatment program. An updated Industrial Waste Survey must be completed within 120 days of permit reissuance.

At least once each reporting period, all permittees with approved pretreatment programs are required to analyze the STP influent and effluent for the following pollutant parameters: chromium, copper, lead, nickel, zinc, silver, cadmium, mercury, total phenols, and cyanide. These pollutants were selected because, historically, they are the ones that tend to be predominant in industrial wastewaters. Other pollutants may be added to the list, as required.

For the new permit, data from the permittee's pretreatment annual reports for 2002, 2003, 2004, 2005, 2006, 2009 and 2010 were reviewed. If any particular value of a pollutant equals or exceeds 85% of the pass-through limit, the pollutant was considered for additional monitoring and/or limitations. Based on the division's review of the annual reports, sampling for additional pollutants is not required at this time.

Pretreatment Compliance Inspections (PCI) were completed by Messrs. Phil Simmons (TDEC Pretreatment Manager) and Eddy Bouzeid (TDEC Memphis Environmental Field Office) on June 10-12, 2003 and by Mr. Bouzeid on April 10-12, 2006 and on each occasion the permittee received a satisfactory rating. A pretreatment audit was conducted on August 17, 2007 and a minor deficiency was determined. The permittee received an in-compliance rating based on a pretreatment compliance oversight visit which occurred on July 7, 2008. Pursuant to a pretreatment compliance oversight on-site evaluated completed on June 22, 2010, an order was requested due to the Outfall 001 treated effluent causing a color contrast in the immediate mixing area in the Mississippi River. The permittee indicated that the condition was due to the discharges from two industrial users (one manufactures yeast and uses molasses and the other processes cotton fiber).

R9.4 WASTEWATER TREATMENT SYSTEM INTEGRITY EVALUATION

The permittee must within eighteen months from the permit's effective date submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management) and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities and any waterborne waste and sludge storage/disposal units that are constructed of earthen fill.

Upon submittal of the structural integrity assessment and based on recommendations and/or qualifiers provided in the report, TDEC and the permittee will determine what,

if any, improvements will be required. Based on the potential for harm to human health as described, additional site specific evaluations may be required.

Requirements to include permit provisions deemed necessary to protect waters of the state, are based on T.C.A. § 69-3-108. It is expected that the permittee's structural integrity submittals will be reviewed by the division's Water Pollution Control and Solid Waste Management personnel. Although it has not been determined at this time, the division may request additional evaluation input from its outside consultants and/or the U.S. EPA.

R9.5. PERMIT TERM

Due to the extended period to reissue the new permit and the permittee's M.C. Stiles STP (TN0020711) and its T.E. Maxson STP (TN0020729) are essentially the sole dischargers to the Mississippi Watershed, these permits will expire in 2015.

R10. RECEIVING STREAM WATER QUALITY STATUS/ANTIDEGRADATION CONSIDERATIONS

Tennessee's Antidegradation Statement is found in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06. It is the purpose of Tennessee's standards to fully protect existing uses of all surface waters as established under the Act.

Stream determinations for this permit action are associated with the waterbody segment identified by the division as segment ID# TN080100000_1000.

The division has made a determination of the receiving stream for the permittee's discharge and has found the river to be a high quality water. No permanent degradation of water quality will be allowed unless the applicant demonstrates to the Water Quality Control Board that the degradation is for necessary economic or social development and will not interfere with or become injurious to any existing uses. The specific requirements for this demonstration are described in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06(4). Further discussion should be included here to describe the permittee's specific argument and the board's determination.

This water does not fully support its fish/aquatic life and recreation designated uses due to mercury, dioxin, chlordane, physical substrate habitat alterations, polychlorinated biphenyls (PCBs). The proposed new permit specifically addresses the relevant contaminants (mercury via more sensitive monitoring, dioxin/chlordane/PCBs discharge limits at water quality standards pursuant to the following referenced TMDL. The division has noted sources causing this not fully supporting status as being due to dredging, contaminated sediments, grazing in riparian or shoreline zones and atmospheric deposition (toxics).

The Mississippi River is classified as Exceptional Tennessee Waters (since it provides habitat for the Pallid Sturgeon (federally endangered) and the Blue Sucker (state of Tennessee threatened) and no increase in water quality degradation will be authorized unless the permittee demonstrates to the Water Quality Control Board

such degradation is economically and socially justifiable. The specific requirements for this demonstration are described in Rule 1200-4-3-.06(4).

The following TMDL has been developed and approved for the Mississippi River:

Parameters	TMDL Approval Date
Chlordane, Dioxins and Polychlorinated Biphenyls (PCBs)	July 25, 2008

The proposed terms and conditions of this permit comply with the wasteload allocations of this TMDL.

Appendix R-1

Current NPDES Permit Requirements

Maynard C. Stiles STP (TN0020711) - Current Permit Effluent Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
BOD_5	45	60,666	85	68	76,661	90		40	7/week	composite	effluent
	Report					Report			7/week	composite	influent
Total Suspended Solids	52	58,547	85	78	87,820	104		40	7/week	composite	effluent
	Report					Report			7/week	composite	influent
Settleable Solids (ml/l)						1.0			7/week	composite	effluent
Dissolved Oxygen							1.0 instantaneous		7/week	grab	effluent
pH (standard units)						9.0	6.0		2/week	grab	effluent
Flow (MGD)	Report Report					Report Report			7/week 7/week	continuous continuous	influent effluent
Organic Pesticide Chemicals (40CFR455)						Report			1/year	grab	effluent
DDT	0.000001								1/year	composite	effluent
Dieldrin	0.0000014								1/year	composite	effluent
Total Dioxin						Report			1/year	composite	effluent
IC_{25}	Report (Survival, reproduction and growth for serial effluent dilutions)								(a)	composite	effluent
Sanitary Sewer Overflows, Total Occurrences	Report								continuous	visual	NA
Dry Weather Overflows, Total Occurrences	Report								continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report								continuous	visual	NA

(a) Within 180 days of permit issuance.

Appendix R-2A

Discharge Monitoring Report (DMR) Summary

M.C. STILES STP - DMR SUMMARY (TN0020711)

Month Ending	Eff Flow MAvg (MGD)	Eff Flow DMax (MGD)	Eff D.O. DMin. (mg/L)	Inf BOD5 MAvg (mg/L)	Inf BOD5 DMax (mg/L)	Eff BOD 5 Wk Avg (mg/L)	Eff BOD 5 DMax (mg/L)	Eff BOD 5 MAvg (mg/L)	Eff BOD 5 MAvg (lb/day)	Eff BOD 5 Wk Avg (lb/day)	Eff pH DMax (s.u.)	Eff pH Dmin (s.u.)	Inf TSS MAvg (mg/L)	Inf TSS DMax (mg/L)	Eff TSS Wk Avg (mg/L)	Eff TSS DMax (mg/L)	Eff TSS MAvg (mg/L)	Eff TSS MAvg (lb/day)	Eff TSS Wk Avg (lb/day)	Settleable Solids (ml/L)	BOD5 Removal MAvg (%)	BOD5 Removal Dmin (%)	TSS Removal MAvg (%)	TSS Removal Dmin (%)	Overflows (No./Month)
4/30/2000	81.8	116.7	3.1	285	404	24	33	21	14 549	16 026	7.51	7.18	377	648	14	29	10	8 786	9 820	<0.50	96	90	96	90	25
5/31/2000	85.5	123.1	1	270	401	30	42	25	17 579	21 321	7.64	7.24	295	687	16	40	16	11 592	13 383	<0.50	91	86	94	85	31
6/30/2000	82.6	104.3	1.1	288	421	33	49	33	22 708	22 956	7.55	7.26	307	459	18	32	18	12 489	12,250	<0.50	88	83	94	87	17
7/31/2000	79.8	83.6	1.7	280	391	24	39	22	14 710	23 756	7.56	7.28	318	610	16	28	15	9 935	10 717	<0.50	92	83	95	88	
8/31/2000	78.8	86.9	2.5	245	347	24	29	17	11 480	16 699	7.65	7.26	310	705	17	24	12	7 802	11 689	<0.50	93	88	96	94	
9/30/2000	78.6	84.3	2.3	266	406	26	64	23	15 443	17 571	7.54	7.13	291	578	16	56	11	7 216	10 773	<0.50	91	73	96	84	35
10/31/2000	74.1	85.0	2	292	429	27	42	20	12 650	17 506	7.63	7.18	322	596	14	39	12	7 320	8 309	<0.50	93	84	96	87	29
11/1/2000	83.6	125.0	1.3	287	393	23	30	19	13 468	15 721	7.66	7.22	305	691	22	32	13	9 146	12 546	<0.50	93	89	93	89	30
12/31/2000	82.2	115.3	3.6	250	333	26	44	20	13 874	19,818	7.82	7.09	282	469	19	39	16	10 864	14,305	<0.50	91	80	94	85	35
1/31/2001	82.6	102.6	2.3	249	387	29	45	27	18 491	19 408	7.77	7.31	310	632	25	45	21	14 965	16 534	<0.50	89	82	93	84	46
2/28/2001	123.9	183.1	2.4	302	571	33	52	32	23 776	30,235	7.73	7.27	479	1 566	30	54	28	21 163	25 897	< 5	89	74	93	84	55
3/31/2001	83.9	109.1	2.9	274	592	34	50	28	19 634	26,192	7.68	7.3	317	626	29	58	26	18 606	21 684	1	90	80	91	82	34
4/30/2001	85.4	117.6	2.8	285	481	35	50	27	19 469	26 593	7.84	7.14	352	813	35	50	22	19 469	26 593	<5	90	78	90	78	37
5/31/2001	87.7	129.7	3.1	271	382	19	36	17	12 502	13,605	7.61	7.31	355	704	18	32	13	12 502	13,605	< 5	94	83	94	83	18
6/30/2001	88.4	107.7	3.2	285	429	18	26	18	13 227	14,350	7.93	7.26	375	559	18	21	13	13 227	14 350	< 5	93	85	93	85	22
7/31/2001	87.3	97.9	2.8	312	584	23	31	17	12 230	16 404	7.57	7.3	343	655	23	25	10	12,230	16 404	< 5	95	90	95	90	30
8/31/2001	85.1	108.0	2.8	328	496	21	30	16	11,164	14 156	7.62	7.32	399	2 026	13	18	11	7,543	9,183	< 5	95	92	97	94	23
9/30/2001	80.5	109.7	2.6	298	423	19	29	16	10 470	13,496	8.17	7.34	402	747	14	30	10	6,747	8 786	< 5	96	91	97	92	20
10/31/2001	83.7	157.6	1.8	289	367	27	69	21	15 664	26,494	7.59	7.25	379	654	24	61	17	13,213	23 808	< 5	92	73	95	89	26
11/30/2001	83.6	205.9	2.4	279	400	29	56	26	20 058	17 834	7.71	7.23	348	923	22	91	20	17 517	13 499	< 5	90	59	94	79	42
12/31/2001	98.3	188.8	1.7	221	327	36	66	27	23 264	43 174	7.66	7.03	281	491	33	46	17	15 021	45 153	< 5	87	49	93	72	40
1/31/2002	83.1	131.9	2.4	287	419	43	73	37	26 528	33 114	7.69	7.16	283	524	24	75	20	14 535	20 638	< 5	87	77	93	85	43
2/28/2002	82.4	100.6	2.8	285	368	47	46	30	20 626	33,218	7.61	7.01	343	618	25	40	17	11 741	17 801	< 5	89	84	95	87	34
3/31/2002	115.5	192.7	2.2	197	336	40	51	31	31 390	51 467	7.86	6.99	270	653	23	48	21	20 987	30.441	< 5	80	47	91	69	42
4/30/2002	110.4	201.3	1	256	454	102	140	67	61 696	105 648	7.71	6.93	328	613	55	93	33	31 453	54 920	< 5	70	42	87	67	31
5/31/2002	151.0	232.0	1	185	457	45	67	32	44 729	79 161	7.96	7.01	291	985	40	88	24	38 413	72 310	< 5	75	6	85	24	19
6/30/2002	92.9	184.6	1	205	482	61	99	41	34 494	73 869	7.58	7.23	377	1 371	69	126	34	31 191	98 094	<1	83	43	89	57	22
7/31/2002	83.5	99.0	1.1	314	498	31	46	21	14 456	21 135	7.54	7.17	297	549	14	20	11	7 729	9 598	< 5	93	76	96	90	15
8/31/2002	84.1	116.9	2.9	362	549	18	47	15	10 607	13 830	7.63	7.25	432	810	13	23	8	5 871	9 226	<0.50	96	84	98	92	13
9/30/2002	89.5	186.4	2.4	310	523	19	46	14	12 370	19 305	7.69	7.23	345	793	15	39	9	8 084	14 871	<5	94	74	97	87	28
10/31/2002	98.7	156.7	1.9	281	604	35	99	25	23 314	51 132	7.75	7.07	340	671		93	30	18 952	37 612	4	90	52	94	77	31
11/30/2002	79.7	110.9	1.1	269	362	30	62	23	15 392	21 880	7.76	7.19	312	708	28	58	20	13 563	70 778	<0.50	92	75	93	72	33
12/31/2002	66.4	175.3	2.9	272	521	38	95	23	19 095	37 647	8.74	7.15	314	853	28	87	16	13 768	29 594	<0.5	90	27	94	68	46
1/31/2003	75.1	84.5	2	261	362	28	58	22	14 217	17 053	7.64	7.05	232	451	24	62	21	13 641	15 264	< 5	91	71	90	71	11
2/20/2003	99.2	156.2	1.7	246	434	32	57	27	23 742	29,423	7.83	6.91	276	725	40	63	23	21 784	34 253	< 5	87	46	89	60	32
3/31/2003	92.7	101.2	3.2	272	348	22	43	17	11 897	33 316	7.3	6.89	297	421	21	71	14	10 039	16 890	<0.50	92	80	94	79	43
4/30/2003	77.4	94.0	1.9	294	427	20	52	17	11 445	13 862	7.34	5.95	291	470	19	89	14	9 269	14 294	0	94	86	95	81	31
5/31/2003	126.4	205.1	1	213	348	62	78	15	41 386	93 928	7.36	6.71	306	959	57	82	30	35 975	85 663	0	77	11	86	24	34
6/30/2003	81.9	94.6	1.1	310	397	24	31	21	14 341	17 335	7.33	6.8	329	715	20	48	11	7 927	14 884	0	93	88	97	88	24
7/31/2003	73.4	94.4	1	349	592	30	50	22	13 951	19 887	7.31	6.88	359	575	23	51	13	8 542	15 484	0	94	87	96	88	22
8/31/2003	79.5	89.2	1.5	334	507	23	37	17	11 405	15 956	7.56	7.1	321	487	13	34	10	6 522	9 308	0	95	91	97	92	15
9/30/2003	77.9	117.5	1.6	322	512	22	38	19	12 572	14 169	7.39	7.03	395	531	14	29	9	6 171	8 538	0	94	87	98	95	22
10/31/2003	72.8	94.2	1.5	316	410	23	48	22	13 341	14 567	7.53	7.11	408	637	16	29	13	7 854	10 120	0	93	86	97	91	24
11/30/2003	77.7	110.3	1.2	299	429	39	61	31	20 473	28 637	7.43	7.05	320	487	43	122	32	20 979	31 805	0	90	79	90	53	25
12/31/2003	72.6	90.5	1.8	360	503	33	56	26	15 942	18 917	7.53	7.02	408	775	27	46	24	14 327	17 288	1	93	86	94	77	44
1/31/2004	75.9	128.7	1.7	342	522	40	60	30	18 938	23,843	8.56	6.87	294	664	27	49	22	13,921	16,482	1	91	80	93	82	40
2/29/2004	80.3	147.5	2.9	327	506	33	58	30	20 640	23 847	7.92	6.96	256	369	26	54	22	15 885	19 305	0	91	72	91	75	39
3/31/2004	80.6	112.8	1	339	601	27	45	23	15,267	19,002	7.35	6.85	270	355	21	44	16	11 035	14 465	0	93	83	94	82	32
4/30/2004	91.3	154.5	2.1	318	494	35	85	26	21 070	36 779	7.34	6.94	279	566	21	67	18	14,529	22,760	0	92	64	93	78	35
5/31/2004	85.1	117.5	2.4	318	465	28	44	22	15 825	18 348	7.39	7.06	266	447	15	31	13	9 396	11 348	0	93	89	95	89	26
6/30/2004	87.8	97.8	1.3	316	462	25	34	21	15 140	19,576	7.39	7.11	257	383	21	42	17	12,478	16,539	0	93	88	93	80	20
7/31/2004	85.0	121.0	1.5	320	459	27	35	23	16,543	19,107	7.4	7	263	409	15	30	11	7,823	10,615	0	93	90	96	90	14
8/31/2004	93.0	95.4	1.6	333	486	27	40	24	16 664	19 274	7.44	6.99	350	636	16	25	13	9 116	11 056	0	93	80	95	92	13
9/30/2004	79.1	90.8	1.6	363	644	23	34	21	13 851	15 054	7.36	7	294	470	16	31	14	9 459	10 053	0	94	91	95	91	15
10/31/2004	80.6	138.1	1.5	344	464	27	40	23	15 324	18 126	7.5	7.02	254	367	17	34	16	10 930	13 169	0	93	84	94	84	25
11/30/2004	88.7	150.3	1.9	321	546	22	37	21	15 367	17 916	7.42	7.03	268	614	17	34	15	11 357	13 124	0	93	79	95	88	26
12/31/2004	96.5	131.8	2	279	384	22	42	22	18 218	18 494	7.46	6.84	205	381	18	37	18	14 962	14,912	0	92	87	91	82	30
1/31/2005	135.1	182.6	1.9	231	395	76	141	50	58 872	112 173	7.46	6.94	202	452	47	99	39	45 627	69 118	0	78	19	81	7	33
2/28/2005	88.7	123.5	1	308	390	95	135	36	30,028	101 951	7.59	7.03	388	1 836	83	102	35	28 679	85 514	0	88	58	91	57	32
3/31/2005	86.9	120.4	3	333	492	22	40	22	16 814	17,678	7.45	7.07	279	484	25	48	22	16 226	20 749	0	93	86	92	77	26
4/30/2005	93.0	130.3	2.8	343	484	24	59	22	17,456	19 506	7.48	7.09	310	605	29	103	19	15 173	20 635	1.5	94	81	94	67	23
5/31/2005	90.8	86.3	1.5	352	583	21	31	19	12 965	14 646	7.48	7.14	306	470	20	31	16	11 027	13 683	0	96	91	95	80	27
6/30/2005	80.5	92.4	2	396	536	22	30	19	13 059	14 931	7.52	7.19	340	575	17	33	16	10 195	11 260	0	96	09	96	89	15
7/31/2005	82.4	115.8	1.7	333	484	22	31	18	12 421	15 217	7.51	7.02	324	602	18	29	14	9 843	12 533	0	96	90	96	92	11
8/31/2005	88.1	164.9	1.8	338	542	21	34	20	14 931	14 563	7.4	7.04	344	530	19	27	16	11 832	12 486	0	94	85	95	92	18
9/30/2005	85.2	103.8	1.5	343	432	22	29	18	13 041	19 900	7.42	6.98	360	667	18	30	16	11 266	15 926	0	95	93	96	92	15
10/31/2005	77.6	84.6	1.7	359	464	23	29	19	12 458	14 519	7.63	7.11	329	447	20	29	17	10 680	14 057	0	95	92	95	91	11
11/30/2005	103.1	142.9	1.7	369	518	22	28	19	16 653	20 230	7.43	7.05	419	795	20	29	15	12 980	16 144	0	95	92	96	92	20
12/31/2005	75.6	91.2	1.6	350	444	26	35	22	13 584	16 020	7.37	6.93	345	859	23	44	21	13 519	15 488	1	94	91	94	86	29

M.C. STILES STP - DMR SUMMARY (TN0020711)

Month	Eff Flow		Eff D.O.	Inf BOD5		Eff BOD 5					Eff pH		Inf TSS		Eff TSS					Settleable	BOD5 Removal		TSS Removal		Overflows
Ending	MAvg (MGD)	DMax (MGD)	DMin. (mg/L)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	DMax (s.u.)	Dmin (s.u.)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	Solids (ml/L)	MAvg (%)	Dmin (%)	MAvg (%)	Dmin (%)	(No./Month)
1/31/2006	83.8	133.3	2.3	346	513	30	42	24	16,879	19,496	7.26	6.85	307	547	30	47	24	17,015	20,865	0	93	87	92	85	28
2/28/2006	82.9	106.1	2.6	361	562	32	50	28	19,125	21,449	7.69	6.8	328	677	38	60	33	22,876	26,632	0	92	84	90	80	27
3/31/2006	79.5	115.6	2.4	354	457	25	39	25	16,359	18,191	7.59	6.8	308	615	32	55	28	18,838	20,583	0	93	87	91	81	31
4/30/2006	78.2	106.8	2.3	380	526	30	40	25	16,102	18,807	6.05	6.96	387	596	34	44	23	16,075	21,202	0	93	88	94	88	36
5/31/2006	79.0	116.3	2	363	518	40	54	31	20,364	24,868	8	6.73	457	892	21	30	19	12,515	13,867	0	91	85	96	92	24
6/30/2006	74.8	87.7	1.3	374	608	30	42	22	13,698	19,068	7.61	7.19	424	945	22	44	19	11,596	14,060	0	94	90	96	88	9
7/31/2006	74.2	82.6	1.2	390	839	25	36	20	12,539	16,126	7.67	7.26	365	767	24	34	16	9,930	14,666	0	95	90	96	90	18
8/31/2006	75.7	89.6	1.1	372	517	23	32	19	12,306	14,502	7.82	7.21	405	641	23	32	20	12,592	14,784	0	95	91	95	92	14
9/30/2006	74.4	102.1	1.0	386	536	25	29	23	13,893	15,065	7.55	7.27	341	525	23	29	21	12,962	14,756	0	94	89	94	88	15
10/31/2006	71.6	81.5	1.3	377	531	25	36	25	14,801	15,540	7.54	7.26	326	447	26	36	24	14,299	15,754	0	93	89	93	86	22
11/30/2006	72.9	101.6	1.3	408	555	39	71	32	19,701	25,155	7.89	7.22	371	763	35	64	32	19,389	21,514	0	92	83	91	83	25
12/31/2006	77.2	108.6	1.8	396	751	57	101	33	21,262	38,794	7.55	7.13	360	722	35	54	27	17,144	21,610	0.1	92	87	92	86	30
1/31/2007	85.3	132.7	2.9	378	494	27	35	25	18,022	21,013	7.52	7.07	346	937	28	53	24	17,485	19,330	0	93	88	93	83	32
2/28/2007	78.4	97.6	1.4	419	585	29	41	28	18,543	18,441	7.53	7.22	355	526	29	48	26	17,157	18,750	0	93	89	93	83	30
3/31/2007	76.5	89.5	1.3	411	612	29	39	27	16,988	19,880	8.07	7.23	329	454	34	55	28	17,584	21,748	0	93	91	92	84	36
4/30/2007	77.5	101.3	2	376	552	25	31	22	14,028	16,240	7.48	7.2	387	608	23	42	21	13,298	14,556	0	94	92	95	90	21
5/31/2007	76.3	83.9	1.9	401	580	27	52	23	14,473	17,163	7.55	7.29	398	536	27	53	22	14,006	17,451	0	94	89	95	87	13
6/30/2007	73.4	81.9	1.3	395	545	25	31	22	13,303	15,389	7.58	7.16	375	614	21	32	17	10,651	12,721	0	95	92	95	89	19
7/31/2007	76.6	91.4	1.7	356	464	23	29	18	11,679	14,608	7.56	7.12	333	593	16	27	13	8,596	10,457	0	95	93	96	92	19
8/31/2007	70.3	78.7	1.4	379	444	23	39	21	12,462	13,023	7.61	7.22	360	608	23	39	21	12,462	13,023	0	94	90	94	86	11
9/30/2007	89.3	121.3	1.1	371	483	32	56	27	20,029	23,262	7.47	7.16	356	1,026	25	60	18	13,428	16,904	0	93	87	95	84	18
10/31/2007	74.2	89.6	1.3	395	533	33	46	27	16,673	20,873	7.46	7.18	343	559	26	48	19	11,629	17,469	0	93	87	95	87	19
11/30/2007	70.6	85.0	2	410	740	26	32	22	13,064	15,755	7.6	7.09	369	1,051	13	18	10	6,074	7,546	0	95	92	97	93	24
12/31/2007	73.9	100.6	2.7	367	476	29	37	22	13,833	19,109	7.61	7.05	378	761	16	31	11	6,766	10,677	0	94	88	97	93	31
1/31/2008	71.4	115.5	2.8	410	702	20	24	16	9,906	13,949	7.52	7.2	466	829	13	16	10	6,132	7,647	0	96	92	98	96	29
2/28/2008	82.3	109.9	3.1	395	704	18	31	19	12,878	13,675	7.5	7.16	486	1,671	13	18	11	7,863	7,953	0	95	91	98	96	25
3/31/2008	143.1	224.4	1.2	270	527	90	144	58	79,427	142,588	7.45	6.9	294	1,052	52	69	36	48,510	81,737	0	78	11	88	45	23
4/30/2008	203.4	229.9	1	200	382	81	99	79	132,743	151,120	7.23	6.56	190	602	52	62	43	73,309	96,483	0	60	22	77	53	25
5/31/2008	102.7	135.2	1	394	1071	77	96	49	40,734	67,871	7.43	6.79	393	837	35	55	25	21,595	30,113	0.1	86	76	92	81	17
6/30/2008	86.4	109.8	1.8	417	681	36	47	35	24,705	25,195	7.46	6.89	510	911	27	43	22	15,808	19,112	0.3	92	85	96	89	13
7/31/2008	78.0	84.4	1.2	360	607	42	51	34	22,473	28,389	7.47	7	358	600	26	31	23	14,830	17,122	0	90	82	94	90	9
8/31/2008	78.2	97.4	1.2	393	559	33	49	31	20,351	21,679	7.43	7.13	372	749	26	43	22	14,247	16,490	0.1	92	87	94	86	11
9/30/2008	77.0	100.6	1.1	394	630	34	45	25	16,245	22,460	7.43	7.05	392	813	34	48	22	14,543	22,458	0.1	94	88	94	87	19
10/31/2008	7.4	93.9	1.8	410	703	19	38	17	10,170	12,201	7.5	7.16	392	739	10	13	8	4,976	6,075	0.5	96	92	98	97	16
11/30/2008	70.4	87.5	1.2	384	493	20	31	18	10,615	11,429	7.46	7.04	350	818	10	16	9	5,344	5,983	0.1	95	90	97	92	10
12/31/2008	80.0	159.8	1.4	354	1205	42	98	24	16,453	31,011	7.38	6.78	304	524	17	31	11	7,923	14,423	0.1	93	82	96	90	12
1/31/2009	80.1	136.1	1.4	362	1069	27	41	24	16,008	20,220	7.43	6.96	306	602	22	42	17	11,657	13,534	0.3	93	90	94	88	23
2/28/2009	74.8	101.6	1.7	412	758	38	52	35	21,426	23,272	7.47	6.88	320	513	30	48	27	16,889	18,660	0.1	91	87	91	84	13
3/31/2009	86.5	140.0	2.2	361	560	35	47	29	20,452	24,913	7.38	6.86	329	653	35	61	28	20,771	28,531	0.1	92	87	91	80	
4/30/2009	81.0	122.9	1.8	347	1112	24	41	22	15,091	17,334	7.7	6.5	316	722	22	40	19	12,544	16,025	NODI=B	93	87	94	65	22
5/31/2009	141.9	181.7	1	176	354	51	78	37	43,893	71,587	7.4	6.62	296	803	36	104	29	34,980	50,229	0.1	78	55	88	63	18
6/30/2009	81.7	97.0	1	330	523	36	46	22	14,868	26,184	7.28	6.98	491	1,166	29	41	16	11,180	20,464	0.1	93	88	96	91	10
7/31/2009	86.4	134.3	1.2	328	526	21	30	19	13,894	13,899	7.37		547	21	10	21	9	6,542	7,376	1	94	86	85	96	14
8/31/2009	80.2	94.2	1.2	257	688	31	59	26	17,367	25,832	7.38	6.91	396	1,301	22	46	14	9,103	14,593	0.1	92	79	96	90	12
9/30/2009	84.7	141.1	1.1	321	482	28	35	23	16,320	20,692	7.42	7	354	756	14	24	13	9,118	10,650	0.2	92	86	96	91	14
10/31/2009	94.3	149.6	6	297	695	31	51	27	21,938	29,488	7.55	6.86	324	697	21	52	18	14,717	20,725	0.1	90	79	94	81	16
11/30/2009	91.8	108.1	6.8	297	469	41	53	32	24,062	28,458	7.44	6.88	250	1,107	29	42	22	16,862	20,235	0.1	89	83	90	77	12
12/31/2009	83.7	124.3	6.5	360	1188	56	88	42	28,989	40,682	7.49	7.02	265	815	46	72	27	19,315	30,522	0.2	87	71	90	64	16
1/31/2010	84.7	119.6	2	300	415	52	70	39	27,359	33,220	7.54	6.95	278	1,368	30	57	23	16,598	23,713	0.5	87	68	91	78	23
2/28/2010	102.2	151.5	8	282	508	48	68	41	34,639	45,821	7.58	6.78	274	1,024	34	51	28	23,872	32,400	0.1	85	76	88	68	13
3/31/2010	93.7	135.4	7.2	335	989	47	60	38	30,619	41,950	7.45	6.84	318	513	31	46	24	19,127	27,805	0.1	88	81	92	80	21
4/30/2010	99.6	140.9	6.5	308	461	60	84	49	40,265	48,360	7.34	6.94	324	489	49	103	34	28,005	35,342	1	83	63	89	76	18
5/31/2010	163.1	189.4	1.3	184	397	67	86	44	61,867	99,164	7.3	6.53	214	1,233	52	86	36	60,804	76,933	0.4	74	49	77	35	18
6/30/2010	81.7	101.2	5.9	393	826	41	76	36	24,767	26,672	6.96	7.36	356	519	37	77	28	18,961	24,822	0.2	90	81	76	92	
7/31/2010	83.6	132.9	6.7	361	839	34	38	28	19,772	24,586	6.91	7.3	285	599	17	38	14	9,661	13,247	0.1	92	81	86	95	10
8/31/2010	75	84.8	6.7	394	567	25	39	23	14,278	16,164	6.87	7.3	296	427	15	25	12	7,636	9,851	0.1	94	92	91	96	16
9/30/2010	70.7	77.7	6.5	452	731	30	45	25	14,695	18,432	7.02	7.33	300	540	17	31	12	7,161	10,244	0.1	94	89	91	96	14
10/31/2010	69.2	79	6.3	461	607	48	60	41	23,708	27,636	6.86	7.47	343	537	28	37	21	12,017	16,076	0.1	91	86	86	94	12
11/30/2010	73.1	98.3	7.3	405	642	47	56	38	13,153	26,651	6.78	7.36	387	681	30	47	24	14,473	17,845	0.2	90	82	85	93	16
12/31/2010	69.4	98.1	7.5	461	818	58	68	46	26,572	34,593	6.96	7.43	390	680	28	59	25	14,276	16,892	0.1	90	80	86	93	20
1/31/2011	71.4	112.8	7.8	393	583	50	62	38	22,663	29,650	7	7.47	343	583	33	56	22	12,198	19,275	0.1	90	85	80	93	41
2/28/2011	73.6	93.4	7.8	387	712	41	63	37	22,715	25,877	7.01	7.5	292	465	22	30	21	12,899	13,881	0.2	90	80	88	93	26
3/31/2011	141.1	164.2	2.6	220	422	50	68	31	35,201	41,445	6.73	7.29	175	414	27	59	24	27,965	29,956	0.1	85	74	57	84	27
Average	86.3	120.6	2.4	329	539	34	52	27	20,746	28,848	7.52	7.07	335	695	26	48	20	15,159	22,049	0.2	91	79	92	82	24
Median	82.3	110.1	1.8	333	505	29	46	24	16,363	20,060	7.52	7.07	329	617	23	44	19	12,971	16,240	0.0	93	85	94	87	23
Maximum	203.4	232.0	8.0	461	1,205	102	148	79	132,743	151,120	8.74	7.60	547	2,026	83	126	43	73,309	98,094	4	96	93	98	97	55
Minimum	7.4	77.7	1.0	176	327	18	24	14	9,906	11,429	6.73	6.50	175	21	10	13	8	4,976	5,983	0	60	6	57	7	9
Count	132	132	132	132	132	132	132	132	132	132	132	131	132	132	131	132	132	132	132	97	132	132	132	132	128
Permit Limits	Report	Report	1.0	Report	Report	68	90	45	50,666	76,561	9.0	6.0	Report	Report	78	104	52	58,547	87,820	1.0	85	40	85	40	0
Exceedances	NA	NA	0	NA	NA	6	11	6	5	8	0	0	NA	NA	1	2	0	1	2	2	11	6	6	4	128

Note: Above statistics for period April 2000 through March 2011

Appendix R-2B
E. coli Monitoring Data

MISSISSIPPI RIVER *E. coli* DATA

4-23-07 Draft

Sampling Location	Approx. River Mile	Station ID	*E. coli* (cfu/100 mL)									
			3/24/05		5/24/05		8/25/05		11/17/05		3/29/06	
River Stage (ft)			7.9		10.5		-5.7		-5.2		12.0	
Approx. 1.5 miles upstream of Loosahatchie River's mouth												
About 500 ft from AR bank	742	1	15		500		32,800		73		73 (a)	
About 500 ft from TN bank	742	2	100		400		36		117		-	
Nos. 13 & 14 N. Plant sludge lagoons (approx. 1 mile upstream of N. Plant discharge)												
About 100 ft from AR bank	740	3	74		720		18		36		-	
About mid-channel	740	4	33		200		36		91		36	
About 100 ft from TN bank	740	5	86		364		18		255		109	
North bank of Wolf River's mouth (approx. 1,600 ft downstream of N. Plant discharge)												
About 100 ft from AR bank	738.5	6	40		400		73		91		-	
About mid-channel	738.5	7	48		327		18		109		73	
About 100 ft from TN bank	738.5	8	2,200		3,260		8,600		2,600		5,000	
South end of Mud Island												
About 100 ft from AR bank	736	9	70		255		36		73		-	
About mid-channel	736	10	68		218		36		73		145	
About 100 ft from TN bank	736	11	840		2,280		11,000		436		700	
Wolf River Harbor												
Underneath Mud Island Monorail, mid-channel	-	12	256		73		1,120		600		-	
Parallel Gayoso pumping station discharge, mid-channel	-	13	356		36		1,040		1,000		73	
Parallel Marble pumping station discharge, mid-channel	-	14	124		36		460		418		182	

(a) Mid-channel

Note - grab samples, see "Source" for sampling notes, including climatological information

Source - www.sierraclub.org/watersentinels/tennessee/

Appendix R-2C
Treated Effluent – Listed Organic Pesticide Chemicals, DDT, Dieldrin, and PCB Results

Listed Organic Pesticide Chemicals and PCBs - M.C. Stiles Treatment Plant Effluent Results

Pesticide	Aug. 7, 2000 (ug/l)	Dec. 20, 2001 (ug/l)	Aug. 28, 2002 (ug/l)	Oct. 21, 2003 (ug/l)	Jun. 23, 2004 (ug/l)	Oct. 13, 2005 (ug/l)	Dec. 7, 2006 (ug/l)	Dec. 3, 2007 (ug/l)	Nov. 5, 2008 (ug/l)	Oct. 29, 2009 (ug/l)	Nov. 15, 2010 (ug/l)
Alphe-BHC	<0.042										
Lindane (gamme-BHC)	<0.042	<0.500	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor	<0.042	<0.050	<0.050	<0.015	<0.050	<0.05	0.07	0.15	<0.05	<0.05	<0.004
Aldrin	<0.042	<0.500	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor Epoxide	<0.042	<0.080	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Endosulfen I (alpha)	<0.042	<0.100	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.06	<0.05	<0.004
Endosulfen II (beta)	<0.042	<0.050	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDD	<0.042	<0.100	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDE	<0.042	<0.100	<0.050	<0.015	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Methoxychlor	<0.042										
Endrin Aldehyde	<0.042										
Hexachlorobenzene	<0.042										
Hexechloro-1,3,Butadiene	0.103										
Hexechlorocyclopentadiene	<0.042										
Hexachloronorbornadiene	<0.042										
Octachlorocyclopentene	<0.042										
Heptachloronorbornene	<0.042										
Chlordene	<0.042	<0.100	<1.0	<0.300	<1.0	<1.0	<1.0	<1.0	2.15	<1.0	<0.02
Endrin Ketone	<0.042										
Endrin	0.048	<0.100	<0.060	<0.015	<0.05	<0.05	<0.05		<0.05	<0.05	<0.004
PCBs-Total	Not Anelyzed	<5.0	<6.0	<1.5	<1.5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Toxaphene	Not Anelyzed	<0.5	<10.0	<5.0	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.03
DDT	<0.040 (e)	<0.006 (b)	<0.006 (c)	<0.015 (d)	<0.010 (e)	<0.009 (f)	<0.009 (g)	0.055 (h)	<0.009 (i)	<0.009 (j)	<0.004 (k)
Dieldrin	<0.040 (e)	<0.010 (b)	<0.010 (c)	<0.015 (d)	<0.010 (e)	<0.009 (f)	<0.009 (g)	0.018 (h)	<0.009 (i)	<0.009 (j)	0.009 (k)

Note: Results for greb samples, unless otherwise noted.

(a) Jun. 22-23, 2000 compoeite semple
(b) Dec. 19-20, 2001 composite sample
(c) Aug. 27-28, 2002 composite sample
(d) Oct. 20-21, 2003 composite sample
(e) Jun. 21-22, 2004 composite sample
(f) Oct. 12-13, 2005 composite sample
(g) Jun. 6-7, 2006 composite semple
(h) Dec. 12-13, 2007 composite sample
(i) Jan. 15-16, 2008 composite semple
(j) Oct. 28-29, 2009 composite sample
(k) Nov. 9-10, 2010 composite sample

Permittee indicated that as a result of 2000 NPDES permit the following pesticides were removed as analytical requirements: Alpha BHC, Methoxychlor, Endrin Aldehyde, Hexachlorobenzene, Hexachloro-1-3 Butadiene, hexachlorocyclopentadiene, Hexachloronorbornadiene,

Appendix R-2D
Treated Effluent - Total Dioxin Results

Outfall 001 Treated Effluent Total Dioxin (Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans)

PARAMETERS	TEF	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.	Plt. Eff.
Sample Date		06/18/2000		12/19-20/2001		08/22/2002		10/22/2003		3/9-10/2004		6/16-17/2005		11/29-30/2006		12/12-13/2007		1/15-16/2008		10/21-22/2009		12/6-7/2010	
		ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD
2,3,7,8 TCDD	1	0.91	0.9100	4.8	0.0000	2.1	0.0000	5.4	0.0000	2.8	0.0000	1.1	0.0000	1.9	0.0000	2.00	0.0000	0.91	0.0000	1.5	0.0000	0.81	0.0000
1,2,3,7,8-PeCDD	0.5	0.60	0.0000	5.7	2.8500	3.1	0.0000	5.1	0.0000	2.8	0.0000	5.5	2.7500	3.1	0.0000	1.30	0.0000	1.20	0.0000	1.5	0.0000	0.85	0.0000
1,2,3,4,7,8-HxCDD	0.1	0.8	0.0000	6	0.6000	3.6	0.0000	5.4	0.0000	2.7	0.0000	4.4	0.0000	2.1	0.0000	1.10	0.0000	0.56	0.0000	1.7	0.0000	1.70	0.0000
1,2,3,6,7,8-HxCDD	0.1	0.7	0.0000	6.9	0.6900	3.6	0.0000	5.6	0.0000	2.2	0.0000	1.3	0.0000	2.3	0.2300	2.3	0.2300	1.20	0.0000	1.5	0.0000	0.64	0.0000
1,2,3,7,8,9-HxCDD	0.1	0.7	0.0000	4.5	0.4500	3.4	0.0000	5.7	0.0000	2.5	0.0000	1.3	0.0000	2.1	0.0000	1.60	0.0000	1.20	0.0000	5.6	0.0000	0.60	0.0000
1,2,3,4,6,7,8-HpCDD	0.01	7.8	0.0780	14.9	0.1490	7.2	0.0000	15.9	0.0000	4.0	0.0000	19.2	0.1920	21.6	0.2160	3.90	0.0390	2.2	0.022	9.1	0.0000	5.5	0.055
1,2,3,4,6,7,8,9-OCDD	0.001	74.5	0.0745	122	0.1220	14.2	0.0000	128	0.1280	25.8	0.0258	127	0.1270	187	0.1870	52.0	0.0520	32.0	0.032	64.0	0.064	81.0	0.081
2,3,7,8 TCDF	0.1	[illegible]	0.1100	6.2	0.0000	1.7	0.0000	4.6	0.0000	2.1	0.0000	4.1	0.0000	1.4	0.0000	1.50	0.0000	0.91	0.0000	1.5	0.0000	1.50	0.0000
1,2,3,7,8-PeCDF	0.05	0.3	0.0000	5.8	0.2900	2	0.0000	3.1	0.0000	1.6	0.0000	6.4	0.0000	2.0	0.0000	1.20	0.0000	1.10	0.0000	1.2	0.0000	0.63	0.0000
2,3,4,7,8-PeCDF	0.5	0.4	0.0000	5.5	0.0000	1.9	0.0000	3.5	0.0000	1.9	0.0000	5.5	2.7500	1.9	0.0000	0.96	0.0000	0.95	0.0000	1.2	0.0000	0.55	0.0000
1,2,3,4,7,8-HxCDF	0.1	1.6	0.1600	5.3	0.0000	2.2	0.0000	3.7	0.0000	1.4	0.0000	6.8	0.6800	3.5	0.3500	1.2	0.1200	1.0	0.1	1.7	0.0000	0.67	0.0000
1,2,3,6,7,8-HxCDF	0.1	1.7	0.1700	6.5	0.0000	2.2	0.0000	3.9	0.0000	1.5	0.0000	5.9	0.0000	2.8	0.2800	0.99	0.0000	0.93	0.0000	1.5	0.0000	0.62	0.0000
2,3,4,6,7,8-HxCDF	0.1	0.6	0.0000	3.1	0.0000	2.4	0.0000	4.0	0.0000	1.4	0.0000	4.3	0.4300	2.4	0.2400	0.91	0.0000	0.79	0.0000	1.4	0.0000	0.78	0.0000
1,2,3,7,8,9-HxCDF	0.1	0.7	0.0000	8.1	0.8100	3.4	0.0000	5.2	0.0000	2.0	0.0000	1.3	0.0000	1.7	0.0000	0.48	0.0000	0.93	0.0000	1.6	0.0000	0.78	0.0000
1,2,3,4,6,7,8-HpCDF	0.01	4.0	0.0000	11	0.0000	3.8	0.0000	4.6	0.0000	1.9	0.0000	14.2	0.0000	10.3	0.0000	3.1	0.0310	2.2	0.022	2.1	0.0000	2.0	0.02
1,2,3,4,7,8,9-HpCDF	0.01	1.9	0.0000	2.7	0.0000	3.2	0.0000	5.6	0.0000	3.1	0.0000	1.9	0.0000	2.3	0.0000	3.30	0.0000	2.10	0.0000	5.6	0.0000	5.60	0.0000
1,2,3,4,6,7,8,9-OCDF	0.001	10.9	0.0109	23.6	0.0236	11.8	0.0000	8.3	0.0000	6.1	0.0000	45.5	0.0455	21.6	0.0216	7.0	0.0070	7.9	0.0079	6.8	0.0000	2.80	0.0000
TOTAL (pg/L)			1.5134		5.9846		0.0000		0.1280		0.0258		6.9745		1.5266		0.4790		0.1839		0.064		0.156

Note. TEF = Toxicity Equivalency Factor; Eq/TCDD = Concentration in terms of 2,3,7,8. TCDD ppq(parts per quadrillion)

1pg/L=1/1000000ug/L or 1000000pg/L=1ug/L or 1pg/L=1/1000000000 mg/L

Dioxins/Furans (total): industrial discharge limit is 10 ppq (parts per quadrillion) and Non detect=0.0000

Method 1613B (9/97)

Appendix R-2E

Treated Effluent - Biomonitoring Results

LC_{50} and NOEC Results:

LC_{50} (96 hour): (Jun. 27-28, 2000, and Jul. 2, 2000)

Ceriodaphnia dubia (water flea) = 70.7%
Pimephales promelas (fathead minnow) = 45.1%

NOEC (7 day): (Jun. 27-28, 2000, Jun. 29-30, 2000, and Jul. 2, 2000)

Ceriodaphnia dubia (water flea): Survival = 50% and Reproduction = 25%
Pimephales promelas (fathead minnow): Survival 50% and Reproduction 50%

IC_{25} Results:

M. C. Stiles STP IC_{25} WET Testing Results

Sample Date	*Ceriodaphnia dubia* (water flea)	*Pimephales promelas* (fathead minnow)
Dec. 9 -11, 2003	30.3%	33.3%
Feb. 9 -13, 2004	34.2%	22.9%
Apr. 26 - 30, 2004	36.4%	47.7%
Jul. 19 - 23, 2004	35.9%	11.2%

(a) Submitted with Sept. 24, 2004 Permit Renewal Application.

Appendix R-2F

Treated Effluent - Other Parameters

M.C. Stile Landfill Groundwater Mercury Monitoring Results

Date	Upgradient Wells		Old Landfill							New Landfill						
	No. 14 (ug/L)	No. 15 (ug/L)	No. 1 (ug/L)	No 2 (ug/L)	No. 3 (ug/L)	No. 4 (ug/L)	No. 5 (ug/L)	No. 6 (ug/L)	No. 7 (ug/L)	No. 1 (ug/L)	No. 2 (ug/L)	No. 3 (ug/L)	No 4 (ug/L)	No. 5 (ug/L)	No. 6 (ug/L)	No 7 (ug/L)
2/20/95														0.3	0.2	0.2
2/22/95											0.4	0.4	0.4			
2/23/95			0.4	0.5	0.3					0.4						
2/24/95							0.3	0.5								
3/1/95						0.41										
4/26/95													0.61	0.71	0.91	0.3
5/3/95										<0.2	<0.2	0.3				
9/5/95													<0.2	0.2	0.2	
9/6/95										<0.2						<0.2
9/12/95	<0.2	<0.2														
11/20/95			0.2		<0.2	0.2	0.2	0.2								
11/21/95										0.2	0.2		<0.2	0.2	0.2	<0.2
11/27/95	0.2	0.2										<0.2				
10/7/97	<0.2	<0.2														

Median landfill mercury value = 0.3 ug/L (range < 0.2 - 0.91 ug/L)

M C Stiles STP Sludge Mercury Content

Date	Mercury (mg/kg)
6/20/2000 (a)	1.61
12/4/2001 (a)	0.977
9/10/2002 (a)	1.6
10/8/2003 (a)	1.2
Median =	1.4

(a) Data provided in permittee's NPDES permit renewal application.

Note: 1.05 mg/kg reported for 2010.

Appendix R-3

Calculations – Variances From Federal Secondary Treatment Standards for Effluent BOD_5 and TSS

M.C. STILES STP - SECONDARY TREATMENT STANDARDS VARIANCE. PER 40 CFR PART 133.103(b)

A. Variance possible since selected industries contributions are >10 % of flow and/or BOD5 or TSS loadings.

		Flow (mgd)	BOD5 (lb/day)	TSS (lb/day)
M.C. Stiles STP - Design Capacity		135	275,000	375,000
Pulp & Paper Industries (a)	**40CFR Part 130**			
	Subpart			
Buckeye Technologies	H	[illegible]	43,656	24,965
KTG	L	2.89	1,855	5,329
Cascades Tissue Group - Tennessee Inc	J	0.60	2,449	5,565
Total		8.25	47,960	35,859
Pulp & Paper Industries Input to STP (%)		**6.1**	**17.4**	**9.6**
OCPSF Industries (a)	**40CFR Part 414**			
	Subpart			
Chemtura	G	1.22	14,846	3,172
E I DuPont	F	4.09	8,548	10,258
Penn Specialty	H	0.40	3,993	656
Velsicol Chemical	H	[illegible]	1,534	1,841
Total		11.96	28,921	15,927
OCPSF Input to STP (%)		**8.9**	**10.5**	**4.2**
Selected Pulp & Paper and OCPSF Industries Input to STP (%)		**15.0**	**28.0**	**13.8**

(a) Values shown based on (12) months self-monitoring data

B. Selected Industrial Contributions (b)

	Actual Production Rate	BOD5				TSS			
		Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(1,000 lb/day)	(lb/1,000 lb)	(lb/day)	(lb/1,000 lb)	(lb/day)	(lb/1,000 lb)	(lb/day)	(lb/1,000 lb)	(lb/day)
Selected Pulp & Paper Industries (40 CFR Part 130)									
Buckeye Technologies	620 (c)	21.5	13,330	41.4	25,668	38.05	23,591	70.65	43,803
KTG	170	6.25	1,063	11.4	1,938	5.00	850	10.25	1,743
Cascades Tissue Group - Tennessee Inc	250	7.1	1,775	13.7	3,425	9.2	2,300	17.05	4,263
Total			16,168		31,031		26,741		49,808
	Actual Production Flow	**BOD5**				**TSS**			
		Monthly Avg.		**Daily Max.**		**Monthly Avg.**		**Daily Max.**	
	(mgd)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)
Selected OCPSF Industries (40 CFR Part 414)									
Chemtura	1.22	34	346	92	936	49	499	159	1,618
E I DuPont	4.09	30	1,023	80	2,729	46	1,569	149	5,082
Penn Specialty	0.40	45	150	120	400	57	190	183	610
Velsicol Chemical	0.40 (d)	45	150	120	400	57	190	183	610
Total	6.1		1,670		4,466		2,448		7,921
Total (Pulp & Paper + OCPSF)	15.2		17,837		35,497		29,189		57,729

(b) Pursuant to relevent Federal Effluent Guidelines Limitations for direct dischergers, effluent values calculated using actual production rates for Pulp & Paper Industries and Flows for OCPSF Industries

(c) Buckeye Technologies' Federal Effluent Guidelines Limitatons for Subpart H is "Reserve". Based on Best Professional Judgment (BPJ) determination, direct discharge allocations pursuant to Subpart K Dissolving Sulfite Pulp Mills appears applicable since Buckeye Technologies' production results in similar end-products to Subpart K. Also, the Subpart K allocations were used to establish the permittee's current permit limits

(d) The Velsicol Chemical actual production flow subject to OCPSF limitations is now 0.4 instead of 6.25 mgd

C. M.C. Stiles STP Effluent Requirements - Without and With Secondary Treatment Standards Variance

M.C. Stiles STP Effluent Requirements	Flow	BOD5				TSS			
		Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(mgd)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)
Without Secondary Variance	135	30	33,777	60	67,554	30	33,777	60	67,554
Corrected for Selected Industrial Flow	15.2	30	3,058	60	6,115	30	3,058	60	6,115
net			30,719		61,439		30,719		61,439
With Secondary Variance Loading Allocation			48,557		96,935		59,908		119,168
	135	43.1		86.1		53.2		105.8	
Resulting weekly concentration assuming 1.5 times monthly value		64.7	Weekly Avg			79.8	Weekly Avg		

Appendix R-4

Aquatic Toxicity Potential due to Ammonia Nitrogen and/or Total Residual Chlorine (TRC) - Considerations

NH_3-N tOXICITY potential considerations

To access toxicity impacts, the state utilizes the EPA document, 1999 Update to Ambient Water Quality Criteria for Ammonia and assumed stream temperatures of 25°C and 15°C and pH of 7.5 or 8.0 to derive an allowable instream protection value protective of chronic exposure to a continuous discharge. A mass balance equation with sewage treatment facility and stream flows and this allowable value determines the monthly average permit limit. The criteria document states that a 30Q5 flow value is protective in deriving allowable values. Where the division has 30Q5 flow values, the division may use them. Otherwise, the division utilizes the available 7Q10 or 1Q10 values that are generally more conservative. The criteria continuous concentrations (CCC) derived from assumed temperature and pH values are as follows:

CCC values based on temperature and pH, in mg/L:

Temperature (°C)	7.5 pH	8.0 pH
30	1.61	0.90

Temperature (°C)	7.5 pH	8.0 pH
20	3.06	1.71

The mass balance equation is as follows:

$$CCC = \frac{Q_S C_S + Q_{STP} C_{STP}}{Q_S + Q_{STP}} \qquad \text{or,} \qquad C_{STP=} \frac{CCC(Q_S + Q_{STP}) - (Q_S C_S)}{Q_{STP}}$$

where:

CCC = Criteria continuous concentration (mg/l)
Q_S = receiving stream 7Q10 flow (70,500 MGD)
Q_{STP} = STP Design flow (135 MGD)
C_S = Assumed/Measured instream NH_3 – N (0.1 mg/l)
C_{STP} = Allowable STP discharge NH_3 – N (mg/l)

Assuming Complete Effluent Dispersion:

(summer)

$$C_{STP} = \frac{0.90\ (70{,}500\ \text{MGD} + 135\ \text{MGD}) - (70{,}500\ \text{MGD} \times 0.1\text{mg/l})}{135\ \text{MGD}} = 419\ \text{mg/l}$$

(winter)

$$C_{STP} = \frac{1.71\ (70{,}500\ \text{MGD} + 135\ \text{MGD}) - (70{,}500\ \text{MGD} \times 0.1\text{mg/l})}{135\ \text{MGD}} = 842\ \text{mg/l}$$

Based on the above evaluation results, specific limitations for instream NH_3-N toxicity is not warranted. However, if the Outfall 001 discharge transport/dispersion evaluations per the new permit's Section 3.5, demonstrate a concentrated/extended discharge plume, the permit may be modified for numerical NH_3-N permit limitations.

TOTAL RESIDUAL CHLORINE TOXICITY POTENTIAL CONSIDERATIONS

Should the permittee start using chlorination for effluent disinfection the following approach would be applied. Acute and chronic residual chlorine limits are determined using the following mass balances and the EPA instream protection values for fish and aquatic life:

Assuming Complete Effluent Dispersion:

where:

0.019	=	instream acute protection value (mg/l)
0.011	=	instream chronic protection value (mg/l)
135	=	Qd, STP design flow (MGD)
70,500	=	Qs, receiving stream 7Q10 flow (MGD)

Acute Calculation

$$\frac{0.019\ (Qd + Qs)}{Qd} = \text{Limit (mg/l)} = \frac{0.019(135+70{,}500)}{135} = 9.9\ \text{mg/l}$$

Chronic Calculation

$$\frac{0.011\ (Qd + Qs)}{Qd} = \text{Limit (mg/l)} = \frac{0.011(135+70{,}500)}{135} = 5.8\ \text{mg/l}$$

The proposed new permit TRC limit for Outfall 001 discharge = 2.0 mg/l (from industry practice for breakpoint chlorination where 2.0 mg/l of free residual chlorine is associated with a 30 minute hydraulic retention time).

Appendix R-5

Whole Effluent Testing - Biomonitoring LC_{50} and IC_{25} Considerations

The division evaluates all dischargers for reasonable potential to exceed the narrative water quality criterion, "no toxics in toxic amounts". The division has determined that for municipal facilities with stream dilutions of less than 500 to 1, any of the following conditions may demonstrate reasonable potential to exceed this criterion.

a. Some toxicity is suspected or demonstrated.
b. A pretreatment program is required.
c. The design capacity of the facility is greater than 1.0 MGD.

EPA's **Technical Support Document for Water Quality Based Toxics Control** (TSD) recommends that the evaluation of both acute and chronic toxicity be based on the number of observations in the data set, the coefficient of variation and an uncertainty factor. The uncertainty factor value is taken from a chart in the technical support document and the coefficient of variation (C.V.) is based on the following numbers.

Less than ten observations C.V. = 0.6
More than ten observations C.V. = Standard Deviation/Mean

Biomonitoring test results are converted to Toxic Units (TU) as follows:

$TUa = 100/LC_{50}$ (for acute test results)
$TUc = 100/NOEC$ or $100/IC_{25}$ (for chronic test results)

To determine if acute and/or chronic biomonitoring is required in the new permit, the final acute value is compared to the criteria maximum concentration (CMC) for acute toxicity (CMC = 0.3 X TUa). The CMC is defined as the highest instream concentration of an effluent to which organisms can be exposed to for a brief period of time without causing an acute effect. The final chronic value is compared to the criteria continuous concentration (CCC) for chronic toxicity (CCC = 1.0 X TUc). The CCC is defined as the highest instream concentration of an effluent to which organisms can be exposed to indefinitely without causing an unacceptable effect. In the absence of chronic data, an acute to chronic ratio (ACR) of 4.4 is assumed (TSD Appendix A.3).

The following biomonitoring assessment assumes the the permittee's Outfall 001 discharge 100% dispersion in Mississippi River under low-flow conditions:

Facility	M.C. Stiles STP						
NPDES No.	TN0020711			7Q10 = 70.500 MGD		TUupstream =	0.0 acute
Q_{design} =	135 MGD			1Q10 = N A		TUupstream =	0.0 chronic
Sample Dates	LC_{50} (%)	sp.	TU_a 100 LC_{50}	Sample Dates	sp.	NOEC or IC_{25} (%)	TU_c 100 NOEC or 100 IC_{25}
Jun 27-28 & Jul 2 2000	70 7	CD	1.4				
Jun 27-28 & Jul 2 2000	45 1	PP	2.2	Jun 27-28 & Jul 2 2000	CD		
				Jun 27-28 & Jul 2 2000	PP	50	2 0
				Dec 9-11, 2003	CD	30 3	3 3
				Dec 9-11, 2003	PP	33 3	3 0
				Feb 9-13, 2004	CD	34 2	2 9
				Feb 9-13, 2004	PP	22 9	4 4
				Apr 26-30, 2004	CD	36 4	2 7
				Apr 26-30, 2004	PP	47 7	2.1
				Jul 19-23, 2004	CD	35 9	2 8
				Jul 19-23, 2004	PP	11 2	8 9
Count			2				9
Average			N/A				3.6
Maximum			2.2				8 9
Std Dev			N/A				2.1
Coeff. Of Variation (c.v.)			0.6				0.6
Uncertainty Factor (u.f.) (a)			3.8				1.8
TU loading @ Discharge = TU*u.f.*Q_{design}			1,137				2,170
TU loading @ Upstream = TUupstream * 7Q10			0				0
TU @ Downstream (c)			0.016				0.031
Biomonitoring Requirement (b)			NO				NO

(a) From uncertainty factors table. If standard deviation = 0.0, then use 1.0 for uncertainty factor.
(b) Biomonitoring required if TUa $\geq$ 0.3 and/or if TUc $\geq$ 1.0.
(c) TU loading downstream (Qdesign + 7Q10)
Note: Maximum TUa and Tuc values were used for discharge TU loadings. Also, upstream TU values are assumed.

The acute toxicity tests specified herein shall begin no later than 120 days from the effective date of this permit.

In the current permit, the division used the NOEC as the measure of chronic toxicity and coupled it with the requirement to estimate the 96-hour LC_{50} (acute toxicity) from the NOEC. However, LC_{50} values cannot be accurately calculated from the NOEC, since the test requirements are different. The chronic toxicity IC_{25} test is deemed equal to but statistically preferred to the NOEC because the IC_{25} is not readily affected by variability in the test data and it incorporates both mortality and chronic effects.

As shown in the above biomonitoring summary table for discharge to the Mississippi River, the estimated TUa and TUc values do not exceed the CMC and CCC, respectively. As such, a reasonable potential for instream acute and chronic toxicity are not demonstrated, for the Outfall 001 treated effluent fully dispersed in the Mississippi River under low-flow conditions. However, since the actual Outfall 001 discharge mixing characteristics within the Mississippi River have not been determined at this time, 48-hour LC_{50} biomonitoring testing is required for the new permit. The division may modify the new permit acute WET requirements if warranted based the actual Outfall 001 biomonitoring results, and the Outfall 001 discharge transport/dispersion characteristics within the Mississippi River, pursuant to the new permit's Section 3.5 requirements.

Appendix R-6

Water-Quality Based Effluent Calculations- Other Parameters/Antidegradation Considerations

The following procedure is used to calculate the allowable instream concentrations, pass-through guidelines, and permit limitations.

a. The most recent background conditions of the receiving stream segment are compiled. This information includes:

   * 7Q10 of receiving stream (70,500 MGD, USGS)
   * Hardness as CaO_3 (192 mg/l)
   * Total suspended solids (71 mg/l)
   * Background metals concentrations (½ water quality criteria)
   * Other dischargers impacting this segment (none)
   * Downstream water supplies, if applicable

b. The chronic water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel and zinc. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions.

c. The acute water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel, zinc, silver and mercury. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions for the following metals: cadmium, copper, lead, nickel, silver and mercury.

d. The chronic criteria for Chromium (T) is given in the total recoverable form and is not converted to a dissolved lab condition or to the total recoverable ambient condition.

e. A standard mass balance equation determines the total allowable concentration (permit limit) for each pollutant. This equation also includes a percent stream allocation of no more than 90%.

The following formulas are used to evaluate water quality protection:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow
Qs = stream low flow

to protect water quality:

$$Cw \leq \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

where (S_A) is the percent "Stream Allocation".

Calculations for this permit have been done using a standardized spreadsheet, titled "Water Quality Based Effluent Calculations." Division policy dictates the following procedures in establishing these permit limits:

1. The critical low flow values are determined using USGS data:

   Fish and Aquatic Life Protection
   7Q10 - Low flow under natural conditions
   1Q10 - Regulated low flow conditions

   Other than Fish and Aquatic Life Protection
   30Q5 - Low flow under natural conditions

2. Fish & Aquatic Life water quality criteria for certain Metals are developed through application of hardness dependent equations. These criteria are combined with dissolved fraction methodologies in order to formulate the final effluent concentrations.

3. For criteria that are hardness dependent, chronic and acute concentrations are based on a Hardness of 25 mg/L and Total Suspended Solids (TSS) of 10 mg/L unless STORET or Water Supply intake data substantiate a different value. Minimum and maximum limits on the hardness value used for water quality calculations are 25 mg/L and 400 mg/L respectively. The minimum limit on the TSS value used for water quality calculations is 10 mg/L.

4. Background concentrations are determined from the division database, results of sampling obtained from the permittee, and/or obtained from nearby stream sampling data. If this background data is not sufficient, one-half of the chronic "In-stream Allowable" water quality criteria for fish and aquatic life is used. If the measured background concentration is greater than the chronic "In-stream Allowable" water quality criteria, then the measured background concentration is used in lieu of the chronic "In-stream Allowable" water quality criteria for the purpose of calculating the appropriate effluent limitation (Cw). Under these circumstances, and in the event the "stream allocation" is less than 100%, the calculated chronic effluent limitation for fish and aquatic life should be equal to the chronic "In-stream Allowable" water quality criteria. These guidelines should be strictly followed where the industrial source water is not the receiving stream. Where the industrial source water is the receiving stream, and the measured background concentration is greater than the chronic "In-stream Allowable" water

quality criteria, consideration may be given as to the degree to which the permittee should be required to meet the requirements of the water quality criteria in view of the nature and characteristics of the receiving stream.

The spreadsheet has fifteen (15) data columns, all of which may not be applicable to any particular characteristic constituent of the discharge. A description of each column is as follows:

Column 1: The "Stream Background" concentrations of the effluent characteristics.

Column 2: The "Chronic" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Continuous Concentration (CCC) is calculated using the equation:

$$CCC = (\exp \{ m_C [\ln (\text{stream hardness})] + b_C \}) (CCF)$$

CCF = Chronic Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained *in The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no chronic criteria exists for silver. Published criteria are used for non-metal parameters.

Column 3: The "Acute" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, Silver, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Maximum Concentration (CMC) is calculated using the equation:

$$CMC = (\exp \{ m_A [\ln (\text{stream hardness})] + b_A \}) (ACF)$$

ACF = Acute Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no acute criteria exists for Total Chromium. Published criteria are used for non-metal parameters.

Column 4: The "Fraction Dissolved" converts the value for dissolved metal at laboratory conditions (columns 2 & 3) to total recoverable metal at in-stream ambient conditions (columns 5 & 6). This factor is calculated using the linear partition coefficients found in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996) and the equation:

$$\frac{C_{diss}}{C_{total}} = \frac{1}{1 + \{ [K_{po}] [ss^{(1+a)}] [10^{-6}] \}}$$

ss = in-stream suspended solids concentration [mg/l]

Linear partition coefficients for streams are used for unregulated (7Q10) receiving waters, and linear partition coefficients for lakes are used for regulated (1Q10) receiving waters. For those parameters not in the dissolved form in columns 2 & 3 (and all non-metal parameters), a Translator of 1 is used.

Column 5: The "Chronic" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 2 by the value in column 4.

Column 6: The "Acute" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 3 by the value in column 4.

Column 7: The "Chronic" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the chronic limit.

Column 8: The "Acute" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the acute limit.

Column 9: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Organism Consumption (Recreation).

Column 10: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Water and Organism Consumption. These criteria are only to be applied when the stream use classification for the receiving stream includes both "Recreation" and "Domestic Water Supply."

Column 11: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Domestic Water Supply.

Column 12: The Calculated Effluent Concentration associated with Organism Consumption.

Column 13: The Calculated Effluent Concentration associated with Water and Organism Consumption.

Column 14: The Calculated Effluent Concentration associated with Domestic Water Supply.

Column 15: The Effluent Limited criteria. This upper level of allowable pollutant loading is established if (a) the calculated water quality value is greater than accepted removal efficiency values, (b) the treatment facility is properly operated, and (c) full compliance with the pretreatment program is demonstrated. This upper level limit is based upon EPA's 40 POTW Survey o n levels of metals that should be discharged from a POTW with a properly enforced pretreatment program and considering normal coincidental removals.

The most stringent water quality effluent concentration from Columns 7, 8, 12, 13, 14, and 15 is applied if the receiving stream is designated for domestic water supply. Otherwise, the most stringent effluent concentration is chosen from columns 7, 8, 12, and 15 only.

PASS-THROUGH LIMITATIONS

Pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit issuance process and/or due to changes in industrial waste contribution to the POTW. This POTW is required to implement/maintain a pretreatment program. More frequent monitoring will be required in the permit if (a) the reported concentrations approach or exceed calculated allowable values, (b) significant amounts of particular pollutants are present which may impact the treatment process sludge character or the receiving stream, or (c) minimum information is lacking to accurately calculate water quality protection values, in which case additional stream monitoring may also be required.

A summary of the semi-annual report data does not indicate that the potential exists for the water quality criteria for any parameter to be exceeded. Appendix 3 lists the metal and toxic parameters calculations and the procedure used to derive the results.

Volatile Organic, Acid-Extractable, and Base-Neutral Compounds

The division evaluated effluent concentrations of volatile organic, acid-extractable, and base-neutral compounds and antimony, arsenic, beryllium, selenium and thallium for potential to violate water quality criteria using the following mass balance equation:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow, (STP design flow)
Qs = stream low flow

to protect water quality:

$$Cw \leq Ca$$

where:

Ca = STP effluent concentration allowable

$$= \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

and (S_A) = the percent "Stream Allocation".

The reasonable potential evaluation uses the following assumptions and procedures:

a. Stream background concentrations, Cs, for all volatile organic, acid-extractable, and base-neutral compounds equal zero unless actual stream data exists to show otherwise. Use of the effluent concentrations of such pollutants contributed by upstream dischargers as background is not justifiable due to the volatility and reactivity of these pollutants.

b. The stream allocation, S_A, is 50% and is used as a factor of safety.

c. A mass balance uses the STP design flow, the receiving stream critical low flow (7Q10 or 1Q10), the state water quality numeric criteria, and the stream allocation safety factor to derive the allowable effluent concentrations.

d. When pollutants have potential to violate standards because the concentrations are below the scan detection levels but could be above the allowable water quality based effluent concentrations, the pollutants are handled one of three (3) ways:

   i. Additional testing of detected and non-detected pollutants is required if contributing industrial processes are likely to contain them and the effluent scans have not met the minimum required detection levels (RDL) in the state water quality standards or approximated the method detection limits (MDL) of the approved test methods for the pollutants in 40 CFR Part 136.
   ii. If the required RDL has been used and resulted in non-detection, or if an MDL has been used with non-detection and the contributing industrial processes do not reasonably contain that pollutant, the division drops the pollutant from further consideration.
   iii. Pollutants detected at levels high enough to violate standards are limited in the permit to the allowable concentration, Cw, based on STP design flow.

Calculations for this permit have been done using the standardized attached spreadsheet, titled "Water Quality Based Effluent Calculations- Other Compounds", as presented in this appendix. All metals other than antimony, arsenic, beryllium, selenium, and thallium have been evaluated using procedures described in the rationale, Section 8.7 entitled "Metals and Toxics Control Considerations".

The evaluation indicates that volatile organic, acid extractable, and base neutral compounds and antimony, arsenic, beryllium, selenium, and thallium do not exhibit

the potential to violate water quality criteria, and thus will not be given effluent limitations and monitoring requirements in the permit.

2007 WQC

Calculations for Copper, Chromium and Zinc Only
Waste Flow includes flwo from Premcor Refining (R 0746)

PASS-THROUGH LIMITATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY:	PERMIT #:	DATE:	CALC BY:
Memphis - M.C. Stiles STP	TN0020711	5/12/2011	YLM

non-regulated stream worksheet (7Q10)

Stream (7Q10)	Stream (30Q5)	Waste Flow	Tot Susp Solids	Hardness	Margin of Safety
(MGD)	(MGD)	(MGD)	(mg/l)	(mg/l as CaCO3)	(%)
70.500	89.900	135.075	71	192	50

Mississippi River is considered non-wadeable

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Stream Bckgrnd Conc	Fish/Aqua Life (F & AL) WQC lab conditions		Fraction Dissolved	F & AL- instream allowable ambient conditions (Tot)		Calc Effluent Concentration based on F & AL		Human Health Water Quality Criteria * In-Stream Criteria			Calc Effluent Concentration **			effluent limited case	
PARAMETER	[ug/l]	Chronic [ug/l]	Acute [ug/l]	[Fraction]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Organisms [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Organisms [ug/l]	DWS [ug/l]	ug/l	PARAMETER
Copper (a,b)	5.500	15.638	24.848	0.244	64.153	101.937	**15338.62**	**25217.87**	N/A	N/A	N/A	N/A	N/A	N/A	**80.0**	Copper (a,b)
Chromium III	1.000	126.452	972.116	0.181	[illegible]	5368.575	**182263.54**	**1402916.10**	N/A	N/A	N/A	N/A	N/A	N/A		Chromium III
Chromium VI	1.000	11.000	16.000	1.000	11.000	16.000	**2615.16**	**3922.49**	N/A	N/A	N/A	N/A	N/A	N/A		Chromium VI
Chromium, Total	1.000	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**	N/A	N/A	100.0	N/A	N/A	32995.04	**60.0**	Chromium, Total
Nickel (a,b)	3.000	90.309	813.088	0.248	364.751	3283.990	**94065.19**	**857349.79**	4600.0	610.0	100.0	**1531415.31**	201635.74	31563.92	**180.0**	Nickal (a,b)
Cadmium (a,b)	0.500	0.387	3.795	0.304	1.273	12.492	**202.47**	**3135.84**	N/A	N/A	5.0	N/A	N/A	1500.00	**5.0**	Cadmium (a,b)
Lead (a,b)	2.500	5.080	130.362	0.132	38.444	986.532	**9399.32**	**267292.32**	N/A	N/A	5.0	N/A	N/A	334.45	**45.0**	Lead (a,b)
Mercury (T) (c,e)	0.720	0.770	1.400	1.000	0.770	1.400	**13.43**	**178.16**	0.051	0.05	2.0	**-222.60**	222.94	426.96	**0.4**	Mercury (T) (c,a)
Silver (a,b,f)	4.939	N/A	9.879	1.000	N/A	9.879	**N/A**	**1293.93**	N/A	N/A	N/A	N/A	N/A	N/A	**5.0**	Silver (a,b,f)
Zinc (a,b)	18.000	205.321	203.656	0.185	1112.488	1103.462	**286180.59**	**283820.52**	N/A	N/A	N/A	N/A	N/A	N/A	**200.0**	Zinc (a,b)
Cyanide (d)	2.600	5.200	22.000	1.000	5.200	22.000	**681.11**	**5073.74**	140.0	140.0	200.0	**45793.71**	45793.71	65790.39	**230.0**	Cyanide (d)
Toluene	0.000								15000.0	1300.0	1000.0	**4999171.29**	433461.51	332778.09	**15.0**	Toluene
Benzene	0.000								510.0	22.0	5.0	**169971.82**	7332.12	1666.39	**3.0**	Benzene
1,1,1 Trichloroethane	0.000								N/A	N/A	200.0	N/A	N/A	66655.62	**30.0**	1,1,1 Trichloroethane
Ethylbenzene	0.000								2100.0	530.0	700.0	**699883.98**	176637.39	233294.66	**4.0**	Ethylbenzene
Carbon Tetrachloride	0.000								16.0	2.3	5.0	**5332.46**	766.54	1666.39	**15.0**	Carbon Tetrachloride
Chloroform	0.000								4700.0	57.0	N/A	**1566407.01**	18996.85	N/A	**85.0**	Chloroform
Tetrachloroethylene	0.000								33.0	6.9	5.0	**10998.18**	2299.62	1666.39	**25.0**	Tetrachloroethylene
Trichloroethylene	0.000								300.0	25.0	5.0	**99983.43**	8331.05	1666.39	**10.0**	Trichloroethylene
1,2 trans Dichloroethylene	0.000								10000.0	140.0	100.0	N/A	46658.93	33327.81	**1.5**	1,2 trans Dichloroethylene
Methylene Chloride	0.000								5900.0	46.0	N/A	**1966340.71**	15330.75	N/A	**50.0**	Methylene Chloride
Total Phenols	0.000								N/A	N/A	N/A	N/A	N/A	N/A	**50.0**	Total Phenols
Naphthalene	0.000								N/A	N/A	N/A	N/A	N/A	N/A	**1.0**	Naphthalene
Total Phthalates	0.000								N/A	N/A	N/A	N/A	N/A	N/A	**84.5**	Total Phthalates
Chlorine (T. Res.)	5.500	11.000	19.000	1.000	11.000	19.000	**2881.63**	**7065.09**	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**	Chlorine (T. Res.)

a Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.
b The criteria for this metal is in the dissolved form at lab conditions. The calculated effluent concentration is in the total recoverable form
c The chronic criteria for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity.
d The criteria for this parameter is in the total form
e Previously, the Division established that 0.006 ug/L would be maximum background default if no sample data available or if all samples were <RDL (<0.2 ug/L), based on reference stream monitoring by DOE.
f Silver limit is daily max if column 6 is most stringent.
g When columne 7 or 8 result in a negative number, use results from columns 5 or 6, respectively.
h When columns 12, 13 or 14 result in a negative number, use results from columns 9, 10 or 11, respectively, as applicable.
* Domestic supply included in river use so pick from columns 7,8,12,13,14,15 or Domestic supply not included in river use so pick from columns 7, 8, 12 or 15
** Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow

Maynard Stiles	PTL 2/6/1998	85% PTLs	Proposed 5/12/2011	Jan-Dec 09	Jan-Dec 08	Jan-Dec 07	Jan-Dec 06	Jan-Dec 05	Jan-Dec 04	Jan-Dec 03	Jan-Dec 02	AR - Feb 01	Apr-00
COPPER	**0.0800**	**0.0680**	**0.0800**	0.01077	0.02300		0.01138	0.00844	0.01010	0.01300	0.02800	0.01985	0.01858
CHROMIUM, III	**n/a**	**n/a**	**report**										
CHROMIUM, VI	**n/a**	**n/a**	**report**										
CHROMIUM, TOTAL	**0.0600**	**n/a**	**n/a**	0.00170	0.00422		0.01899	0.00817	0.00606	0.00606	0.00900	0.01060	0.01133
NICKEL	**0.1800**	**0.1530**	**0.1800**	0.02079	0.02950		0.01985		0.01440	0.01667	0.02600	0.01405	0.01175
CADMIUM	**0.0050**	**0.0043**	**0.0050**	0.00071	0.00100		0.00101	0.00101	0.00101	0.00050	0.00050	0.00001	0.00002
LEAD	**0.0450**	**0.0383**	**0.0450**	0.00086	0.00358		0.00239	0.00220	0.00031	0.00212	0.00300	0.00019	0.00040
MERCURY	**0.000400**	**0.000043**	**0.000051**									0.00020	0.00020
SILVER	**0.0050**	**0.0043**	**0.0050**									0.00027	0.00036
ZINC	**0.2000**	**0.1700**	**0.2000**	0.03089	0.04790		0.03996	0.03920	0.03589	0.03708	0.07000	0.02920	0.03738
CYANIDE	**0.2300**	**0.1955**	**0.2300**	0.01900	0.02100		0.00038	0.01210	0.03690	0.01820	0.03030	0.00001	0.00001
TOLUENE	**0.1500**	**0.1275**	**0.1500**		0.00100							0.01990	0.01990
BENZENE	**0.0030**	**0.0026**	**0.0030**		0.00100							0.00100	0.00100
1,1,1 TRICHLOROETHANE	**0.0300**	**0.0255**	**0.0300**		0.00100							0.00100	0.00100
ETHYLBENZENE	**0.0040**	**0.0034**	**0.0040**		0.00100							0.00100	0.00100
CARBON TETRACHLORIDE	**0.0150**	**0.0128**	**0.0150**		0.00100							0.00100	0.00100
CHLOROFORM	**0.0850**	**0.0723**	**0.0850**		0.00206							0.00572	0.00570
TETRACHLOROETHYLENE	**0.0250**	**0.0213**	**0.0250**		0.00100							0.00200	0.00200
TRICHLOROETHYLENE	**0.0100**	**0.0085**	**0.0100**		0.00100							0.00100	0.00100
1,2 TRANSDICHLOROETHYL	**0.0015**	**0.0013**	**0.0015**		0.00100							0.00100	0.00100
METHYLENE CHLORIDE	**0.0500**	**0.0425**	**0.0500**		0.00100							0.00200	0.00200
TOTAL PHENOLS	**0.1000**	**0.0850**	**0.1000**	0.05000	0.05000		0.00003	0.00858	0.01564	0.00207	0.00810	0.00650	0.06900
NAPHTHALENE	**0.0500**	**0.0425**	**0.0500**		0.00100							0.00200	0.00200
TOTAL PHTHALATES	**0.0645**	**0.0548**	**0.0645**		0.00100							0.01770	0.01030

Bolded in effluent data exceeds 85% of proposed PTLs
Shaded means detection level

First Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl Susp Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	90	71	192	50

	1	2	3	5	6	7	8	9	10	11	12	13	14	15
	Stream	Dectection Levels		Fish/Aqua Life		Calculated Effluent		Human Health Water Quality Criteria (30Q5)						Permit Renewal
	Bckgrnd	Scan	WQC RDL	Water Quality Criteria		Concentration		In-Stream Criteria			Calculated Effluent Concentration			Application (3 Values)
PARAMETER	Conc [ug/l]	MDL [ug/l]	*EPA MDL [ug/l]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Avg/Max [ug/l]
HEPTACHLOR		0.004	*	0.0038	0.52	1.5	203.9	0.00079	0.00079	0.4	0.395	0.395	200.0	Max = 0.15 (See App. R-2C)
DDT		0.004	*	0.001	1.1	0.4	431.4	0.0022	0.0022	0.1	1.100	1.100	50.0	Max = 0.055 (See App. R-2C)
DIELDRIN		0.004	*	0.056	0.24	22.0	84.1	0.00054	0.00052		0.270	0.260		Max = 0.019 (See App. R-2C)
ANTIMONY		5.0	3.0					540.0	0.6	8.0	318964.4	2798.7	2999.7	<5.0/<5.0
ARSENIC		1.0	1.0	150.0	340.0	58825.0	133336.7	10.0	10.0	10.0	4999.4	4999.4	4999.4	2.9/4.04
BERYLLIUM		1.0	1.0							4.0			1999.9	<1.0/<1.0
SELENIUM		3.0	2.0	5.0	20.0	1960.8	7943.3			50.0			24997.2	<3.0/<3.0
THALLIUM		10.0	*					0.47	0.24	2.0	235.0	120.0	999.9	<10/<10
ACROLEIN	0.0	10.0	1.0					290.0	190.0		144993.9	94889.4		<10/<10
ACRYLONITRILE	0.0	10.0	1.0					2.5	0.51		1249.8	255.0		<10/<10
BENZENE	0.0	5.0	1.0					510.0	22.0	5.0	254971.7	10999.9	2499.7	<5/<5
BROMOFORM	0.0	5.0	1.0					1400.0	43.0		999922.2	21497.6		<5/<5
CARBON TETRACHLORIDE	0.0	5.0	1.0					16.0	2.3	5.0	7999.1	1149.9	2499.7	<5/<5
CHLOROBENZENE	0.0	5.0	*					1600.0	130.0	100	799911.1	64992.5	49994.4	<5/<5
CHLORODIBROMO-METHANE	0.0	10.0	*					130.0	4.0		64992.9	1999.8		<10/<10
CHLOROETHANE	0.0	10.0	*											<10/<10
2-CHLORO-ETHYLVINYL ETHER	0.0	10.0	*											<10/<10
CHLOROFORM	0.0	5.0	0.5					4700.0	57.0		2348738.9	29496.8		<5/<5
DICHLOROBROMO-METHANE	0.0	5.0	1.0					170.0	5.5		84990.9	2749.7		<5/<5
1,1-DICHLOROETHANE	0.0	5.0	1.0					NA	NA	NA	NA	NA	NA	<5/<5
1,2-DICHLOROETHANE	0.0	5.0	1.0					370.0	3.8	5.0	184979.4	1999.9	2499.7	<5/<5
TRANS 1,2-DICHLORO-ETHYLENE	0.0	5.0	*					10000	140.0	100.0	4999444.4	69992.2	48894.4	<5/<5
1,1-DICHLOROETHYLENE	0.0	5.0	1.0					7,100	330	7.0	3549905.9	164981.7	3499.9	<5/<5
1,2-DICHLOROPROPANE	0.0	5.0	*					100.0	5.0	5.0	74991.7	2499.7	2499.7	<5/<5
1,3-DICHLORO-PROPYLENE	0.0	5.0	1.0					210.0	3.4		104998.3	1699.8		<5/<5
ETHYLBENZENE	0.0	5.0	1.0					2100	530.0	700.0	1049993.3	264970.6	349991.1	<5/<5
METHYL BROMIDE	0.0	10.0	*					1500.0	47.0		749916.7	23487.4		<10/<10
METHYL CHLORIDE	0.0	1.0	1.0											<10/<10
METHYLENE CHLORIDE	0.0	10.0	1.0					5900.0	46.0		2949672.2	22997.4		<5/<5
1,1,2,2-TETRACHLORO-ETHANE	0.0	5.0	0.5					40.0	1.7		19997.8	649.9		<5/<5
TETRACHLORO-ETHYLENE	0.0	0.0	0.5					33.0	6.9	5.0	18499.2	3449.6	2499.7	<5/<5
TOLUENE	0.0	5.0	1.0					15000	1300.0	1000.0	7499166.7	649927.5	499944.4	<5/<5
1,1,1-TRICHLOROETHANE	0.0	5.0	1.0							200.0			99988.8	<5/<5
1,1,2-TRICHLOROETHANE	0.0	5.0	0.2					160.0	5.9	5.0	79991.1	2949.7	2489.7	<5/<5
TRICHLORETHYLENE	0.0	5.0	1.0					300.0	25.0	5.0	149953.3	12498.6	2499.7	<5/<5
VINYL CHLORIDE	0.0	10.0	2.0					24.0	0.25	2.0	11995.7	125.0	999.9	<10/<10
P-CHLORO-M-CRESOL	0.0	10.0	*											<10/<10
2-CHLOROPHENOL	0.0	10.0	*					150.0	81.0		74991.7	40495.5		<10/<10
2,4-DICHLOROPHENOL	0.0	10.0	*					290.0	77.0		144993.9	38495.7		<10/<10
2,4-DIMETHYLPHENOL	0.0	10.0	*					950.0	390.0		424952.9	199978.9		<10/<10
4,6-DINITRO-O-CRESOL	0.0	20.0	24.0					280.0	13.0		139994.4	6499.3		<20/<20
2,4-DINITROPHENOL	0.0	10.0	42.0					5300.0	68.0		2649705.6	34496.2		<10/<10
2-NITROPHENOL	0.0	10.0	*											<10/<10
4-NITROPHENOL	0.0	10.0	*											<10/<10
PENTACHLOROPHENOL	0.0	20.0	5.0	15	19	0982.5	7461.2	30.0	2.7	1.0	14995.3	1349.9	489.9	<20/<20
PHENOL	0.0	10.0	*					1700000	21000.0		849805505.6	10499633.3		<20/<20

Second Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: M.C. STILES STP
PERMIT. TN0020711

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Tot Susp Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	136	71	192	60

PARAMETER	1 Stream Bckgrnd Conc [ug/l]	2 Detection Levels Stan MDL [ug/l]	3 WQC RDL *EPA MDL [ug/l]	5 Fish Aqua Life Water Quality Criteria Chronic [ug/l]	6 Acute [ug/l]	7 Calculated Effluent Concentration Chronic [ug/l]	8 Acute [ug/l]	9 Human Health Water Quality Criteria (30Q5) In-Stream Criteria Organisms [ug/l]	10 Water/Org [ug/l]	11 DWS [ug/l]	12 Calculated Effluent Concentration Organisms [ug/l]	13 Water/Org [ug/l]	14 DWS [ug/l]	15 Permit Renewal Application (3 Values) Avg/Max [ug/l]
2,4,6-TRICHLOROPHENOL	0.0	10.0	2.7					24.0	14.0		6003.1	4666.5		<10/<10
ACENAPHTHENE	0.0	10.0	*					990.0	670.0		330128.3	223420.2		<10/<10
ACENAPHTHYLENE	0.0	10.0	2.3											<10/<10
ANTHRACENE	0.0	10.0	0.7					40000	8300.0		13338518.5	2767742.6		<10/<10
BENZIDINE	0.0	10.0	*					0.0020	0.00066		0.667	0.3		<10/<10
BENZO(A)ANTHRACENE	0.0	10.0	0.3					0.18	0.038		60.0	12.7		<10/<10
BENZO(A)PYRENE	0.0	10.0	0.3					0.18	0.038	0.2	60.0	12.7	66.7	<10/<10
3,4 BENZO-FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		60.0	12.7		<10/<10
BENZO(GHI)PERYLENE	0.0	10.0	*											<10/<10
BENZO(K)FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		60.0	12.7		<10/<10
BIS (2-CHLOROETHOXY) METHANE	0.0	10.0	*											<10/<10
BIS (2-CHLOROETHYL)-ETHER	0.0	10.0	1.0					5.3	0.30		1767.4	100.0		<10/<10
BIS (2-CHLOROISO-PROPYL) ETHER	0.0	10.0	*					65000	1400.0		21675092.6	466648.1		<10/<10
BIS (2-ETHYLHEXYL) PHTHALATE	0.0	10.0	2.5					22.0	12.0	6.0	7336.2	4001.6	2000.8	<10/<10
4-BROMOPHENYL PHENYL ETHER	0.0	10.0	*											<10/<10
BUTYL BENZYL PHTHALATE	0.0	10.0	*					1900.0	1500.0		633579.6	500194.4		<10/<10
2-CHLORONAPHTHALENE	0.0	10.0	*					1600.0	1000.0		533540.7	333463.0		<10/<10
4-CHLORPHENYL PHENYL ETHER	0.0	10.0	*											<10/<10
CHRYSENE	0.0	10.0	2.5					0.18	0.038		60.0	12.7		<10/<10
DI-N-BUTYL PHTHALATE	0.0	10.0	2.5					4500.0	2000.0		1500583.3	666925.9		<10/<10
DI-N-OCTYL PHTHALATE	0.0	10.0	*											<10/<10
DIBENZO(A,H) ANTHRACENE	0.0	10.0	*					0.18	0.038		60.0	12.7		<10/<10
1,2 DICHLOROBENZENE	0.0	5.0	2.0					1300.0	420.0	600	433501.9	140054.4	200077.8	<5/<5
1,3-DICHLOROBENZENE	0.0	5.0	2.0					960.0	320.0		320124.4	106708.1		<5/<5
1,4-DICHLOROBENZENE	0.0	5.0	2.0					190.0	63.0	75	63356.0	21006.2	25009.7	<5/<5
3,3-DICHLOROBENZIDINE	0.0	10.0	*					0.28	0.21		93.4	70.0		<10/<10
DIETHYL PHTHALATE	0.0	10.0	1.9					44000	17000.0		14672370.4	5666870.4		<10/<10
DIMETHYL PHTHALATE	0.0	10.0	1.6					1100000	270000.0		366609259.3	90035000.0		<10/<10
2,4-DINITROTOLUENE	0.0	10.0	1.0					34.0	1.1		11337.7	366.8		<10/<10
2,6-DINITROTOLUENE	0.0	10.0	*											<10/<10
1,2 DIPHENYLHYDRAZINE	0.0	10.0	*					2.0	0.36		666.9	120.0		<10/<10
FLUORANTHENE	0.0	10.0	2.2					140.0	130.0		46684.6	43350.2		<10/<10
FLUORENE	0.0	10.0	0.3					5300.0	1100.0		1767353.7	366609.3		<10/<10
HEXACHLOROBENZENE	0.0	10.0	1.9					0.0029	0.0026	1.0	0.667	0.9	333.5	<10/<10
HEXACHLOROBUTADIENE	0.0	10.0	5.0					180.0	4.4		60023.3	1467.2		<10/<10
HEXACHLOROCYCLO-PENTADIENE	0.0	50.0	*					1100.0	40.0	50.0	366809.3	13338.6	16673.1	<50/<50
HEXACHLOROETHANE	0.0	10.0	0.5					33.0	14.0		11004.3	4666.5		<10/<10
INDENO(1,2,3-CD)PYRENE	0.0	10.0	*					0.18	0.038		60.0	12.7		<10/<10
ISOPHORONE	0.0	10.0	*					9600	350.0		3201244.4	116712.0		<10/<10
NAPHTHALENE	0.0	10.0	*											<10/<10
NITROBENZENE	0.0	10.0	10.0					690.0	17.0		230069.4	5666.9		<10/<10
N-NITROSODI-N-PROPYLAMINE	0.0	10.0	*					5.1	0.050		1700.7	16.7		<10/<10
N-NITROSODI-METHYLAMINE	0.0	10.0	*					30.0	0.0069		10003.9	2.3		<10/<10
N-NITROSODI-PHENYLAMINE	0.0	10.0	*					60.0	33.0		20007.6	11004.3		<10/<10
PHENANTHRENE	0.0	10.0	0.7											<10/<10
PYRENE	0.0	10.0	0.3					4000.0	830.0		1333851.9	276774.3		<10/<10
1,2,4-TRICHLOROBENZENE	0.0	10.0	*					70.0	35.0	70.0	23342.4	11671.2	23342.4	<10/<10

a. Columns 7-8, and 12-14 are the effluent concentrations allowable to prevent exceedence of water quality criteria
b. Potential to exceed criteria exists if the measured quantity in column 15 exceeds, or could exceed, the calculated allowable concentrations in columns 7-8, and 12-14
c. Additional testing is required if the detection level used in the scan is higher than the state RDL and/or the MDL of the approved EPA scan method and industry is known to have that pollutant
d. All background concentrations for these volatile organic, acid-extractable, and base-neutral compounds are assumed zero in the absence of supporting monitoring data
e. Other metals for which data were provided on the application are evaluated on the Metals & Toxics spreadsheet
f. Reasonable potential not demonstrated. In some cases, the MDLs are not sufficient to identify potential water quality problems

WATER QUALITY BASED CALCULATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
OUTFALL 001

FACILITY: M.C. STILES STP
PERMIT #: TN0020711

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl Susp Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Stream Allocation [%]
70,500	89,900	135	71	192	50

EFFLUENT CHARACTERISTIC	1 Stream Bckgrnd Conc [ug/l]	2 Fish/Aqua Life Water Quality Criteria Chronic [ug/l]	3 Fish/Aqua Life Water Quality Criteria Acute [ug/l]	4 Effluent Fraction Dissolved [Fraction]	5 Fish & Aquatic Life Water Quality Criteria (7Q10) In-Stream Allowable Chronic [ug/l]	6 Fish & Aquatic Life Water Quality Criteria (7Q10) In-Stream Allowable Acute [ug/l]	7 Fish & Aquatic Life Water Quality Criteria (7Q10) Calc Effluent Concentration Chronic [ug/l]	8 Fish & Aquatic Life Water Quality Criteria (7Q10) Calc Effluent Concentration Acute [ug/l]	Permit Renewal Application Avg/Max [ug/l]
Cadmium *	0.193	0.387	3.795	0.304	1.273	12.492	**282.6**	**3217.6**	<0.5/<0.5
Copper *	5.500	15.638	24.848	0.244	64.153	101.937	**15347.1**	**25231.8**	15.2/28.3
Lead *	2.500	5.080	130.362	0.132	38.444	986.532	**9404.6**	**257435.0**	<2.0/<2.0
Nickel *	5.000	90.309	813.088	0.248	364.751	3283.999	**94117.3**	**857825.2**	16.2/17.2
Silver *	4.939	NA	9.879	1.000	NA	9.879	**N/A**	**1294.7**	1.34/2.02
Zinc *	18.000	205.321	203.656	0.185	1112.488	1103.462	**286339.3**	**283977.9**	36.7/66.7
Mercury, (T) **	0.006	0.770	1.400	1.000	0.770	1.400	**188.87**	**364.7**	<0.2/<0.2
Chromium III	63.226	126.452	972.116	0.181	698.081	5366.573	**166116.7**	**1387446.1**	(a)
Chromium VI	5.500	11.000	16.000	1.000	11.000	16.000	**1441.8**	**2748.7**	(a)
Cyanide ***	2.600	5.200	22.000	1.000	5.200	22.000	**681.5**	**6076.6**	23.9/35.4

EFFLUENT CHARACTERISTIC	9 Human Health Water Quality Criteria (30Q5) In-Stream Criteria Organisms [ug/l]	10 In-Stream Criteria Water/Organisms [ug/l]	11 In-Stream Criteria DWS [ug/l]	12 Calculated Effluent Concentration Organisms [ug/l]	13 Calculated Effluent Concentration Water/Organisms [ug/l]	14 Calculated Effluent Concentration DWS [ug/l]	Permit Renewal Application Avg/Max [ug/l]
Cadmium *	NA	NA	5.0	**NA**	**NA**	**1602.9**	<0.5/<0.5
Copper *	NA	N/A	NA	**NA**	**NA**	**NA**	15.2/28.3
Lead *	NA	NA	5.0	**NA**	**NA**	**834.9**	<2.0/<2.0
Nickel *	4600.0	610.0	100.0	**1532264.8**	**201747.6**	**31681.5**	16.2/17.2
Silver *	NA	NA	NA	**NA**	**NA**	**NA**	1.34/2.02
Zinc *	NA	NA	NA	**NA**	**NA**	**NA**	36.7/66.7
Mercury, (T) **	0.051	0.05	2.0	**15.0**	**14.7**	**664.9**	<0.2/<0.2
Chromium III	NA	NA	100.0	**NA**	**NA**	**12294.3**	(a)
Chromium VI	NA	NA	100.0	**NA**	**NA**	**31515.0**	(a)
Cyanide ***	140.0	140.0	200.0	**45819.1**	**45819.1**	**65826.9**	23.9/35.4

(a) Total chromium, avg/max = 5.7/9.08

* Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.The Fish & Aquatic Life criteria for this metal are in the dissolved form at laboratory conditions The in-stream allowable criteria and calculated effluent concentrations are in the total recoverable form

** The chronic criterion for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity

*** The criteria for this parameter are in the total recoverable form

NOTE Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow

Appendix R-7
New NPDES Permit Limitations and Monitoring Requirements

Maynard C. Stiles STP (TN0020711) - Outfall 001 Discharge Effluent Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement	Sample	Sample
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)	Frequency	Type	Point
BDD_5	43.1	48,528	85	64.7	72,846	86.1		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	52	58,547	85	78	87,820	104		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a)	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits within 36 months from the permit's effective date.

(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

Maynard C. Stiles STP (TN0020711) - Outfall 001 Discharge Effluent Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement	Sample	Sample
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)	Frequency	Type	Point
Drganic Pesticide Chemicals (c)	Report					Report			Annually	grab	effluant
Total Dioxin	0.000000001					0.000000001			Annually	grab	effluent
Totel Polychlorinsted Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	grab	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Mathyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexschlorobenzene	Report					Report			Annually	grab	effluent
Color (Pt Co Units) True and Apparent	Report					Report			Weekly	composite	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report (Survival for serial effluent dilutions)								Annually	grab	effluent
Dutfall Observation, Visual (e)									Daily	visual	effluent
Flow (MGD)	Report			Report		Report			Daily	continuous	influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewsr Dverflows, Total Dccurrences (f)	Report								continuous	visual	NA
Dry Weather Dverflows, Total Dccurrences (f)	Report								continuous	visual	NA
Bypass of Treatment, Total Dccurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I, endosulfan II; endrin; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; PCBs, total; technical chlordane; toxaphene; DDT; and dieldrin).

(d) Per Section 3.4.

(e) Permittee shall provide in the DMR comments section or as an attachment a listing of its visual observations including distinctly visible matter and/or objectionable instream color.

(f) Permittee shall provide with its DMRs a listing of sewage overflows that flowed into buildings.

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243

June 1, 2012

Mr. Don Hudgins
Plant Administrator
City of Memphis Environmental Division
e-copy: donald.hudgins@memphistn.gov
2303 N. Second St.
Memphis, TN 38127

Subject: **NPDES Permit No. TN0026361**
Memphis-Chapel Hill S.D. STP
Memphis, Shelby County, Tennessee

Dear Mr. Hudgins:

In accordance with the provisions of the Tennessee Water Quality Control Act, Tennessee Code Annotated (T.C.A.), Sections 69-3-101 through 69-3-120, the Division of Water Pollution Control hereby issues the enclosed NPDES Permit. The continuance and/or reissuance of this NPDES Permit is contingent upon your meeting the conditions and requirements as stated therein.

Please be advised that a petition for permit appeal may be filed, pursuant to T.C.A. Section 69-3-105, subsection (i), by the permit applicant or by any aggrieved person who participated in the public comment period or gave testimony at a formal public hearing whose appeal is based upon any of the issues that were provided to the commissioner in writing during the public comment period or in testimony at a formal public hearing on the permit application. Additionally, for those permits for which the department gives public notice of a draft permit, any permit applicant or aggrieved person may base a permit appeal on any material change to conditions in the final permit from those in the draft, unless the material change has been subject to additional opportunity for public comment. Any petition for permit appeal under this subsection (i) shall be filed with the board within thirty (30) days after public notice of the commissioner's decision to issue or deny the permit.

If you have questions, please contact the Memphis Environmental Field Office at 1-888-891-TDEC; or, at this office, please contact Mr. Hari Akunuri at (615) 532-0650 or by E-mail at *Hari.Akunuri@tn.gov*.

Sincerely,

[redacted]

Vojin Janjić
Manager, Permit Section
Division of Water Pollution Control

Enclosure

cc: Permit Section File
Memphis Environmental Field Office (Eddy.Bouzeid@tn.gov)
Mr. Paul Patterson, Maynard C. Stiles Wastewater Facility, paul.patterson@memphistn.gov
Mr. William McCrae, Plant Manager, Memphis Utilities, peter.alfonso@memphistn.gov

STATE OF TENNESSEE

NPDES PERMIT

No. TN0026361

Reissuance
Authorization to discharge under the
National Pollutant Discharge Elimination System

Issued By

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
401 Church Street
6th Floor, L & C Annex
Nashville, Tennessee 37243-1534

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger: **Memphis-Chapel Hill S.D. STP**

is authorized to discharge: treated domestic wastewater from Outfall 001

from a facility located: Memphis, Shelby County, Tennessee

to receiving waters named: Mile 0.2 of an unnamed stream to mile 2.1 of an unnamed tributary to Crooked Creek at mile 3.0

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on: July 1, 2012

This permit shall expire on: June 30, 2017

Issuance date: May 31, 2012

[redacted]

for Garland P. Wiggins, Deputy Director
Division of Water Pollution Control

CN-0759

RDAs 2352 and 2366

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PART 1

A. EFFLUENT LIMITATION AND MONITORING REQUIREMENTS

Discharge 001 consists of domestic wastewater from a treatment facility with a design capacity of .045 MGD. Discharge 001 shall be limited and monitored by the permittee as specified below.

Effluent Characteristics	Effluent Limitations			Monitoring Requirements		
	Monthly Avg. Conc. mg/l	Weekly Avg. Conc. mg/l	Daily Max. Conc. mg/l	Measurement Frequency	Sample Type	Sampling Point
$CBOD_5$	10	---	20	2/month	grab	effluent
Ammonia, as N	5	---	10	2/month	grab	effluent
Suspended Solids	30	---	45	2/month	grab	effluent
Total Phosphorous			Report	1/quarter	grab	effluent

Effluent Characteristics	Effluent Limitations			Monitoring Requirements		
	Monthly Average	Daily Min.	Daily Max.	Measurement Frequency	Sample Type	Sampling Point
Flow (MGD)	Report	---	Report	5/week	instantaneous	effluent
E. coli	126/100 ml (see following paragraphs)		941/100 ml	2/month	grab	effluent

Effluent Characteristics	Effluent Limitations			Monitoring Requirements		
	Monthly Average	Daily Min.	Daily Max.	Measurement Frequency	Sample Type	Sampling Point
Total chlorine residual			0.02mg/l instantaneous	5/week	grab	effluent
Settleable solids			1.0 ml/l	2/week	grab	effluent
Dissolved oxygen		6.0 mg/l instantaneous		5/week	grab	effluent
pH (Standard Units)		6.0	9.0	2/week	grab	effluent

"The acceptable methods for analysis of TRC are any methods specified in Title 40 CFR, Part 136 as amended. The method detection level (MDL) for TRC shall not exceed 0.05 mg/l unless the permittee demonstrates that its MDL is higher. The permittee shall retain the documentation that justifies the higher MDL and have it available for review upon request."

The wastewater discharge must be disinfected to the extent that viable coliform organisms are effectively eliminated. The concentration of the E. coli group after disinfection shall not exceed 126 cfu per 100 ml as the geometric mean calculated on the actual number of samples collected and tested for E. coli within the required reporting period. The permittee may collect more samples than specified as the monitoring frequency. Samples may not be collected at intervals of less than 12 hours. For the purpose of determining the geometric mean, individual samples having an E. coli group concentration of less than one (1) per 100 ml shall be considered as having a concentration of one (1) per 100 ml. In addition, the concentration of the E. coli group in any individual sample shall not exceed a specified maximum amount. A maximum daily limit of 487 colonies per 100 ml applies to lakes and exceptional Tennessee waters. A maximum daily limit of 941 colonies per 100 ml applies to all other recreational waters.

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must result in no other materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner which prevents its entrance into or pollution of any surface or subsurface waters.

The wastewater discharge must not cause an objectionable color contrast in the receiving stream.

B. MONITORING PROCEDURES

1. Representative Sampling

Samples and measurements taken in compliance with the monitoring requirements specified above shall be representative of the volume and nature of the monitored discharge, and shall be taken at the following location(s):

nearest accessible point after final treatment but prior to actual discharge to or mixing with the receiving waters.

2. Test Procedures

a. Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304 (h) of the Clean Water Act, as amended, under which such procedures may be required.

b. Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40, CFR, Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act.

3. Sampling Frequency

a. Where the permit requires sampling and monitoring of a particular effluent characteristic(s) at a frequency of less than once per day or daily, the permittee is precluded from marking the “No Discharge” block on the Discharge Monitoring Report if there has been any discharge from that particular outfall during the period which coincides with the required monitoring frequency; i.e. if the required monitoring frequency is once per month or 1/month, the monitoring period is one month, and if the discharge occurs during only one day in that period then the permittee must sample on that day and report the results of analyses accordingly.

4. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The exact person(s) collecting samples;

c. The dates and times the analyses were performed;

d. The person(s) or laboratory who performed the analyses;

e. The analytical techniques or methods used, and;

f. The results of all required analyses.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Division of Water Pollution Control.

C. DEFINITIONS

The "instantaneous concentration" is a limitation on the concentration, in milligrams per liter, of any pollutant contained in the wastewater discharge determined from a grab sample taken of the discharge at any point in time.

The "daily maximum concentration" is a limitation on the average concentration, in milligrams per liter, of the discharge during any calendar day.

The "monthly average concentration" is the arithmetic mean of all samples collected in a one-month period. If only one sample is required per month, the permittee is required to report compliance against the monthly average limit other than *E coli*.

For the purpose of this permit a "calendar day" is defined as any 24-hour period.

D. REPORTING

1. Monitoring Results

Monitoring results shall be recorded monthly and submitted monthly using Monthly Operation Report Forms (MOR) supplied by the Division of Water Pollution Control. Submittals shall be postmarked no later than 15 days after the completion of the reporting period. A copy should be retained for the permittee's files. Monthly Operation Reports and any communication regarding compliance with the conditions of this permit must be sent to:

Attention: Division of Water Pollution Control
Memphis Environmental Field Office
8383 Wolf Lake Drive
Memphis, TN 38133

The first MOR is due on the 15th of the month following permit effectiveness.

Monthly Operation Report must be signed and certified by a responsible corporate officer, as defined at 40 CFR 122.22, or a general partner or proprietor, or a principal municipal executive officer or ranking elected officer, or a duly authorized representative. Such authorization must be submitted in writing and must explain the duties and responsibilities of the authorized representative.

2. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Monthly Operation Report Form (MOR). Such increased frequency shall also be indicated. The Permittee is also required to perform and report influent and operation tests in accordance with the schedule listed on the Monthly Operation Report/Schedule for Analysis for Package Sewage Treatment Facilities or as developed by the design engineer.

3. Falsifying Reports

Knowingly making any false statement on any report required by this permit may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Water Pollution Control Act, as amended, and in Section 69-3-115 of the Tennessee Water Quality Control Act.

E. SCHEDULE OF COMPLIANCE

Full operational level shall be attained from the effective date of this permit.

PART II

A. GENERAL PROVISIONS

1. Duty to Reapply

The permittee is not authorized to discharge after the expiration date of this permit. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information and forms as are required to the Director of Water Pollution Control (the "Director") no later than 180 days prior to the expiration date.

2. Right of Entry

The permittee shall allow the Director, the Regional Administrator of the U.S. Environmental Protection Agency, or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or where records are required to be kept under the terms and conditions of this permit, and at reasonable times to copy these records;

b. To inspect at reasonable times any monitoring equipment or method or any collection, treatment, pollution management, or discharge facilities required under this permit; and

c. To sample at reasonable times any discharge of pollutants.

3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, as amended, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division of Water Pollution Control. As required by the Federal Act, effluent data shall not be considered confidential.

4. Proper Operation and Maintenance

a. The permittee shall at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory and process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. Backup continuous pH and flow monitoring equipment are not required.

b. Dilution water shall not be added to comply with effluent requirements to achieve BCT, BPT, BAT and/or other technology based effluent limitations such as those in State of Tennessee Rule 1200-4-5-.03.

5. Treatment Facility Failure (Industrial Sources)

The permittee, in order to maintain compliance with this permit, shall control production, all discharges or both, upon reduction, loss, or failure of the treatment facility, until the facility is restored or an alternative method of treatment is provided. This requirement applies in such situations as the reduction, loss, or failure of the primary source of power.

6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

7. Severability

The provisions of this permit are severable. If any provision of this permit due to any circumstance, is held invalid, then the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

8. Other Information

If the permittee becomes aware that he failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Director, then he shall promptly submit such facts or information.

B. CHANGES AFFECTING THE PERMIT

1. Planned Changes

The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1).

2. Permit Modification, Revocation, or Termination

a. This permit may be modified, revoked and reissued, or terminated for cause as described in 40 CFR 122.62 and 122.64, Federal Register, Volume 49, No. 188 (Wednesday, September 26, 1984), as amended.

b. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

c. If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established for any toxic pollutant under Section 307(a) of the Federal Water Pollution Control Act, as amended, the Director shall modify or revoke and reissue the permit to conform to the prohibition or to the effluent standard, providing that the effluent standard is more stringent than the limitation in the permit on the toxic pollutant. The permittee shall comply with these effluent standards or prohibitions within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified or revoked and reissued to incorporate the requirement.

d. The filing of a request by the permittee for a modification, revocation, reissuance, termination, or notification of planned changes or anticipated noncompliance does not halt any permit condition.

3. Change of Ownership

This permit may be transferred to another party (provided there are neither modifications to the facility or its operations, nor any other changes which might affect the permit limits and conditions contained in the permit) by the permittee if:

a. The permittee notifies the Director of the proposed transfer at least 30 days in advance of the proposed transfer date;

b. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and liability between them; and

c. The Director, within 30 days, does not notify the current permittee and the new permittee of his intent to modify, revoke or reissue, or terminate the permit and to require that a new application be filed rather than agreeing to the transfer of the permit.

Pursuant to the requirements of 40 CFR 122.61, concerning transfer of ownership, the permittee must provide the following information to the division in their formal notice of intent to transfer ownership: 1) the NPDES permit number of the subject permit; 2) the effective date of the proposed transfer; 3) the name and address of the transferor; 4) the name and address of the transferee; 5) the names of the responsible parties for both the transferor and transferee; 6) a statement that the transferee assumes responsibility for the subject NPDES permit; 7) a statement that the transferor relinquishes responsibility for the subject NPDES permit; 8) the signatures of the responsible parties for both the transferor and transferee pursuant to the requirements of 40 CFR 122.22(a), "Signatories to permit applications"; and, 9) a statement regarding any proposed modifications to the facility, its operations, or any other changes which might affect the permit limits and conditions contained in the permit.

4. Change of Mailing Address

The permittee shall promptly provide to the Director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

C. NONCOMPLIANCE

1. Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable State and Federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

2. Reporting of Noncompliance

a. 24-Hour Reporting

In the case of any noncompliance which could cause a threat to public drinking supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response team.)

A written submission must be provided within five days of the time the permittee becomes aware of the circumstances unless the Director on a case-by-case basis waives this requirement. The permittee shall provide the Director with the following information:

i. A description of the discharge and cause of noncompliance;

ii. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and

iii. The steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph 2.a. above, the permittee shall report the noncompliance on the Monthly operation report. The report shall contain all information concerning the steps taken, or planned, to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

3. Overflow

a. "***Overflow***" means the discharge to land or water of wastes from any portion of the collection, transmission, or treatment system other than through permitted outfalls

b. Overflows are prohibited.

c. The permittee shall operate the collection system so as to avoid overflows. No new or additional flows shall be added upstream of any point in the collection system, which experiences chronic overflows (greater than 5 events per year) or would otherwise overload any portion of the system.

d. Unless there is specific enforcement action to the contrary, the permittee is relieved of this requirement after: 1) an authorized representative of the Commissioner of the Department of Environment and Conservation has approved an engineering report and construction plans and specifications prepared in accordance with accepted engineering practices for correction of the problem; 2) the correction work is underway; and 3) the cumulative, peak-design, flows potentially added from new connections and line extensions upstream of any chronic bypass point are less than or proportional to the amount of inflow and infiltration removal documented upstream of that point. The inflow and infiltration reduction must be measured by the permittee using practices that are customary in the flow measurement industry and reported in an attachment to a Monthly Operating Report submitted to the local TDEC Environmental Field Office. The data measurement period shall be sufficient to account for seasonal rainfall patterns and seasonal groundwater table elevations.

e. In the event that more than 5 overflows have occurred from a single point in the collection system for reasons that may not warrant the self-imposed moratorium or completion of the actions identified in this paragraph, the permittee may request a meeting with the Division of Water Pollution Control EFO staff to petition for a waiver based on mitigating evidence.

4. Upset

a. "***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. An upset shall constitute an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the permittee demonstrates, through properly signed, contemporaneous operating logs, or other relevant evidence that:

i. An upset occurred and that the permittee can identify the cause(s) of the upset;

ii. The permitted facility was at the time being operated in a prudent and workman-like manner and in compliance with proper operation and maintenance procedures;

iii. The permittee submitted information required under "Reporting of Noncompliance" within 24 hours of becoming aware of the upset (if this information is provided orally, a written submission must be provided within five days); and

iv. The permittee complied with any remedial measures required under "Adverse Impact."

5. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

6. Bypass

a. "***Bypass***" is the intentional diversion of wastewater away from any portion of a treatment facility. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypasses are prohibited unless all of the following three (3) conditions are met:

i. The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

ii. There are not feasible alternatives to bypass, such as the construction and use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment down-time or preventative maintenance;

iii. The permittee submits notice of an unanticipated bypass to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours of becoming aware of the bypass (if this information is provided orally, a written submission must be provided within five days). When the need for the bypass is foreseeable, prior notification shall be submitted to the Director, if possible, at least ten (10) days before the date of the bypass.

c. Bypasses not exceeding permit limitations are allowed **only** if the bypass is necessary for essential maintenance to assure efficient operation. All other bypasses are prohibited. Allowable bypasses not exceeding limitations are not subject to the reporting requirements of 6.b.iii, above.

7. Washout

a. For domestic wastewater plants only, a "washout" shall be defined as loss of Mixed Liquor Suspended Solids (MLSS) of 30.00% or more. This refers to the MLSS in the aeration basin(s) only. This does not include MLSS decrease due to solids wasting to the sludge disposal system. A washout can be caused by improper operation or from peak flows due to infiltration and inflow.

b. A washout is prohibited. If a washout occurs the permittee must report the incident to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours by telephone. A written submission must be provided within five days. The washout must be noted on the Monthly operation report. Each day of a washout is a separate violation.

D. LIABILITIES

1. Civil and Criminal Liability

Except as provided in permit conditions or "***Bypass,***" "***Overflow,***" "***Upset,***" "***Diversion,***" and "***Treatment Facility Failures,***" nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

2. Liability Under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or the Federal Water Pollution Control Act, as amended.

PART III
OTHER REQUIREMENTS

A. CERTIFIED OPERATOR

The waste treatment facilities shall be operated under the supervision of a certified operator in accordance with the Water Environmental Health Act of 1984.

B. PLACEMENT OF SIGNS

The permittee shall place and maintain a sign at each outfall. The sign(s) should be clearly visible to the public from the bank and the receiving stream. The minimum sign size should be two feet by two feet (2' x 2') with one inch (1") letters. The sign should be made of durable material and have a white background with black letters.

The sign(s) are to provide notice to the public as to the nature of the discharge and in the case of the permitted outfalls, that the discharge is regulated by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control. The following is given as an example of the minimal amount of information that must be included on the sign:

NPDES permitted domestic outfall:

TREATED DOMESTIC WASTEWATER
(PERMITTEE'S NAME)
(PERMITTEE'S PHONE NUMBER)
NATIONAL POLLUTANT DISCHARGE ELIMINATION
SYSTEM PERMIT # _____
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
Memphis Environmental Field Office
PHONE NUMBER : 1-888-891-8332

C. ADDITION OF WASTE LOADS

The permittee may not add wasteloads to the existing treatment system without the knowledge and approval of the division.

D. SLUDGE MANAGEMENT PRACTICES

The permittee must comply with the provisions of 40 CFR Part 503. If the sludge is transported to another POTW for disposal, the permittee shall note on the monthly operation report the amount of sludge wasted in gallons, % solids of sludge wasted and the name of the facility to which the sludge was taken.

E. ANTIDEGRADATION

Pursuant to the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06, titled "Tennessee Antidegradation Statement," which prohibits the degradation of high quality surface waters and the increased discharges of substances that cause or contribute to impairment, the permittee shall further be required, pursuant to the terms and conditions of this permit, to comply with the effluent limitations and schedules of compliance required to implement applicable water quality standards, to comply with a State Water Quality Plan or other state or federal laws or regulations, or where practicable, to comply with a standard permitting no discharge of pollutants.

RATIONALE SHEET

NPDES PERMIT No. TN0026361

Permit Writer: HVA

September 2011

I. DISCHARGER

NAME: Memphis-Chapel Hill S.D. STP
REPRESENTATIVE: Mr. Peter Alfonso
LOCATION: Memphis, COUNTY: Shelby, PHONE NUMBER: 901- 789-0510
WASTEWATER:
Discharge number: 001 type: Domestic
WATERSHED: Loosahatchie HUC: 8010209
Average design flow: .045 MGD
PRESENT TREATMENT: Extended aeration
STATUS: Reissuance

II. RECEIVING WATERS

STREAM: Mile 0.2 of an unnamed stream to mile 2.1 of an unnamed tributary to Crooked Creek at mile 3.0
CLASSIFICATION: Fish and aquatic life, recreation, irrigation, livestock watering and wildlife uses.
LOW FLOW: 7Q10= Zero CFS
ESTABLISHED FROM: BPJ estimation based on limited drainage area.
WATER QUALITY STATUS: According to the division's most recent assessment of water quality, the Mile 0.2 of an unnamed stream to mile 2.1 of an unnamed tributary to Crooked Creek at mile 3.0 is considered partially supportive of its designated use classifications.
TIER DESIGNATION: Unavailable/Available Conditions Waters.

III. PREVIOUS PERMIT

ISSUANCE: 29-JUN-07
EXPIRATION: 29-JUN-12

PARAMETERS	MONTHLY AVERAGE CONCENTRATION (MG/L)	MAXIMUM CONCENTRATION (MG/L)
$CBOD_5$	10	20
NH_3-N	5	10
Total Suspended Solids	30	45
Dissolved Oxygen	6.0 (daily minimum)	
Total Chlorine Residual		0.02 (daily maximum)
E. coli	126	941
Settleable Solids (ml/l)		1.0 (daily maximum)
pH (standard units)	6.0-9.0	
Flow (MGD):		
Effluent	Report	Report

IV. PROPOSED EFFLUENT LIMITS & RATIONALE

A. The conditions under which this permit was issued 29-JUN-07 have not changed except for the total phosphorus (See section VI) The permit will be reissued for five years with existing conditions.

B. TEST METHOD FOR *E. COLI*

Disinfection of wastewater is required to protect the receiving stream from pathogenic microorganisms. E. Coli are indicator organisms used as a measure of bacteriological health of a receiving stream and the effectiveness of disinfection.

As of September 30, 2004, the criterion for fecal coliform has been removed from the State's Water Quality Standards. Thus, the division imposes an E. coli limit on discharges of treated sewage for the protection of recreational use of the stream in lieu of the fecal coliform limit.

Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40, CFR, Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act.

V. OTHER REQUIREMENTS & CONDITIONS

A. Certified Wastewater Treatment Operator

The waste treatment facilities shall be operated under the supervision of a certified wastewater treatment operator in accordance with the Water Environmental Health Act of 1984

B. The permittee is required to install a sign notifying the public of its permitted discharge point.

C. PERMIT TERM

This permit is being reissued for 5 years in order to coordinate its reissuance with other permits located within the Loosahatchie Watershed.

VI ANTIDEGRADATION STATEMENT/WATER QUALITY STATUS

Tennessee's Antidegradation Statement is found in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06. It is the purpose of Tennessee's standards to fully protect existing uses of all surface waters as established under the Act.

Stream determinations for this permit action are associated with the waterbody segment identified by the division as segment ID# TN08010209021_0600

Additionally, this water partially/does not support(s) designated uses due to E. coli from MS4's, physical substrate habitat alterations from channelization and Total phosphorous and dissolved oxygen from non-irrigated crop production. The permit for Outfall 001 does not allow increased design flow so there is no permitted increase in oxygen demanding pollutants or sources of which phosphorous is a component. The phosphorus in this discharge has never been quantified, so quarterly (seasonal) monitoring and reporting of total phosphorous is imposed for use in TMDL development and/or anti degradation implementation purposes. This treated effluent is required to meet the State Water Quality Standard for E. coli at the end of the discharge pipe so therefore is not contributing to violation of the water quality standard. This permit does not authorize any physical alterations to the stream channel. The division, therefore, considers the potential for degradation to the receiving stream from these discharges to be negligible.

TMDLs have been developed and approved for this waterbody segment on the following parameters and dates:

Parameter	TMDL Approval Date
E. coli	July 27. 2011

VII. COMPLIANCE SCHEDULE SUMMARY

Section		Description
I.	D 1	DMR/MOR Reports, monthly
III.	B	Placement of Sign(s), within 60 days from the effective date of this permit
III.	D	Sludge management practices, monthly

APPENDIX B

SPECIAL SEWER SERVICE AREAS

1. Mary's Creek Special Sewer Service Area (Ordinance – 2 pages)

ORDINANCE NO. 5070

AN ORDINANCE TO AMEND CHAPTER 33, CODE OF ORDINANCES CITY OF MEMPHIS SO AS TO CREATE THE MARY'S CREEK SEWER SERVICE AREA.

WHEREAS, due to expanding real estate development created by annexation of land areas, the City of Memphis finds it necessary to provide a special service to cover the cost of designing, constructing and financing of a sewer system for the Mary's Creek Special Drainage Basin.

SECTION 1. BE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF MEMPHIS, that Chapter 33, Code of Ordinances, City of Memphis, be amended by adding a new section to be known as 33-137, to read as follows:

"Section 33-137. Mary's Creek Special Sewer Service Area.

There is now established the Mary's Creek Special Sewer Service Area. Due to the cost of designing, constructing, and financing a sewer system for the Mary's Creek Special Drainage Basin the following sewer infrastructure surcharge fees are hereby established for any person directly or indirectly served by the Mary's Creek. Mary's Creek is a tributary of Gray's Creek in an area north of Wolf River, east of the City of Memphis, and in the City of Memphis Annexation Reserve Area as of July, 2004. Mary's Creek runs generally east to west. Sewer service provided Mary's Creek will only serve land in the City of Memphis and/or City of Memphis annexation area.

A) Residential lot infrastructure surcharge development fee (which fee shall be in addition to normal development fees) shall be Two Thousand, Two Hundred Dollars ($2,200) per lot.

B) Multi-family dwelling infrastructure surcharge development fee (which fee shall be in addition to normal development fees) shall be the greater of Seven Thousand Seven Hundred Dollars ($7,700) per acre or Nine Hundred and Fifteen Dollars ($915) per unit.

C) Commercial and industrial multi-unit building infrastructure surcharge development fee (which fee shall be in addition to normal development fees) shall be the greater of One Hundred Ten Dollars ($110) per foot, or seven Thousand Seven Hundred Dollars ($7,700) per acre.

D) Residential and commercial infrastructure user surcharge fee (which shall be in addition to normal user fees) shall be Twelve Dollars ($12.00) per month

E) Industrial user infrastructure surcharge fee (which shall be in addition to normal user fees) shall be One Dollar and Twenty Cents ($1.20) per 1000 gallon.

SECTION 2. BE IT FURTHER ORDAINED, That if any section, subsection, sentence, clause or phrase of this ordinance is for any reason held invalid or unconstitutional by the decision of any court of competent jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance.

SECTION 3. **BE IT FURTHER ORDAINED,** That this ordinance shall take effect from and after the date it shall have been passed by the Council, signed by the Chairman of the Council, certified and delivered to the Office of the Mayor in writing by the Comptroller, and become effective as otherwise provided by law.

JOE BROWN,
Chairman of Council.

Attest:
Rebecca Kissinger, City Comptroller.

THE FOREGOING ORDINANCE
5070 PASSED
1st Reading 7-20-04
2nd Reading 8-3-04
3rd Reading 8-17-04

App[redacted]

Date Signed: 9-7-04

Approved: [redacted]

Date Signed: 9/22/04

I hereby certify that the foregoing is a true copy, and said document was adopted by the Council of the City of Memphis as shown in-closed and approved by the Mayor.

[redacted]
Comptroller

APPENDIX C

Memphis Code Of Ordinances No. 5356

1. A substitute Ordinance To Amend Chapter 33, Code Of Ordinances So As To Increase The Sewer Fee

MEMPHIS CODE OF ORDINANCES NO 5356

A SUBSTITUTE ORDINANCE TO AMEND CHAPTER 33, CODE OF ORDINANCES SO AS TO INCREASE THE SEWER FEE

WHEREAS, the sewer fee was increased from 95.8 cents to 105.3 cents per 1000 gallons on July 1, 2009, and

WHEREAS, in order to maintain the stability of Sewer Fund, the sewer fees need to be increased.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF MEMPHIS THAT SECTION 1: CHAPTER 33 ARTICLE III, DIVISION 2, SEWER FEES AND CHARGES, SECTION 33-131(b)(1) AND DIVISION 4 BILLING PROCEDURES SECTION 33-156(g) ARE HEREBY AMENDED AND RESTATED IN THEIR ENTIRETY TO READ AS FOLLOWS:

Sect. 33-131(b)

(1) Volumetric charges. All customers will be charged a volumetric charge based on the equivalent strength of domestic sewage (BOD5 of two hundred fifty (250) milligrams per liter, SS of three hundred (300) milligrams per liter). Since seven and forty-eight one hundredths (7.48) gallons equals one cubic foot, one thousand (1,000) gallons equals 133.689 cubic feet (cf) or one thousand (1,000) gallons equals 1.33689 hundred cubic feet (ccf). The volumetric charge per one thousand (1,000) gallons is to be based on the annual debt service, capital costs, treatment and operations and maintenance costs, and all other charges assigned to the sewer fund. The volumetric charge will be $2.267 per one thousand (1,000) gallons of flow until changed by amendment to this section. A residential maximum volume fee of fifty dollars ($50.00) and a minimum of two dollars and fifty cents ($2.50) per month per individual dwelling unit is herewith established.

Commencing and retroactive to July 1, 2010, the $2.267 flow charge fee shall be assessed against the name in which a meter has been installed; provided, further, however, in the case of multifamily dwellings a portion of this cost may be recovered through a monthly flat rate per customer charge. The charge, as determined by the Director of Public Works, shall not exceed eight dollars and eighty-five cents ($8.85) per monthly flat rate charge per customer. Amounts collected through any monthly flat rate charge shall be credited in accordance with section 33-156.

Commencing and retroactive to 1 July 2010, all citizens who qualify for the Solid Waste Fee Discount Program as delineated in Chapter 15, Section 12, Code of Ordinances, City of Memphis (as codified in ordinance 5112) shall be charged $1.66 per one thousand gallons until changed by amendment to this section.

#31

Commencing July 1, 2010 all industrial customers assigned an industrial discharge agreement will be charged a volumetric sewer fee of $2.267 per one thousand (1,000) gallons of flow for the first five million gallons per month discharged by each industrial customer. For volumes in excess of five million gallons per month, each industrial customer will be charged a volumetric sewer fee according to the attached schedule:

From 1 July 2010 through 30 June 2011:	$1.458 per 1,000 gallons
From 1 July 2011 through 30 June 2012:	$1.862 per 1,000 gallons
Beginning 1 July 2012:	$2.267 per 1,000 gallons

Effective 1 July 2010, all non-governmental industrial customers with valid City of Memphis issued Sewer Discharge Agreements having flows less than 10 million gallons per month will pay 100% of the latest adopted sewer rate for all wastewater discharged up to a fee amount of $ 500 per month. All wastewater discharge costs in excess of $ 500 per month will be charged a volumetric sewer fee according to the following schedule:

From 1 July 2010 through 30 June 2011:	$1.458 per 1,000 gallons
From 1 July 2011 through 30 June 2012:	$1.862 per 1,000 gallons
Beginning 1 July 2012:	$2.267 per 1,000 gallons

Beginning 1 July 2012, all industrial customers shall pay 100% of the then current sewer rate. This fee schedule shall remain in effect until changed by amendment to this section

Sec. 33-156

(g). In accordance with the apartment credit program the approving authority has the right to charge each tenant eight dollars and eighty-five cents ($8.85) per month if so requested in writing by the apartment owner. The total amount collected will then be credited against the amount billed from the master water meter reading each month.

SECTION 2. BE IT FURTHER ORDAINED, That the various sections of this Ordinance are severable, and that any portion declared unlawful shall not affect the remaining portions

SECTION 3. BE IT FURTHER ORDAINED, that this ordinance shall take effect from and after the date it shall have been passed by the Council, signed by the Chairman

of the Council, certified and delivered to the Office of Mayor in writing by the comptroller and become effective as otherwise provided by law

Passed, approved and adopted this _____ day of_____ , 2010.

_____
Chairman, Memphis City Council

SewerOrdinancemod2010_11junerev

THE FOREGOING ORDINANCE
5356 PASSED
1st Reading 5-11-10
2nd Reading 5-25-10
3rd Reading 6-8-10

Approved [redacted]

Date Signed: 06/22/2010

Approved [redacted]
Mayor, City of Memphis

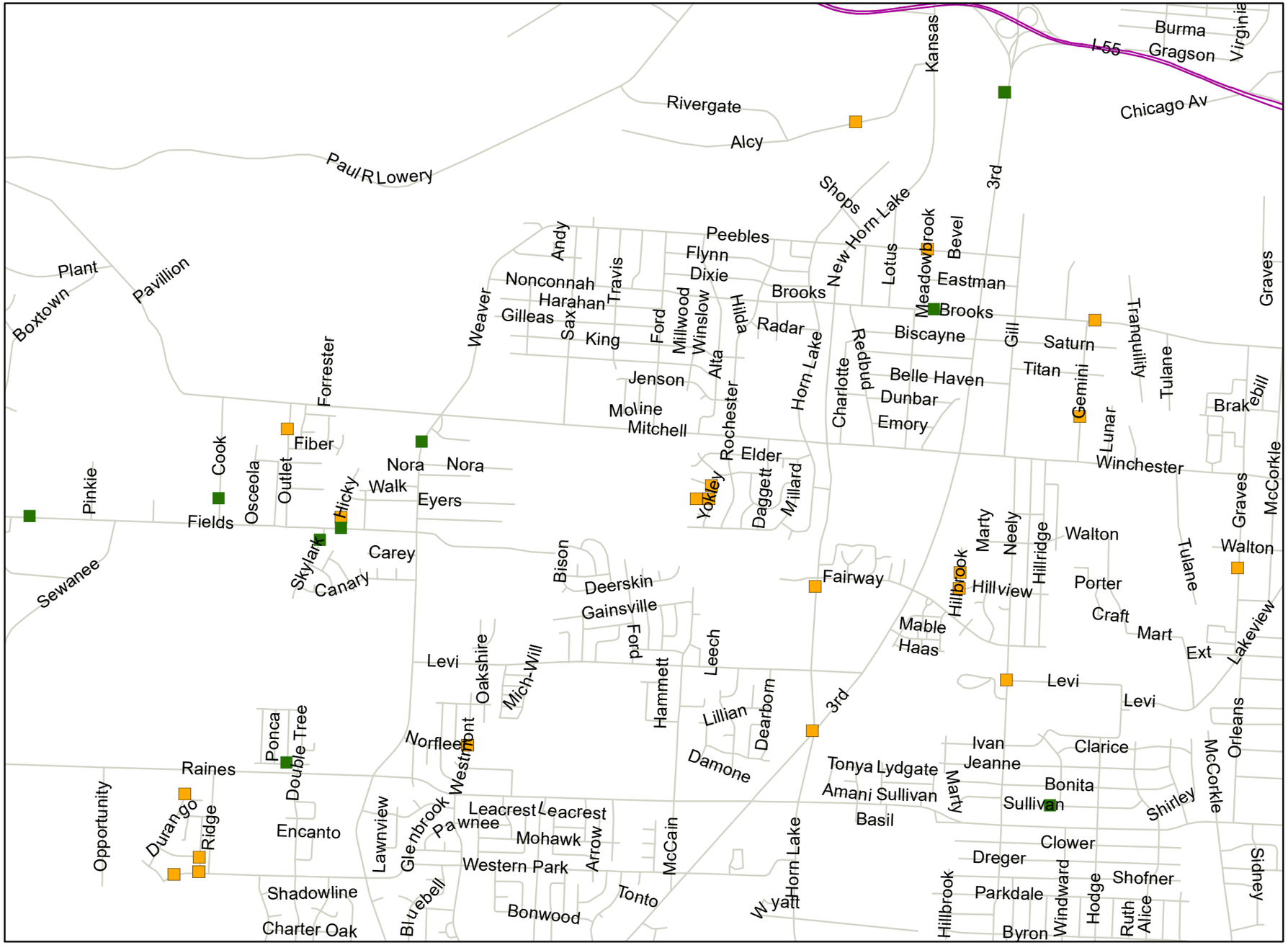
Date Signed: 6/22/2010

I hereby certify that the foregoing is a true copy, and said document was adopted by the Council of the City of Memphis as above indicated and approved by the Mayor.

[redacted]
Comptroller

APPENDIX D

Location Maps of Sewer Overflows.



Legend

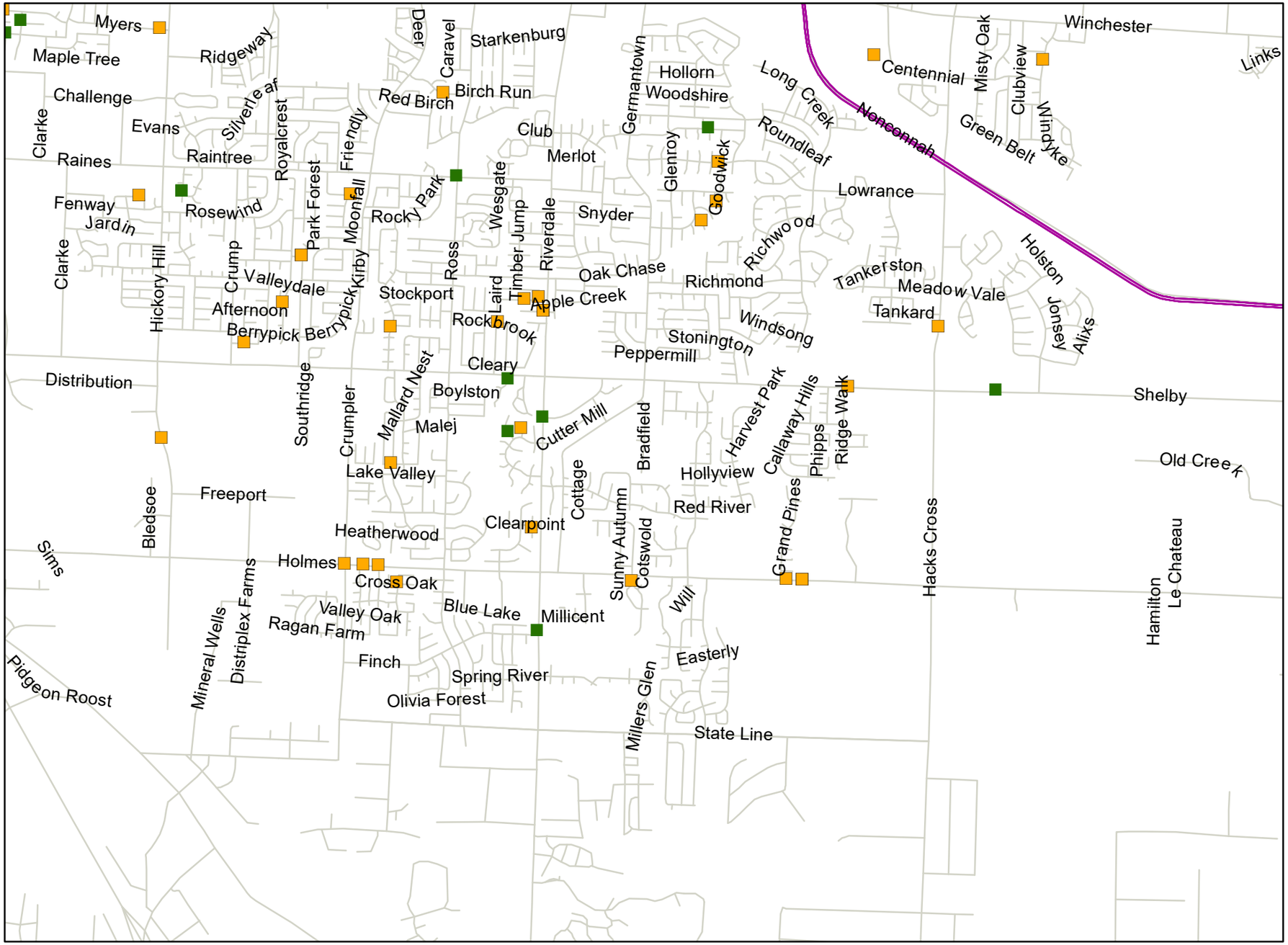
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

Southwest

Note: 2012 SSO's thru June



Legend

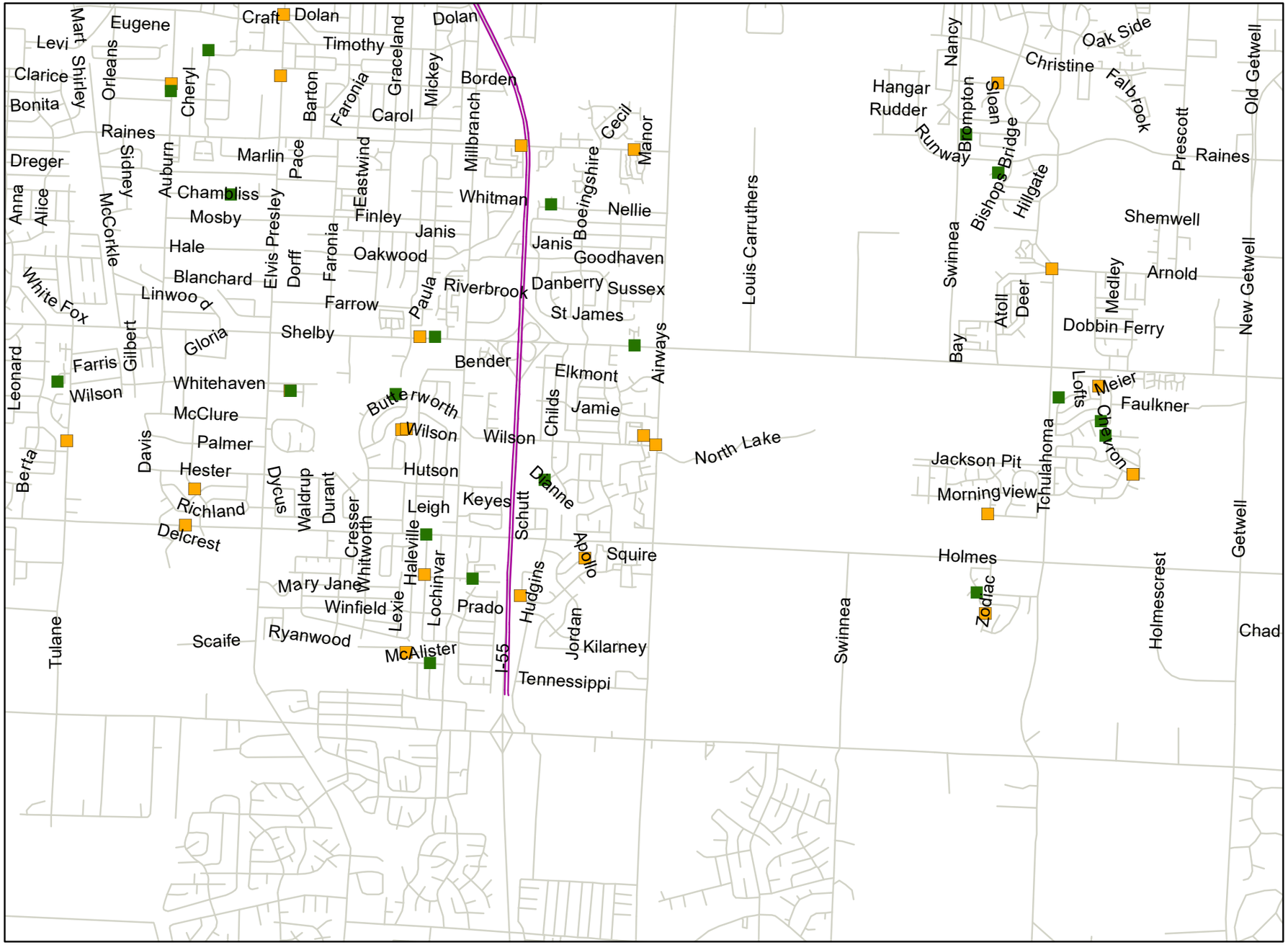
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.25 0.5 1 Miles

South 6 (13)

Note: 2012 SSO's thru June



Legend

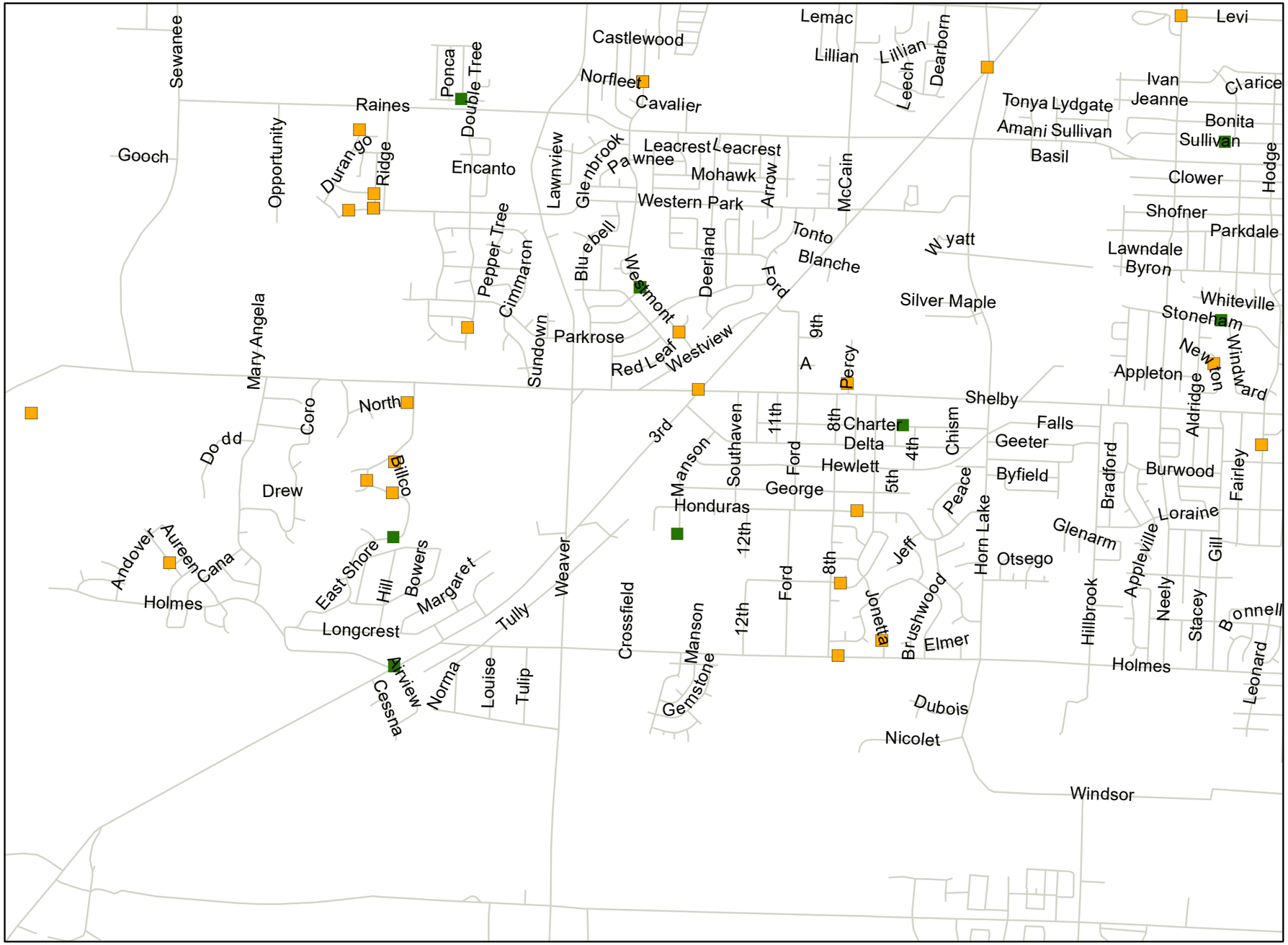
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.25 0.5 1 Miles

South 5 (12)

Note: 2012 SSO's thru June



Legend

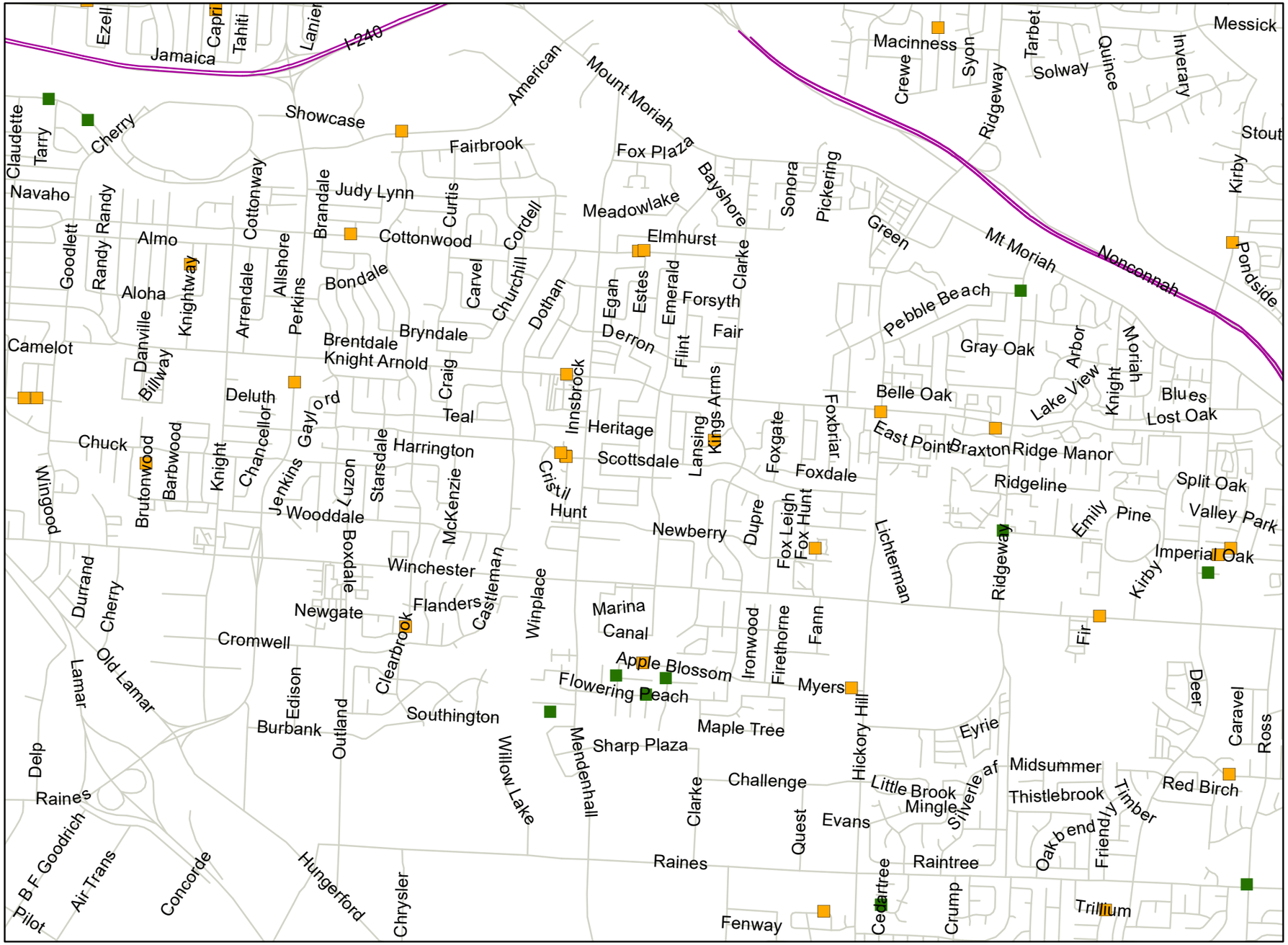
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

South 4

Note: 2012 SSO's thru June



Legend

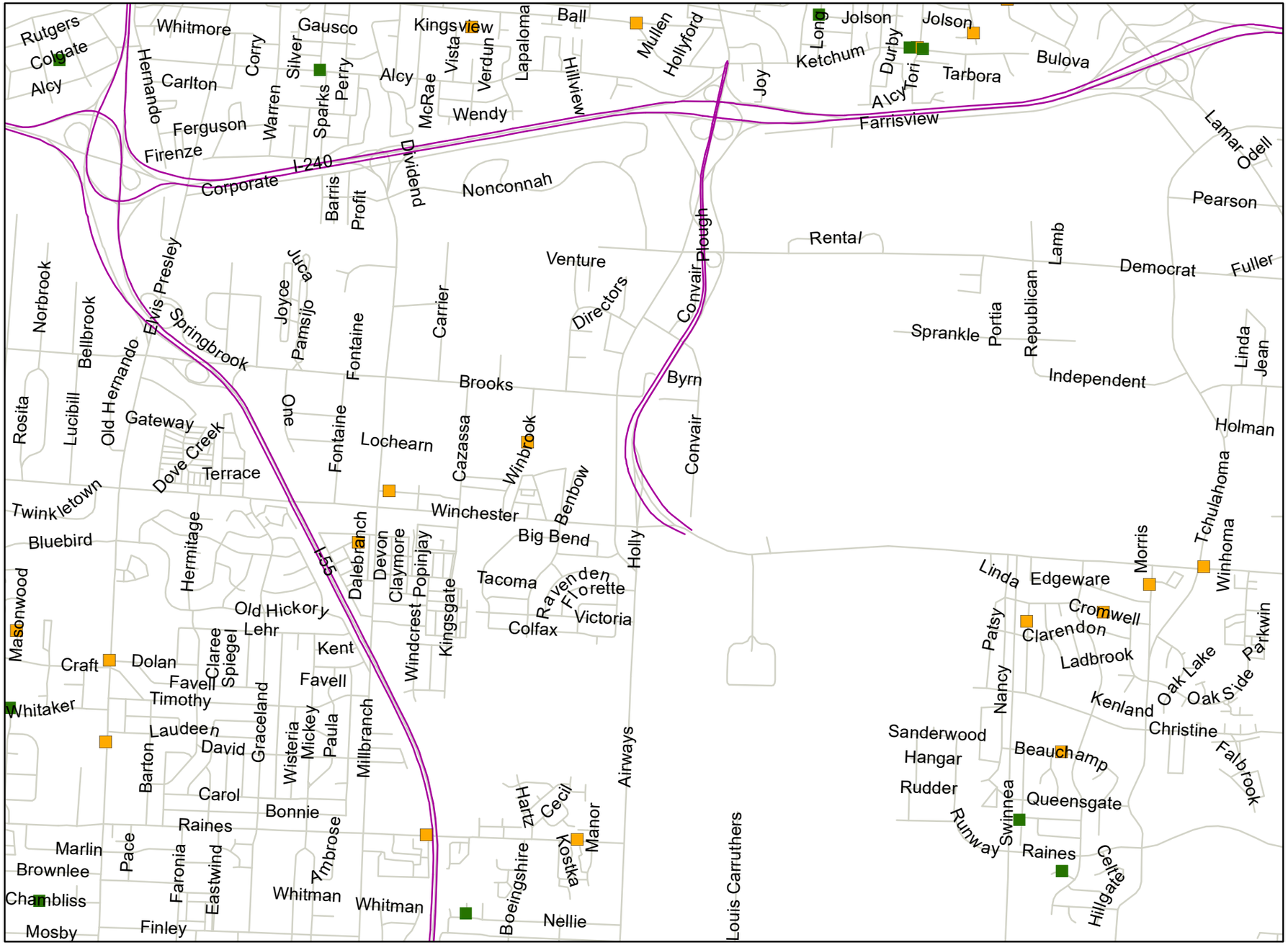
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

South 3

Note: 2012 SSO's thru June



Legend

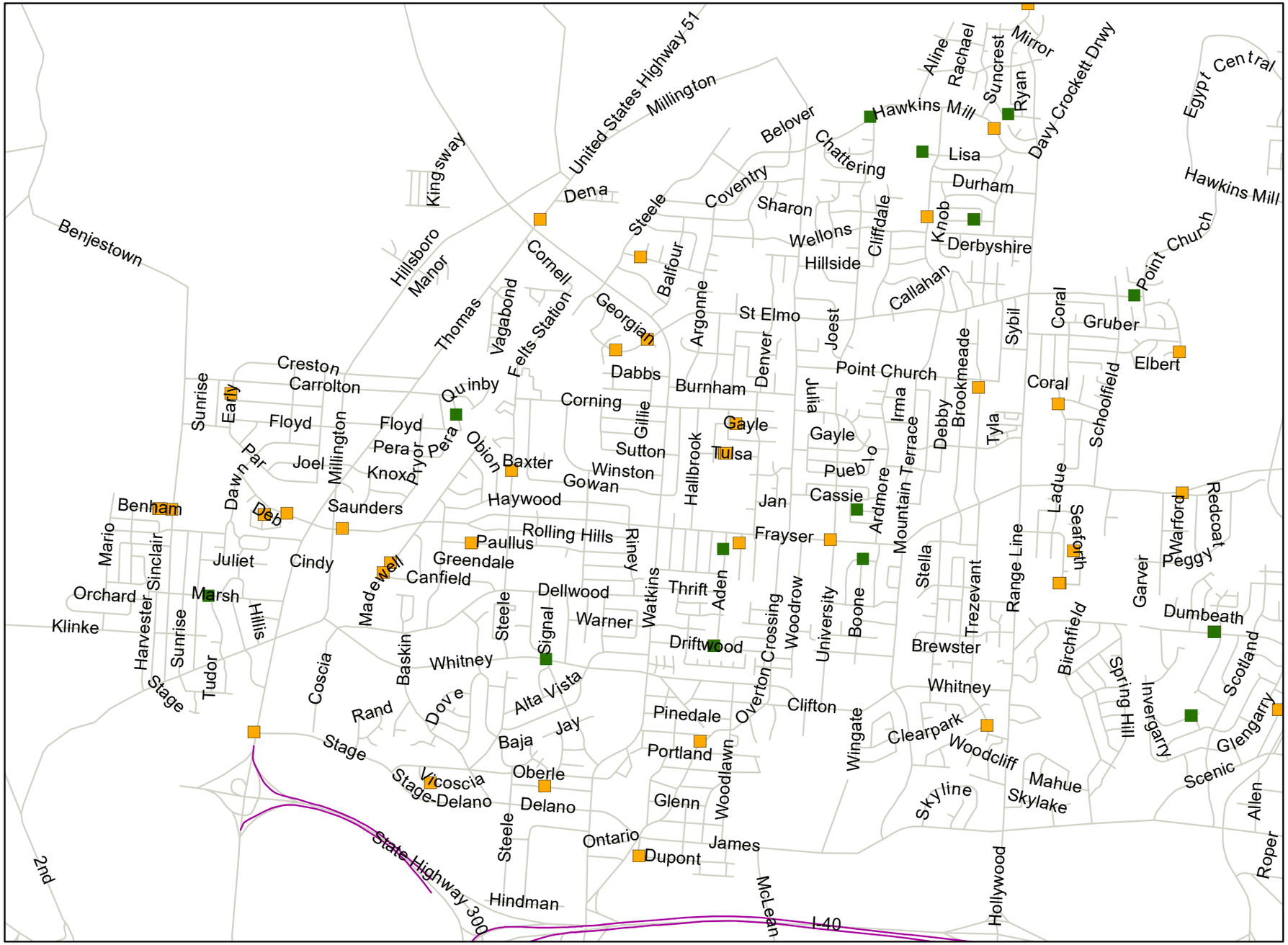
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

South 2

Note: 2012 SSO's thru June



Legend

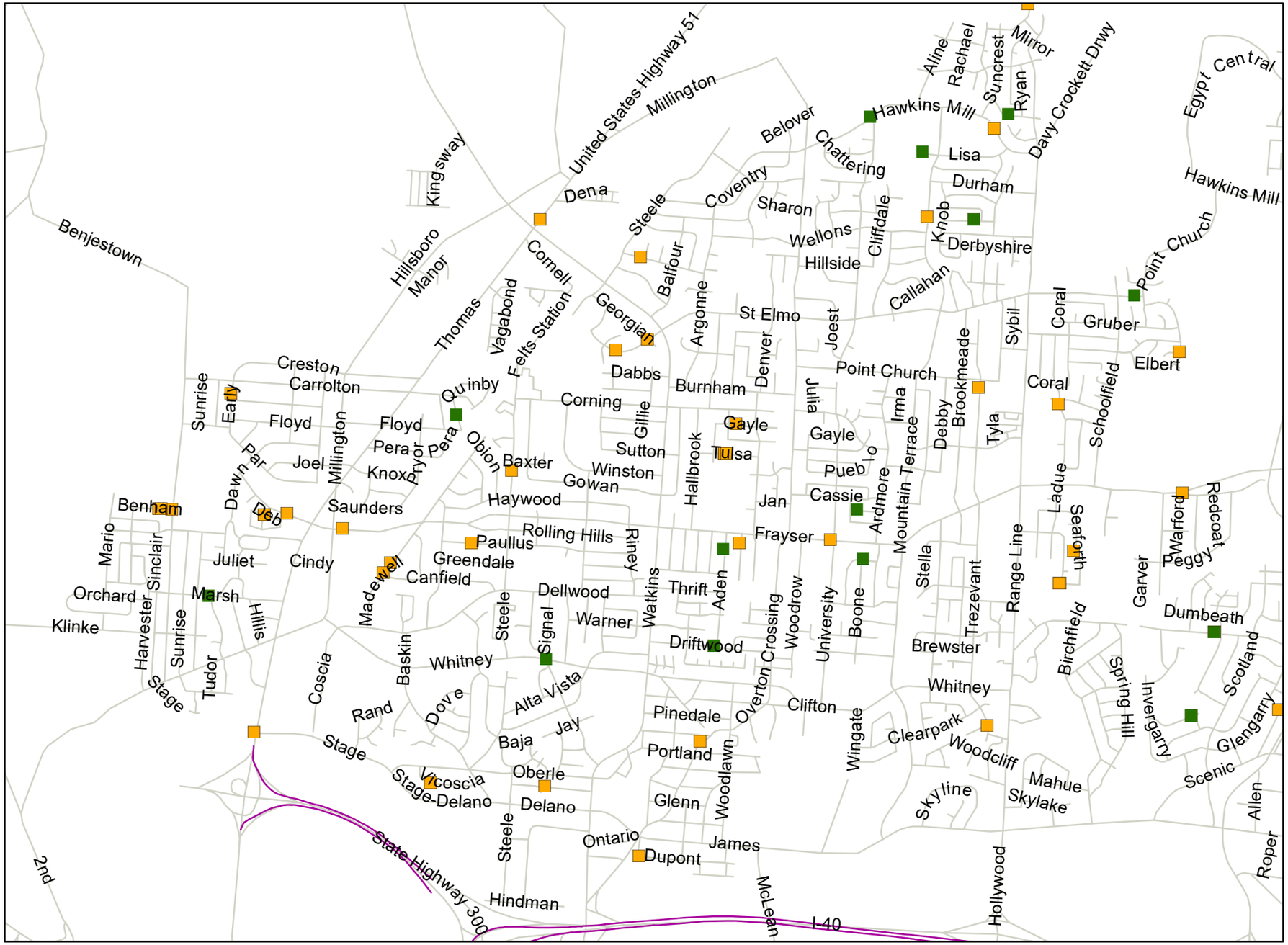
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.25 0.5 1 Miles

NW Quadrant

Note: 2012 SSO's thru June

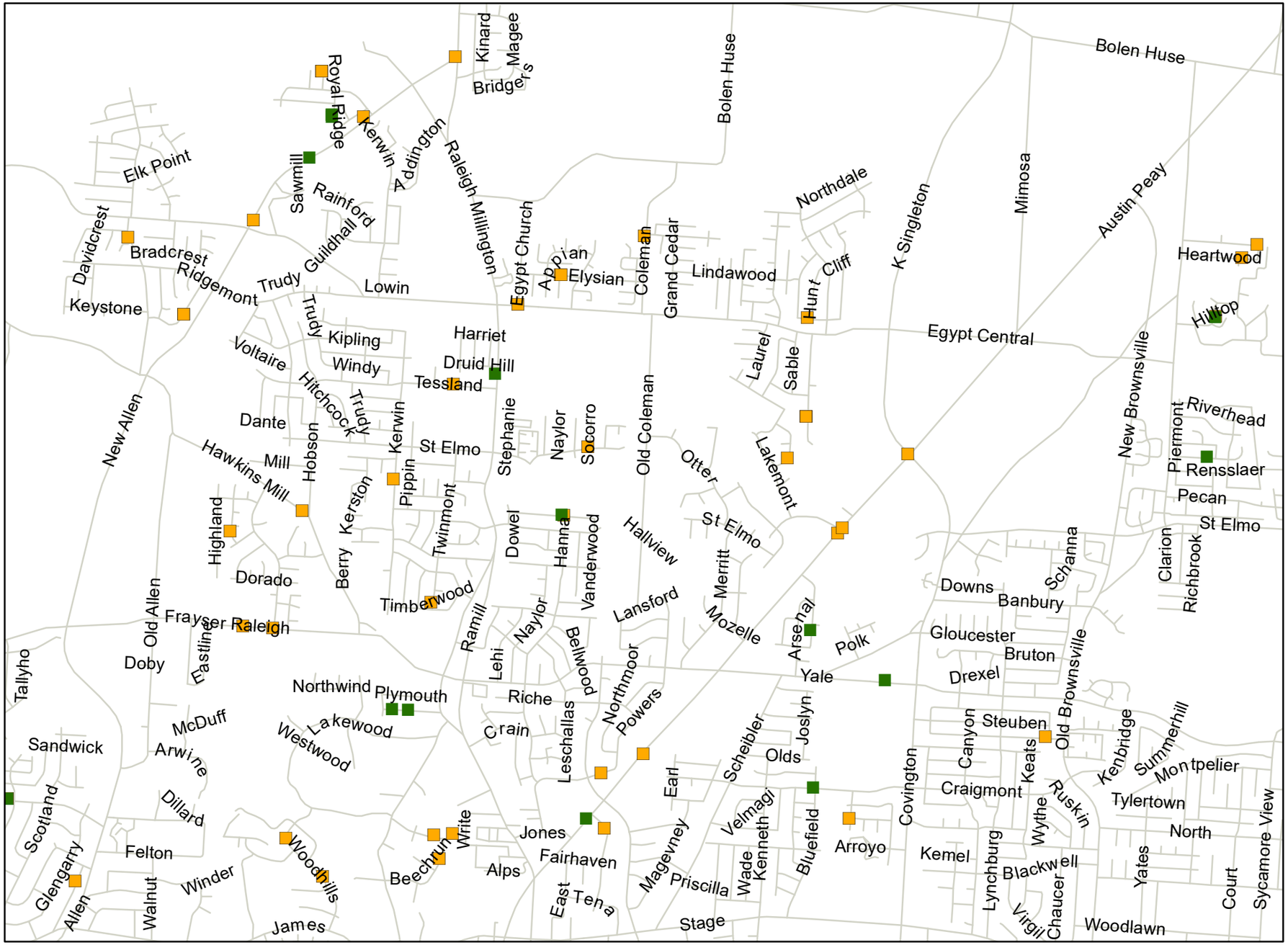


Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

NW Quadrant

Note: 2012 SSO's thru June



Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.25 0.5 1 Miles

NE Quadrant

Note: 2012 SSO's thru June

Legend

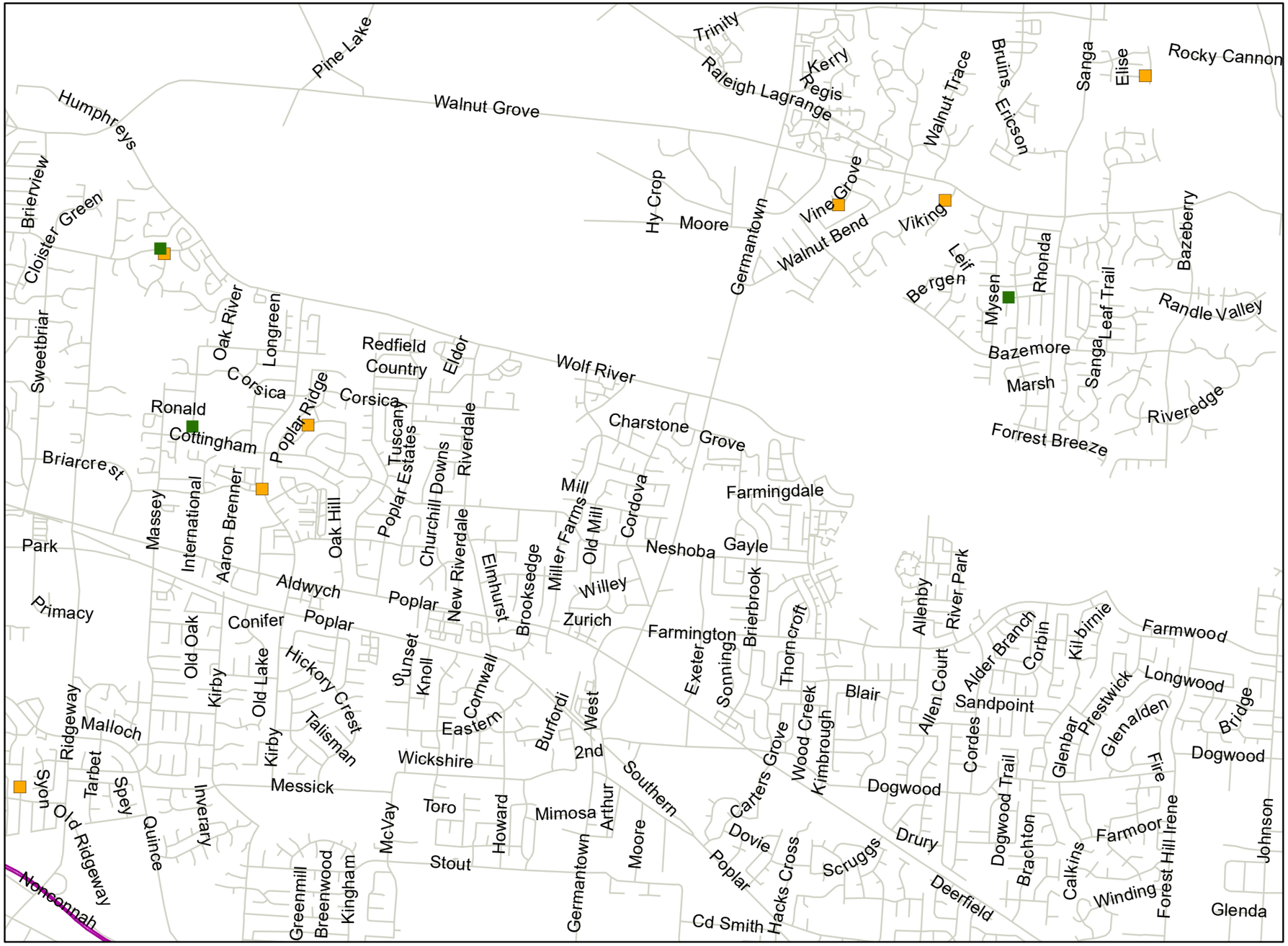
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

Mid West

Note: 2012 SSO's thru June



Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.25 0.5 1 Miles

Mid 5

Note: 2012 SSO's thru June

Legend

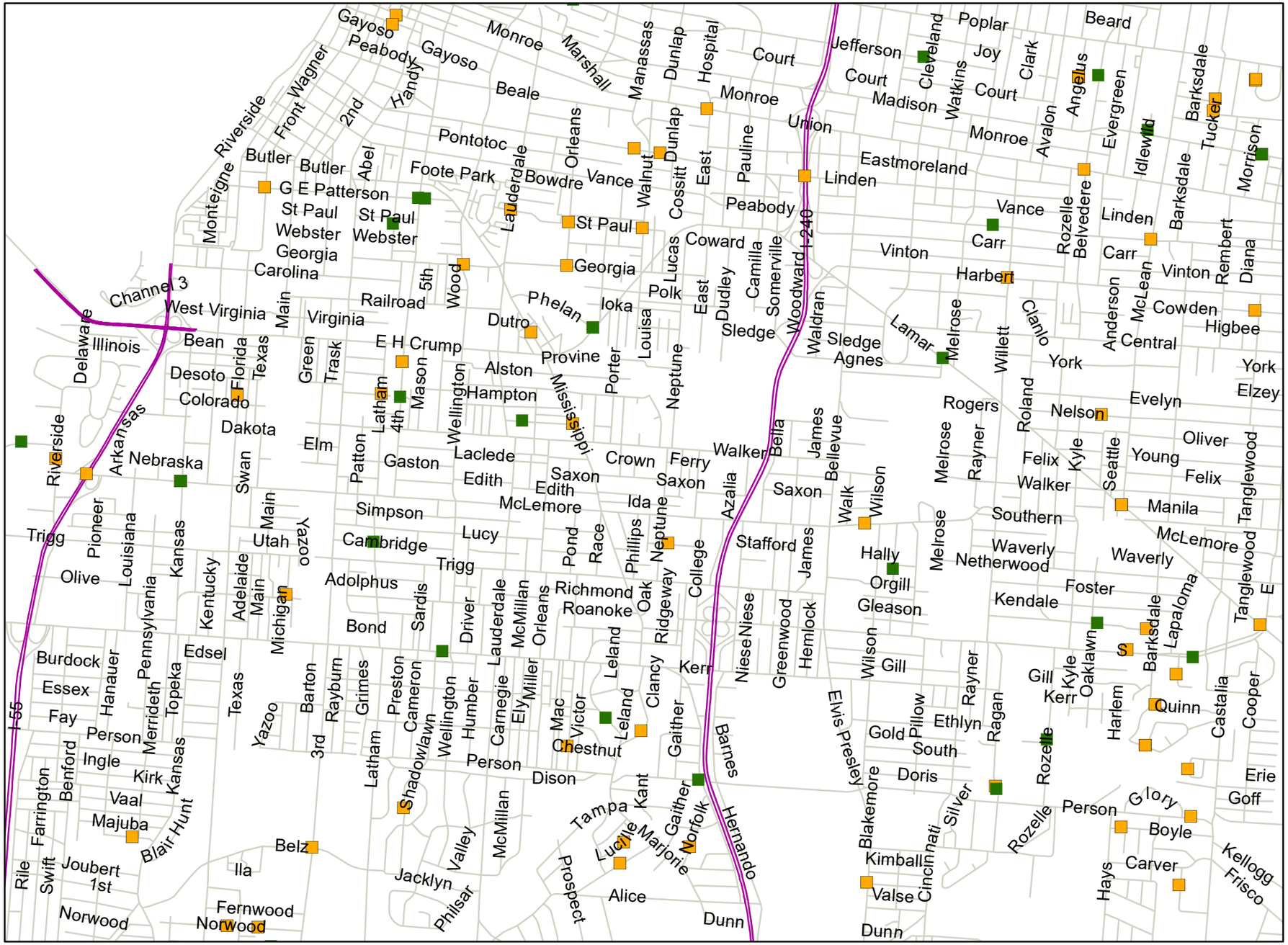
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

Mid 4

Note: 2012 SSO's thru June



Legend

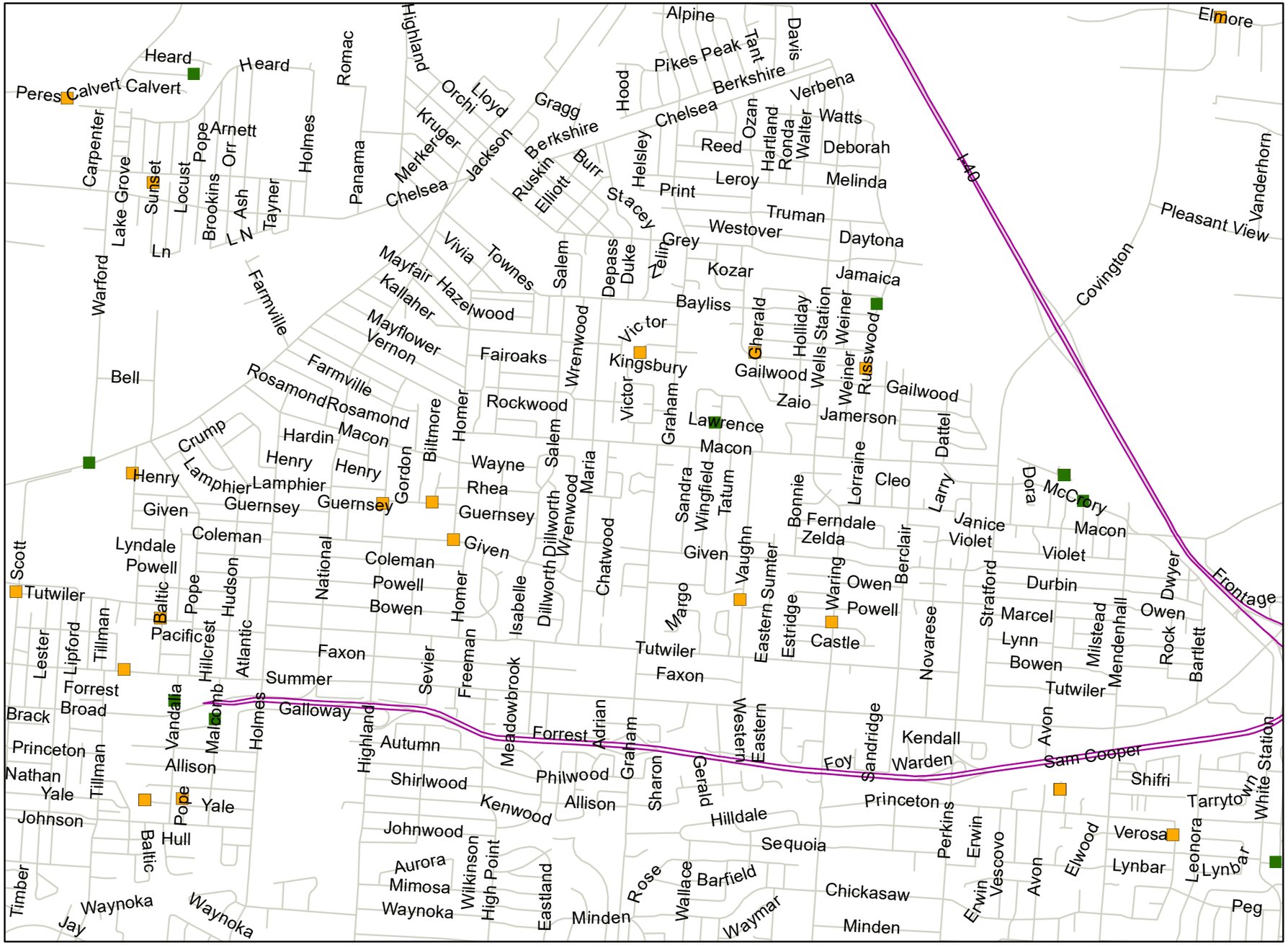
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

Mid 3

Note: 2012 SSO's thru June



Legend

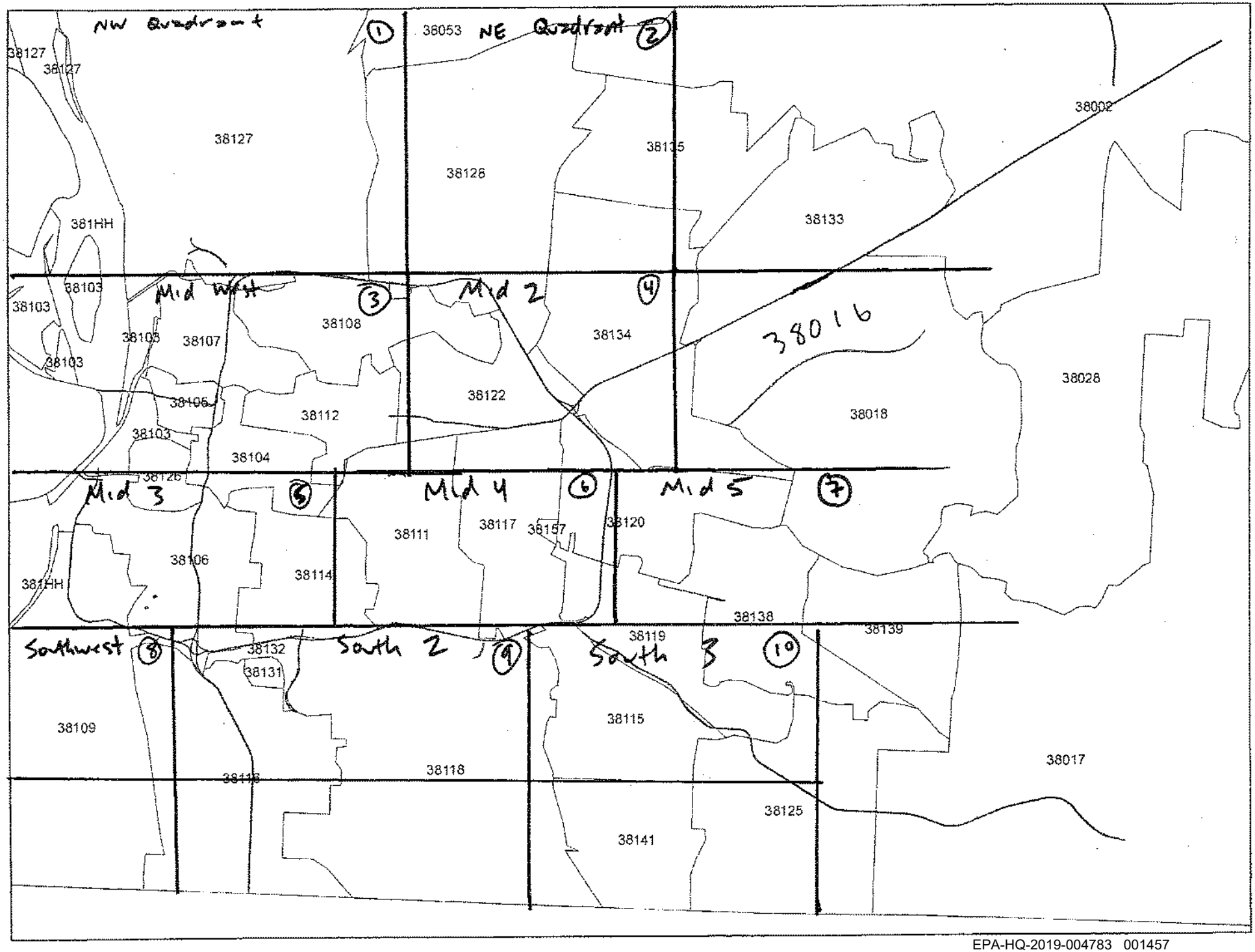
- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 0.2 0.4 0.8 Miles

Mid 2

Note: 2012 SSO's thru June


NW Quadrant
1
38053
NE Quadrant
2
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38128
38135
38133
38002
381HH
38103
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38103
Mid West
3
38108
38107
Mid 2
4
38134
38016
38028
38122
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38112
38018
38103
38104
38126
Mid 3
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Mid 4
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7
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381HH
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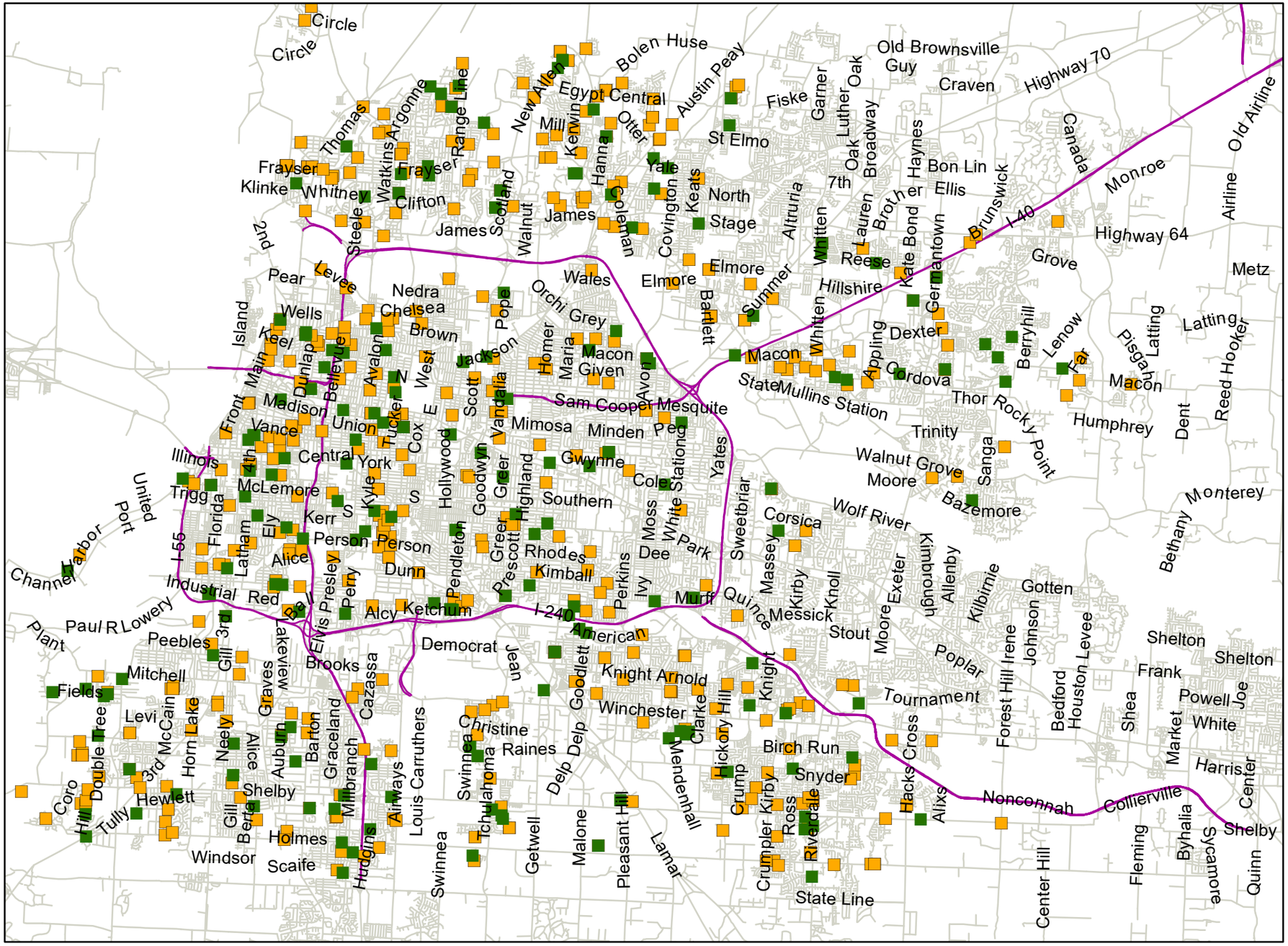

Legend

- 2012 SSO's
- 2011 SSO's
- Interstates
- Roads

N

0 1 2 4 Miles

City Overview

Note: 2012 SSO's thru June

Department of Environment & Conservation

Division of Water Resources / State Revolving Fund Loan Program
William R. Snodgrass TN Tower, 12th Floor
312 Rosa L. Parks Avenue, Nashville TN 37243
Phone: (615) 532-0445

May 26, 2016

The Honorable Jim Strickland, Mayor
City of Memphis
City Hall
125 N. Main Street, Room 700
Memphis, TN 38103

RE: Facilities Plan Approval
Memphis (Shelby County), Tennessee
Loan No. SRF 2015-355, T. E. Maxson Wastewater Treatment Plant Upgrades Project

Dear Mayor Strickland:

The State Revolving Fund (SRF) Loan Program acknowledges the receipt of a Facilities Plan via email on December 14, 2014, and Revised Sections 1, 2, 3, 6, 7, 8, and 9 to the Facilities Plan via email on March 21, 2016. The SRF Loan Program has reviewed the documents associated with your Facilities Plan in accordance with appropriate State rules, policies, regional guidance, and technical publications. Based on our review, a Categorical Exclusion was issued on January 26, 2016. Full approval of this Facilities Plan is now granted. The related documents concerning this approval are as follows:

- "Facilities Plan, Clean Water State Revolving Fund Loan Application, T. E. Maxson WWTF Improvements, City of Memphis, Tennessee, January 2015"
- Revised Sections 1, 2, 3, 6, 7, 8, and 9 to the Facilities Plan

It has been determined that the subject plan is complete as described under provisions of the State Revolving Fund Rule 0400-46-06-.06 and is described as follows:

> Process and disinfection improvements including additional aeration basin and secondary clarifier capacity; a new return activated sludge re-aeration basin; biotower improvements including new media and ventilation systems; replacing the existing screen and associated appurtenances at the headworks; replacing existing coarse bubble diffusers with fine bubble diffusers; new odor control facilities; installation of a peracetic acid (PAA) disinfection system including a new contact basin, bulk storage, and chemical feed facilities; electrical improvements and upgrades; and miscellaneous plant hydraulic improvements including piping, valves, pumps, and gates

Thus, the City of Memphis may be eligible to receive financial assistance through the State Revolving Fund as established under T.C.A. 68-221-1001, et seq.

If we may be of any further assistance on this project, please contact Mr. Rick Hogshead at (615) 532-0482 or *rick.hogshead@tn.gov* .

Sincerely,

[redacted]

Sherwin N. Smith, Director
State Revolving Fund Loan Program

Enclosure: One Copy of the Approved Facilities Plan

cc: Mr. Paul Patterson, Department of Public Works, Memphis, TN
(via email at *paul.patterson@memphistn.gov*)
Mr. Bobby Allen, P.E., Department of Public Works, Memphis, TN
(via email at *bobby.allen@memphistn.gov*)
Mr. Scott Morgan, P.E., Department of Public Works, Memphis, TN
(via email at *scott.morgan@memphistn.gov*)
Mr. Ed Hargraves, P.E., A2H, Lakeland, TN (via email at *edwardh@a2h.com*)
Mr. Brent Hooks, Project Manager, Allworld Project Management, Memphis, TN
(via email at *brent@allworldmail.com*)
Mr. Zack Daniel, P.E., CDM Smith, Nashville, TN
(via email at *danielza@cdmsmith.com*)
Mr. Vojin Janjic, TDEC-DWR, Water Quality Branch, Nashville, TN (via email)
Mr. Ronné Adkins, TDEC, Regional Director for External Affairs, Memphis Environmental Field Office (via email)
Ms. Joellyn Brazille, TDEC, DWR Manager, Memphis Environmental Field Office (via email)
Mr. Sam Gaddipati, Environmental Manager, SRF Loan Program (via email)
Ms. Felicia Freeman, Technical Section, SRF Loan Program (via email)
Dr. Bagher Sami, Administrative Section Manager, SRF Loan Program (via email)

FACILITIES PLAN

CLEAN WATER STATE REVOLVING FUND LOAN APPLICATION

T.E. MAXSON WWTF IMPROVEMENTS (SRF 2015-355)

CITY OF MEMPHIS, TENNESSEE

Prepared by

A2H

ENGINEERS · ARCHITECTS · PLANNERS

3009 DAVIES PLANTATION ROAD
LAKELAND, TN 38002
PHONE: (901) 372-0404
FAX: (901) 373-4002

110 SOUTH LIBERTY, SUITE 100
JACKSON, TN 38301
PHONE: (731)-424-5450
FAX: (731)-424-5451

[redacted]

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TAB 11	**APPENDIX A**	**COPIES OF NPDES PERMITS**
TAB 12	**APPENDIX B**	**MEMPHIS CODE OF ORDINANCES NO. 5356**

SECTION 1 – SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

1.1 – STATEMENT OF THE PROBLEM

Project : T.E. Maxson WWTF Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970s and has undergone multiple improvements and upgrades since it was put into operation. Recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of peracetic acid (PAA) disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant.

The project will be located within the existing boundaries of the Maxson WWTF and will not require any additional land acquisition or easements. The estimated cost for the WWTF improvements is $136 million. Based on discussions with SRF regarding funding, the City is anticipating the total loan amount from SRF to be $85 M funded over multiple fiscal years with the City funding the remaining anticipated $51 M.

1.2 – SUMMARY OF THE ALTERNATIVE SOLUTIONS CONSIDERED

Project : T.E. Maxson WWTF Improvements

Two alternatives were considered during the preliminary design of this project, as follows:

- Alternative No. 1 – "No Action" – Do nothing to make corrections to the WWTF
- Alternative No. 2 – Install the recommended modifications to the existing WWTF.

1.3 – RECOMMENDED SOLUTION

Project : T.E. Maxson WWTF Improvements

The recommended alternative will require the City to have construction plans prepared for this project. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of PAA disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, pumps, and gates for connections to the existing plant.

SECTION 2 – PURPOSE AND NEED

2.1 – STUDY PURPOSE

Project : T.E. Maxson WWTF Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970s and has undergone multiple improvements and upgrades since it was put into operation. Recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of peracetic acid (PAA) disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant.

The project will be located within the existing boundaries of the Maxson WWTF and will not require any additional land acquisition or easements. The estimated cost for the WWTF improvements is $136 million. Based on discussions with SRF regarding funding, the City is anticipating the total loan amount from SRF to be $85 M funded over multiple fiscal years with the City funding the remaining anticipated $51 M.

2.2 – NEED FOR THE PROJECT

Project : T.E. Maxson WWTF Improvements

The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of PAA disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant.

SECTION 3 – GENERAL INFORMATION

3.1 – EXISTING FACILITIES AND AREAS SERVED

The Memphis Sanitary Sewer System serves approximately 265,000 households. The sewer lines extend throughout the entire city and throughout many populated areas of Shelby County, transporting the City's sewage to each of the City's three existing waste water treatment plants - the T.E. Maxson WWTF in southwest Memphis, the M.C. Stiles WWTF in northwest Memphis, and the Chapel Hill WWTF in northeast Shelby County. These three plants treat an estimated sixty billion gallons of wastewater each year. The Maxson and Stiles WWTFs each have several sludge lagoons that handle an estimated 215 million pounds of bio-sludge each year. Treated effluent from both the Maxson and Stiles plants is released into the Mississippi River, and treated effluent from the Chapel Hill plant is released into an unnamed tributary of Crooked Creek.

3.2 – OPTIMUM PERFORMANCE AVAILABLE WITH THE EXISTING FACILITIES/OPERATIONAL PROBLEMS

The Memphis Sanitary Sewer System is capable of treating over 225 million gallons per day, with capacities of each plant as follows:

- Maxson plant capacity = 90 MGD (90 million gallons per day),
- Stiles plant capacity = 135 MGD (135 million gallons per day),
- Chapel Hill plant capacity = 0.045 MGD (45,000 gallons per day).

The normal (dry weather) demand on the Memphis Sanitary Sewer System is over 145 million gallons per day, with normal (dry weather) demand at each plant as follows:

- Maxson plant demand = 70 MGD (70 million gallons per day),
- Stiles plant demand = 75 MGD (75 million gallons per day),
- Chapel Hill plant demand = 0.020 MGD (20,000 gallons per day).

These normal (dry weather) demands are well below the capacities of each plant.

Project : T.E. Maxson WWTF Operational Problem

The operational issues associated with the Maxson WWTF are with the recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, installation of peracetic acid (PAA) disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant. Specific details regarding effluent limitations and monitoring requirements are available in the NPDES permit included in *APPENDIX A* at the end of this document.

3.3 – EXISTING COLLECTION SYSTEM

The Memphis Sanitary Sewer Collection System is comprised of approximately 2,400 linear miles of gravity sewer mains and force mains running throughout the entire city and throughout many populated areas of Shelby County. There are approximately 100 sewer lift stations at various locations throughout the city and county, as topography dictates. The existing sewer lines are constructed of various materials, including clay, ductile iron, concrete, and plastic, and pipe diameters range from as small as six inches to as large as 120 inches. The existing manholes are constructed with brick and mortar or concrete, or a combination of the two.

3.4 – POTENTIAL FOR SERVING ADDITIONAL AREAS

Because of the continued demand for new housing in Memphis annexation areas and in anticipation of the continued development of rural areas of Shelby County to meet this demand, the Memphis Sanitary Sewer System has been purposely planned and designed for expansion into unsewered areas. As noted previously, the Stiles WWTF has a normal demand that is well below the plant's capacity. The existing treatment facilities and sewer interceptors have been designed for a "fully developed" condition of land areas that are currently considered to be rural. Therefore, additional sewer collection lines can be added to the existing system without the need for upgrade to existing equipment or treatment processes or increases in existing sewer interceptor lines.

As mandated in the Consent Decree recently entered into by the City of Memphis, a sewer assessment is under way and will identify defects in the sewer system. Once the areas are identified, a sewer rehabilitation program will commence to take whatever corrective measures

are necessary to ensure that the Memphis sewer collection system is fully functional and all sewer overflows have been eliminated.

SECTION 4 – INFILTRATION AND INFLOW

4.1 – ANALYSIS OF INFILTRATION AND INFLOW

A Consent Decree agreed to by the City of Memphis requires the City to assess approximately 10% of the sewer system per year. The rehabilitation areas will be dependent on the assessment data. The rehabilitation could include repairs to gravity lines, force mains, and pumping stations. Rehabilitation will include all forms of repair dependent on the condition (i.e., CIPP, pipe burst, open cut, etc.).

The analysis of the inflow and infiltration of the Stiles WWTP and the Maxson WWTP are as follows:

	% Rain Induced	%RiverStage Induced	% Total
Maxson WWTF	5.6%	6.4%	12%
Stiles WWTF	3.7%	22.3%	26%

4.2 – STEPS BEING TAKEN TO REDUCE EXCESSIVE INFILTRATION AND INFLOW

In the effort to eliminate sewer system overflows and as specified in the consent decree, the City will implement or update the following programs:

1) Management, Operations and Maintenance Program, which will require the development of the following:
   a) Sewer Overflow Response Plan which will require timely and effective methods of responding to, cleaning up, and/or minimizing the impact of Sewer system overflows;
   b) Fats, Oil, and Grease Management Program which will require a re-evaluation to expand or modify the existing program;
   c) Lift Station and Force Main Operations and Maintenance Program which will require periodic service and calibration of instrumentation, inspection and service of air release valves, predictive and physical inspection and service of lift stations, assessment of force mains such as potential sulfide and corrosion control options, inspection of force mains such as at creek crossings;
   d) Gravity Sewer System Operations and Maintenance Program to prevent sewer system overflows particularly caused by fats, oils and grease, and roots and/or debris obstructions;

e) Inter-Jurisdictional Agreement Program will be implemented to renew existing agreements or enter into new agreements that cover the collection, conveyance, and treatment of sewage by Memphis from municipal satellite sewer systems, with the exclusion of Collierville due to the minimal collection of sewage by Memphis from Collierville.

f) Continuing Sewer Assessment Program to set priorities and schedules for undertaking sewer assessment which may include dyed water, water flooding, corrosion defect identification, manhole assessment, flow monitoring, closed circuit television inspection, defect analysis, smoke testing, and lift station performance assessment;

g) Infrastructure Rehabilitation Program which will include gravity line rehabilitation, manhole rehabilitation, lift station rehabilitation, and force main rehabilitation.

2) Priority Assessment Areas will be completed as stipulated by the Consent Decree

3) Critical Infrastructure Areas Projects will receive priority rehabilitation due to the nature of the infrastructure and the potential consequences of large volumes of sewer overflows in the event of infrastructure failure.

The schedule of compliance with the Consent Decree is as follows: The entire system is planned to be assessed in 10 years. There are certain areas outlined in the Consent Decree that must be 100% repaired (all defects) in a certain time period after the Infrastructure Rehabilitation Plan (IRP) is approved by EPA. Other rehab/repairs will be based upon the approved IRP on such factors as criticality, where it is located, likelihood of failure, integrity, etc.

SECTION 5 – FUTURE CONDITIONS

5.1 – PLANNING PERIOD (20 YEARS)

In anticipation of the growth that the Memphis area has experienced throughout the past several decades, City leaders have been diligent throughout that time in planning for the future regarding the Memphis Sanitary Sewer System. Rather than plan for a specified number of future years (i.e. a planning period of 20 years), the treatment facilities and collection system have been designed and upgraded throughout the past several decades based on "full development" in areas where development was expected to occur. The "planning period" for the Memphis Sanitary Sewer System extends far beyond just twenty years.

Project No. 1: T.E. Maxson WWTF Improvements

The T.E. Maxson WWTF has sufficient excess capacity to handle the anticipated population growth during the twenty year planning period. As previously discussed in chapter 3 of this report the Maxson WWTF is currently operating at approximately 78% of capacity. Implementation of the Consent Decree mandated sewer assessment and rehabilitation and the modifications to the treatment processes and new disinfection processes will result in the Maxson WWTF capable of meeting all discharge limits for the foreseeable future.

5.2 – LAND USE PROJECTIONS

There are no anticipated changes to the land use in the project areas of the Stiles and Maxson WWTF.

5.3 – POPULATION FORECAST

The population forecasts for the City of Memphis during the planning period is modest increasing from approximately 657,000 to 667,000, or approximately 1.5% over the planning period.

SECTION 6 – DEVELOPMENT OF ALTERNATIVES

6.1 "NO ACTION" ALTERNATIVE

Project No. 1: T.E. Maxson WWTF Improvements

Alternative No. 1 – "No Action"

This alternative includes the implementation of no capital improvements at the existing T.E. Maxson WWTF. This alternative is not viable due to the conditions of the new NPDES permit, particularly in regards to the implementation of effluent disinfection, along with the City's desire to ensure adequate treatment capacity at the plant to maintain the ability to process additional flow and continue to recruit new industries to the City of Memphis. In addition to the upgrades to ensure additional treatment capacity and implement effluent disinfection, the third goal of the City WWTF expansion project is the implementation of additional odor control at various process locations throughout the plant. The "no action" alternative will not allow any of these three goals to be achieved.

6.2 ALTERNATIVES (OTHER THAN THE "NO ACTION" ALTERNATIVE) [COMPARED FOR COST-EFFECTIVENESS, ENVIRONMENTAL IMPACTS & FEASIBILITY]

Project No. 2: T.E. Maxson WWTF Improvements

Alternative No. 2 – Decommission Biotowers and Expand Activated Sludge

The second alternative for the upgrades at the plant includes the decommissioning of the existing biotowers as a biological treatment process. The removal of the biotowers and their associated treatment capacity will require a large equivalent capacity of biological treatment to be implemented through upgrades to the activated sludge and secondary clarification processes. The alternative includes the expansion of the activated sludge process and additional secondary clarifier capacity, as well as the implementation of an anaerobic selector for more efficient treatment and control of filamentous bacteria and the promotion of beneficial bacteria growth. Each of the four alternatives evaluated and discussed herein were designed to

produce a higher quality of effluent to allow for the efficient implementation of effluent disinfection. This resulting increase in treatment allows for the successful implementation of disinfection, which included the evaluation of ultraviolent (UV) and peracetic acid (PAA), ultimately resulting in the selection of PAA to complement the selection of the same disinfection method at the Stiles WWTF.

In addition, as discussed previously, this alternative allows for the decommissioning of the biotowers which are a known cause of odor complaints within the surrounding Industrial Park. The ability to adjust the treatment process, opposed to extensive odor control of the biotowers, allows the City to save on the long-term O&M of the addition of an odor control system.

The improvements associated with this alternative would include:

- Biotowers to be abandoned and media and equipment removed
- Additional aeration tank volume to increase treatment capacity. This includes the addition of approximately 11.2 MG of aeration tank volume.
- New secondary blower building and addition of blower capacity (4 – 2,500 HP blowers)
- Addition of 4 - 135 foot secondary clarifiers
- New RAS/WAS Pump Station (1 WAS/2 RAS pumps)
- Addition of an anaerobic selector (both existing and future activated sludge treatment train)
- New PAA disinfection system, including new contact basin, bulk storage and chemical feed facilities
- Electrical improvements for new treatment process
- Miscellaneous plant hydraulic improvements

As shown in the attached financial analysis in Section 8 of the Facilities Plan, this option had a sub-alternative of either implementing conventional activated sludge or step-feed activated sludge, which could reduce the amount of tankage required; however, the applicability of the

two options will not be defined until detailed design, if this alternative were selected for implementation. The conventional activated sludge upgrades were estimated at $149 million with the step-feed option being estimated at $143 million.

Alternative No. 3 – Upgrade Biotowers and Addition of Intermediate Clarifiers

The third alternative evaluated includes the retention and upgrading of the existing biotowers with new media, equipment and odor control system, as well as evaluation of what additional process modifications would be required for the downstream activated sludge process, with or without intermediate clarifiers, to achieve the previously defined project objectives. The upgraded biotowers would provide more efficient soluble BOD removal resulting in higher solids loading to the aeration tanks. Based on the loading, the addition of six intermediate clarifiers and associated pump station will be required to be added to assist in the solids reduction; and therefore, no additional activated sludge tankage or blower capacity is needed.

The improvements associated with this alternative would include:

- Biotowers to be upgraded and media and equipment replaced
- Addition of intermediate clarifiers prior to activated sludge process (6 – 164 foot intermediate clarifiers)
- New PAA disinfection system, including new contact basin, bulk storage and chemical feed facilities
- Electrical improvements for new treatment
- Miscellaneous plant hydraulic improvements

The process improvements allow the three defined project goals to be met and has an estimated capital costs of $152 million.

Alternative No. 3A – Upgrade Biotowers, Expanded Activated Sludge and PAA Disinfection Improvements

The City developed a slightly modified third alternative which we refer to as Alternative 3A. This alternative is a modification to the upgrading of the existing biotowers and includes improvements intended to increase the biological treatment capacity of the plant for influent flows up to 90 million gallons per day (MGD). Increasing the biological treatment capacity will require upgrades to the existing biotowers, including replacement of the existing wood media with new synthetic media for improved treatment efficiency, construction of a new RAS reaeration basin to increase the aeration capacity and constructing two new secondary clarifiers to replace the two existing, poorly performing clarifiers. The increased treatment will allow for the implementation of disinfection system utilizing peracetic acid (PAA). While PAA disinfection has a higher life-cycle cost than the UV system considered, the capital cost required to make UV a viable option for disinfection makes PAA the more cost-effective alternative. The implementation of PAA allows for more operational flexibility at the plant to adjust to changing treatment needs in the future. As previously mentioned, this alternative includes upgrades to the existing biotowers with new plastic module media and new distribution arms. Additionally, each biotower will be equipped with a ventilation system that will maximize treatment capability and reduce the likelihood for off-site odor impacts. This alternative also includes improvements to the odor control system at the plant headworks, replacement of the existing manual coarse screens at the head of the plant with mechanical screens and electrical improvements at the existing Effluent Pump Station.

The improvements associated with this alternative include:

- New RAS reaeration basin
- New secondary clarifiers (2 – 135 foot clarifiers)

- New PAA disinfection system, including new contact basin, bulk storage and chemical feed facilities
- Biotower improvements including new media and ventilation system
- Coarse screen replacement and associated appurtenances for screens removal
- Replacement of existing coarse bubble diffusers with fine bubble diffusers
- Odor control for plant headworks
- Effluent Pump Station electrical improvements
- Electrical improvements for new treatment
- Miscellaneous plant hydraulic improvements

The process improvements included in this alternative allow for the treatment capacity to be increased to 90 MGD and have an estimated capital cost of $136 M.

Alternative No. 4 – Chemically Enhanced Primary Treatment (CEPT), Upgrade Biotowers and Expanded Activated Sludge

The fourth alternative that was evaluated was the addition of Chemically Enhanced Primary Treatment (CEPT) to assist with the efficiency of the primary clarifiers, upgrade of the media and odor control of the existing biotowers, addition of aeration tank volume for activated sludge treatment, addition of a new RAS/WAS pump station and new secondary clarifiers. Due to the fact that the addition of CEPT does not allow for the removal of the biotowers or the lack of the required addition of aeration tank volume, the capital cost and annual operations and maintenance of this proposed alternative is the highest with cost of $153 million.

Based on the overall cost, this alternative was eliminated from consideration by the City.

6.3 – CHOSEN ALTERNATIVE

Selected Alternative

The City felt that Alternatives 2, 3 and 3A were all viable options to meet the stated goals of the wastewater treatment system expansion and implementation of the newly required effluent disinfection. Ultimately, the fact that Alternate 3A provides an additional level of increase of the treatment capacity of the plant compared to the other alternatives was a huge cost-benefit to the alternative. In addition, the alternative will upgrade and continue to utilize the existing biotowers which allows for the upgraded treatment process to remain similar in operations to the existing plant. These clear differentiators led to the selection of Alternative 3A as the selected final upgrade choice.

This alternative addresses the anticipated causes of off-site odor concerns and implements disinfection via PAA, which ensures the City will implement the same disinfection method at both of their WWTFs (same as the Stiles WWTF). The use of PAA, as the selected disinfectant, also reduces the power demands that were required with the potential implementation of UV. The final selection took the potential electrical savings into account.

In addition to the disinfection selection, Alternative 3A also includes the replacement of the existing course bubble diffusers within the existing aeration basins with fine bubble diffusers which will save the plant a significant amount of existing power consumption. By replacing the diffusers in the basins, the selected alternative requires no increase in the amount of blower capacity required at the plant, even with the additional air requirements for the new re-aeration tank.

This selected project is to be implemented entirely with the existing Maxson WWTF site and will not require any additional easements or land acquisition for construction. The estimated cost for the WWTF improvements is $136 million. Based on discussions with SRF regarding funding,

the City is anticipating the total loan amount from SRF to be $85 M funded over multiple fiscal years with the City funding the remaining anticipated $51 M.

T.E. Maxson WWTP							
Process Alternative Evaluation and Upgrades							
Cost Summary							
March 16, 2016							
Alternative			**Alt 2 - Expanded AS**		**Alt 3 - Biotowers & Intermediate Clarifiers**	**Alt 3A - Biotowers & RAS Reaeration**	**Alt 4 - CEPT, Biotowers, AS**
Option			**Conventional AS**	**Step Feed AS**	**Conventional AS**	**Conventional AS**	**Conventional AS**
CONSTRUCTION COST							
Liquid Process Construction							
	Site/Civil Work		$ 12,000,000	$ 12,000,000	$ 10,000,000	$ 10,000,000	$ 12,000,000
	Disinfection		$ 8,000,000	$ 8,000,000	$ 8,000,000	$ 8,000,000	$ 8,000,000
	Plant Hydraulics Improvements w/ Bypass		$ 10,000,000	$ 10,000,000	$ 6,000,000	$ 6,000,000	$ 10,000,000
	Liquids Process Improvements						
	Aeration Basins		$ 14,500,000	$ 10,000,000	$ -	$ -	$ 12,000,000
	Aeration Basin Diffuser Replacement		$ -	$ -	$ 5,000,000	$ 5,000,000	$ -
	Biotower Media and Distibution Arm		$ -	$ -	$ 20,000,000	$ 20,000,000	$ -
	RAS/WAS Pump Station		$ 2,000,000	$ 2,000,000	$ -	$ -	$ 2,000,000
	Blower/Electrical Building		$ 7,000,000	$ 7,000,000	$ -	$ -	$ 7,000,000
	Anaerobic Selector		$ 9,000,000	$ 9,000,000	$ -	$ -	$ 9,000,000
	Secondary Clarifiers		$ 7,000,000	$ 7,000,000	$ 4,500,000	$ 4,500,000	$ 7,000,000
	Intermediate Clarifiers		$ -	$ -	$ 17,000,000	$ -	$ -
	RAS Reaeration Basin		$ -	$ -	$ -	$ 8,000,000	$ -
	CEPT Facilities		$ -	$ -	$ -	$ -	$ 4,000,000
	Course Screen Replacement w/ Bypass		$ 5,500,000	$ 5,500,000	$ 5,500,000	$ 5,500,000	$ 5,500,000
	Headworks Odor Control Upgrades		$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000	$ 5,000,000
	Effluent PS Electrical Improvements		$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000
	Plant-Wide Electrical and Instrumentation		$ 12,000,000	$ 12,000,000	$ 12,000,000	$ 12,000,000	$ 12,000,000
	Total Direct Cost		**$ 92,250,000**	**$ 87,750,000**	**$ 93,250,000**	**$ 84,250,000**	**$ 93,750,000**
	Construction Contingency & Escalation	18.0%	$ 108,855,000	$ 103,545,000	$ 110,035,000	$ 99,415,000	$ 110,625,000
	Contractor GC Field General Conditions	10.0%	$ 119,740,500	$ 113,899,500	$ 121,038,500	$ 109,356,500	$ 121,687,500
	Contractor GC Indirects, Overhead & Profit	12.5%	$ 134,708,063	$ 128,136,938	$ 136,168,313	$ 123,026,063	$ 136,898,438
	Contractor Bonds and Insurance	2.0%	$ 137,402,224	$ 130,699,676	$ 138,891,679	$ 125,486,584	$ 139,636,406
TOTAL CONSTRUCTION COST			**$ 137,000,000**	**$ 131,000,000**	**$ 139,000,000**	**$ 125,000,000**	**$ 140,000,000**
	Design, Preconstruction and Construction Services	9%	$ 12,330,000	$ 11,790,000	$ 12,510,000	$ 11,250,000	$ 12,600,000
TOTAL CAPITAL COST			**$ 149,000,000**	**$ 143,000,000**	**$ 152,000,000**	**$ 136,000,000**	**$ 153,000,000**
	SRF Funded (Anticpated)		**$ 85,000,000**	**$ 85,000,000**	**$ 85,000,000**	**$ 85,000,000**	**$ 85,000,000**
	City Funded		**$ 64,000,000**	**$ 58,000,000**	**$ 67,000,000**	**$ 51,000,000**	**$ 68,000,000**

SECTION 7 – SELECTED PLAN DESCRIPTION

7.1 – DETAILED DESCRIPTION OF CHOSEN ALTERNATIVE

Project No. 1: T.E. Maxson WWTF Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970s and has undergone multiple improvements and upgrades since it was put into operation. Recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of peracetic acid (PAA) disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant.

The project will be located within the existing boundaries of the Maxson WWTF and will not require any additional land acquisition or easements. The estimated cost for the WWTF improvements is $136 million. Based on discussions with SRF regarding funding, the City is anticipating the total loan amount from SRF to be $85 M funded over multiple fiscal years with the City funding the remaining anticipated $51 M.

7.2 – PUBLIC INVOLVEMENT / PUBLIC MEETING

A public hearing will be held in which the T.E. Maxson WWTF project will be identified on a display map for public review and comment during the loan application process. Recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements, the City of Memphis anticipates that public comments will be favorable. Once the Clean Water State Revolving Fund loan application has been approved, the City will move forward with the improvements including an additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of PAA disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant.

SECTION 8 – PROJECT COSTS

8.1 – ESTIMATED CONSTRUCTION COSTS AND OVERALL PROJECT COSTS (AMENDED)

Project No. 1: T.E. Maxson WWTF Improvements

This project is located inside the existing Maxson WWTP site and will not require any additional easements or land acquisition. The estimated cost for the WWTF improvements is $136 million. Based on discussions with SRF regarding funding, the City is anticipating the total loan amount from SRF to be $85 M funded over multiple fiscal years with the City funding the remaining anticipated $51 M.

8.2 – PROPOSED FINANCING

The City of Memphis intends to finance the proposed T.E. Maxson WWTF project with funding obtained via the Clean Water State Revolving Fund Loan Program (SRFLP), for which this Facilities Plan has been written. Based on an analysis of the current sewer rate structure in place, it has been determined that this will generate the revenues required to repay the loan. The City of Memphis does not see any problems with repayment of the borrowed funds.

8.3 – PROJECTED OPERATING COSTS AND USER CHARGE STRUCTURE

The existing normal demand for the Memphis Sanitary Sewer System is 145 MGD. The City of Memphis believes that any additional operating costs incurred by the installation of the new treatment processes will be covered by the current sewer rate structure along with the implemented Additional Treatment Cost (ATC) resolution and will not result in additional fees or increases in the current rate structure for the present time.

The normal user charge structure should remain unchanged at present levels for the next few years. If current projects remain unchanged and the current SRF loans close as projected, a rate increase is projected in fiscal year 2017 to meet fiscal requirements. Per the City of Memphis Sewer Use Ordinance, which is available for review by the public via the City of Memphis website (http://www.cityofmemphis.org/pdf_forms/sewerUse013006.pdf), the sewer service volumetric charge is 2.267 cents per one thousand gallons of flow, with a seasonally adjusted sewer fee for the months of June, July, August, and September for a residential maximum of $35.00 per month. For other periods of the year the residential maximum is $50.00 per month and a residential minimum volume fee of $2.50 per month. There is also an additional charge to any customer (residential or commercial) who discharges wastewater with a strength greater than domestic sewerage levels. Historically, the City's sewer rates have been very stable. Prior to the sewer rate increase in 2010 (which resulted in the above-mentioned rates), the previous rate increases in 1982, 2004, 2008, and 2009. Refer to *APPENDIX B* at the end of this document.

SECTION 9 – ENVIRONMENTAL IMPACTS

9.1 – PLANNING AREA AND PROJECT AREA AND BRIEF PROJECT DESCRIPTION (AMENDED)

The **Planning Area** for this project is the current city limits of the City of Memphis. Previous SRF loan application planning areas have included the City of Memphis and adjacent unincorporated areas of Shelby County that are scheduled for annexation into the City of Memphis. New legislation adopted by the Tennessee legislature makes it much more problematic to annex unincorporated areas of Shelby County. Memphis City Council is also reluctant to extend infrastructure outside the current City limits. Accordingly, the planning area for this loan application is limited to the current City limits of Memphis.

Project No. 1: T.E. Maxson WWTF Improvements

The T.E. Maxson WWTF located at 2685 Steam Plant Road was constructed in the early 1970s and has undergone multiple improvements and upgrades since it was put into operation. Recent industrial growth within the southern service area of the City and the recent revisions to require disinfection in the NPDES permit have led the City to hire a consultant to look at the best options for the City to address these two requirements. The study led to the development of a recommended set of process and disinfection improvements at the plant to address effluent quality and future treatment capacity. In addition to the process and disinfection improvements, the improvements would be implemented to address on-going odor concerns. The improvements include the addition of additional aeration basin and secondary clarifier capacity for greater plant capacity, odor control, and installation of UV disinfection to meet the permit requirements, and miscellaneous piping, valves, pumps, and gates for connections to the existing plant. To adequately implement UV disinfection, the process improvements are

required to ensure the effluent quality allows the UV technology to adequately meet the permit requirements.

The project will be located within the existing boundaries of the Maxson WWTF and will not require any additional land acquisition or easements. The estimate for the project, including all required improvements, maintenance of operations during construction and the appropriate connections into the existing plant operation is estimated at $85 million dollars.

9.2 – PROJECT SPECIFIC IMPACTS

Project No. 1: T.E. Maxson WWTF Improvements

As discussed previously, the proposed T.E. Maxson WWTF Improvements project is located in a remote area of Southwest Memphis. The City anticipates that growth in the project area will be primarily industrial. The topography of the project area varies from generally flat, and the area is drained by the Mississippi River system. The soils in the project area are generally deep, consisting of sand, silt, clay, and gravel.

The City of Memphis anticipates no adverse impacts to historical or archeological features as a result of the proposed project. The State of Tennessee Department of Environment and Conservation Division of Archaeology and the Tennessee Historical Commission both required a review of the proposed project.

The City of Memphis anticipates no adverse impacts to threatened, endangered, or otherwise protected flora or fauna species as a result of the proposed project. According to information obtained from the website of the State of Tennessee Department of Environment and Conservation Division of Natural Areas (www.state.tn.us/environment/na), There are a few flora/fauna species listed with a state status of Endangered (E), Threatened (T), Special

Concern (S), or Deemed in need of management (D) including the following (common names are used herein) within the Nonconnah/Horn Lake Water Shed.:

Cedar Elm (S), Mississippi Kite (D), and Bald Eagle (D)

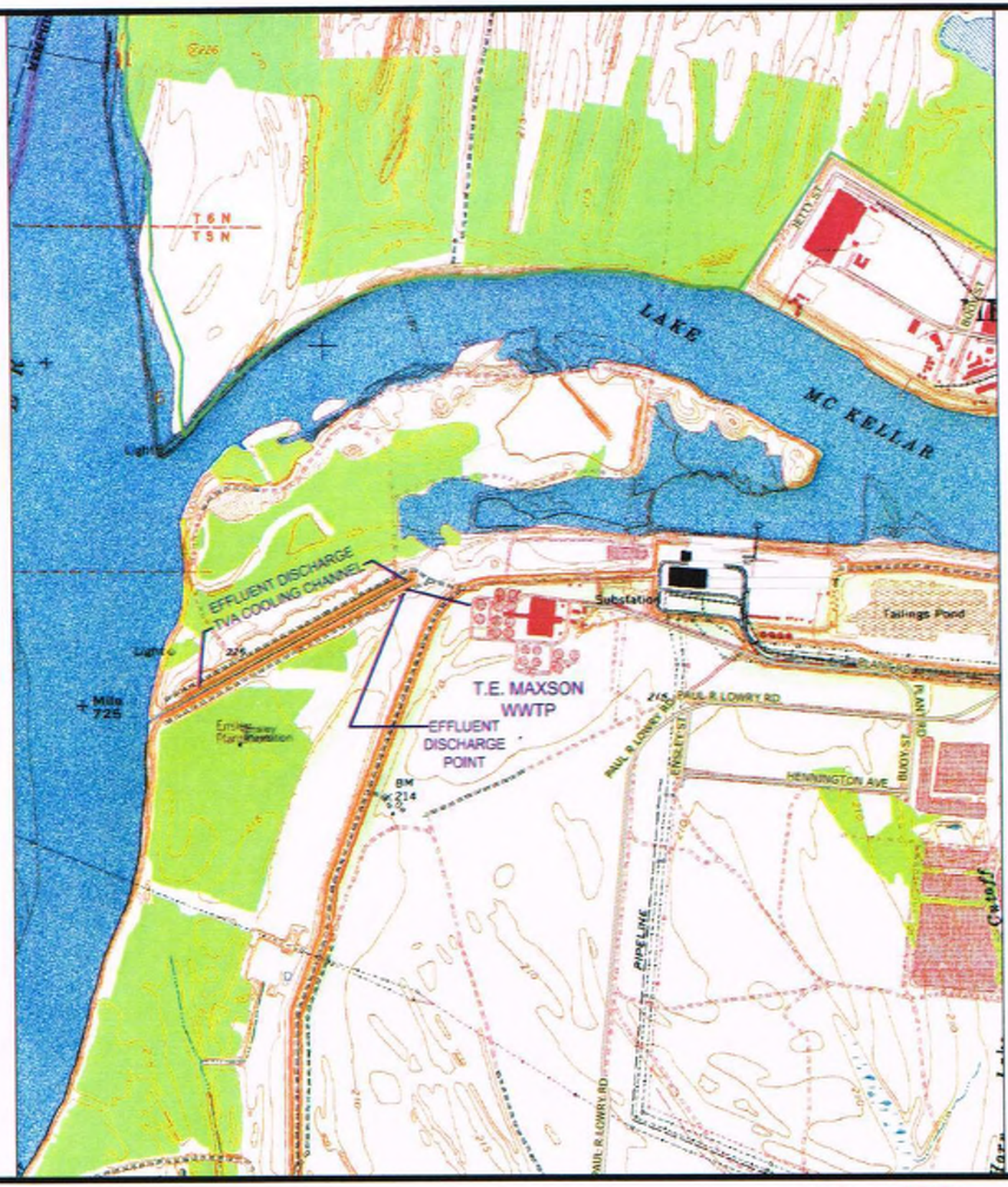
Locations of specific habitats of the above-mentioned flora and fauna species within the proposed project area, if any, are not known. The proposed project will disturb only areas within the confines of the Maxson WWTP property that is on previously disturbed ground impacted during the initial plant construction. Any disturbance will be temporary (only for the duration of the construction itself), and the disturbed areas will be returned as close to their pre-construction states as possible. However, should information be revealed during the design or construction of the proposed project regarding disturbance of habitats of any threatened or endangered species, all necessary procedures required by federal or state law will be taken to reduce or eliminate such disturbances.

The City of Memphis anticipates no adverse impacts to the community's water supply as a result of the proposed project. The City of Memphis does not obtain drinking water from any surface lakes or rivers. Rather, the water is obtained from the Memphis aquifer, which sits beneath Shelby County and contains more than 100 trillion gallons of water. This water is drawn via wells, filtered and treated, and distributed daily to its customers. The proposed project should not threaten the City's water supply. Furthermore, this project promotes cleaner surface waters and ground water by improving the treatment capabilities of the T.E. Maxson WWTP.

The City of Memphis anticipates no adverse impacts to Wild or Scenic Rivers or wetlands as there are no National or State Scenic or Wild Rivers in Shelby County and no jurisdictional wetlands in the project area. Also, the City of Memphis anticipates no long-term adverse

impacts to ambient air quality or fish and wildlife in the project area. While there may be temporary disturbances to air quality and fish and wildlife associated with normal construction activities, such as noise, dust, odor, and erosion, these impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, and restoring disturbed areas to their previous (or better than previous) condition.

Because the proposed project occurs in a remote area, the City of Memphis anticipates few adverse impacts to residential areas. No displacement of the population or alteration of the character of existing residential neighborhoods is expected. As stated previously, the only anticipated adverse environmental impacts are minor and temporary and include those associated with normal construction activities, such as noise, dust, odor, erosion, and inconvenience to nearby residents. These impacts should only last for the duration of work in any specific area, and certain construction practices will be employed to minimize these adverse impacts. Such techniques include, but are not limited to, limiting construction hours to avoid disturbing residents, maintaining good erosion control structures and best management practices (BMPs), notifying residents of construction activities, maintaining access to residences and businesses, and restoring disturbed areas to their previous (or better than previous) condition.



T.E. MAXSON WWTP
IMPROVEMENTS
MEMPHIS, TENNESSEE: FLETCHER LAKE QUADRANGLE MAP
SCALE: 1" = 2,000'

NORTH

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SECTION 10 – ENVIRONMENTAL JUSTICE CONCERNS

10.1 – IDENTIFICATION OF MINORITY AND LOW-INCOME POPULATIONS IN PROJECT AREA

Project No. 1: T.E. Maxson WWTF Improvements

The Project Area is located in a remote area of Southwest Memphis. There are no residential areas in the vicinity. There are no minority or low-income populations within the project area.

10.2 – EVALUATION OF DISPROPORTIONATE RISKS TO IDENTIFIED EJ POPULATIONS

Project No. 1: T.E. Maxson WWTF Improvements

There are no anticipated disproportionate risks to EJ populations associated with this project. The proposed project should benefit all residents of the City of Memphis by encouraging continued growth and development.

10.3 – IDENTIFICATION OF PUBLIC PARTICIPATION OPPORTUNITIES FOR IDENTIFIED EJ POPULATIONS

Project No. 1: T.E. Maxson WWTF Improvements

As stated in Section 7.2 – Public Involvement/Public Meetings, a public hearing will be held in which the project will be identified on a display map for public review and comment during the loan application process. All affected residents of Shelby County, including those in EJ populations, will have opportunity to offer comments, favorable or unfavorable, and ask questions concerning the proposed project. The City of Memphis anticipates that public comments will be favorable.

10.4 – EVALUATION OF ENVIRONMENTAL/HEALTH RISKS AMONG IDENTIFIED EJ POPULATIONS THAT MAY BE EXACERBATED BY PROPER CONSTRUCTION AND OPERATION OF THE SELECTED ALTERNATIVE

Project No. 1: T.E. Maxson WWTF Improvements

There are no anticipated environmental or health risks among EJ populations that will be exacerbated by proper construction and operation of the selected alternative. Certain construction practices will be employed to minimize minor adverse impacts associated with normal construction practices (refer to the ***Specific Impacts*** discussion in Section 9). Again, the proposed project should benefit all residents of the City of Memphis by encouraging continued growth and development.

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243

DEC 06 2011

Mr. Don Hudgins
Plant Administrator
City of Memphis Environmental Division
2303 N. Second St.
Memphis, TN 38127

Subject: **NPDES Permit No. TN0020729**
Memphis-TE Maxson STP South Plant
Memphis, Shelby County, Tennessee

Dear Mr. Hudgins:

In accordance with the provisions of the Tennessee Water Quality Control Act, Tennessee Code Annotated (T.C.A.), Sections 69-3-101 through 69-3-120, the Division of Water Pollution Control hereby issues the enclosed NPDES Permit. The continuance and/or reissuance of this NPDES Permit is contingent upon your meeting the conditions and requirements as stated therein.

Please be advised that a petition for permit appeal may be filed, pursuant to T.C.A. Section 69-3-105, subsection (i), by the permit applicant or by any aggrieved person who participated in the public comment period or gave testimony at a formal public hearing whose appeal is based upon any of the issues that were provided to the commissioner in writing during the public comment period or in testimony at a formal public hearing on the permit application. Additionally, for those permits for which the department gives public notice of a draft permit, any permit applicant or aggrieved person may base a permit appeal on any material change to conditions in the final permit from those in the draft, unless the material change has been subject to additional opportunity for public comment. Any petition for permit appeal under this subsection (i) shall be filed with the board within thirty (30) days after public notice of the commissioner's decision to issue or deny the permit.

If you have questions, please contact the Memphis Environmental Field Office at 1-888-891-TDEC; or, at this office, please contact Mr. Gary Davis at (615) 532-0649 or by E-mail at *Gary.Davis@tn.gov*.

Sincerely,

[redacted]

Vojin Janjić
Manager, Permit Section
Division of Water Pollution Control

P:WAT-3
Enclosure

cc: Permit Section File
Memphis Environmental Field Office (Eddy.Bouzeid@tn.gov)
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Mr. Gary B. Cohen, Special Counsel for Memphis, Hall & Associates, gcohen@hall-associates.com
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Ms. Katherine Terry, CPESC, ENSAFE, kterry@ensafe.com
Mr. Robert M. Todd, Fish and Wildlife Environmentalist, Tennessee Wildlife Resources Agency, Rob.Todd@tn.gov
Mr. George Ricks, EHS Coordinator, Buckeye Technologies Inc., george-ricks@bkitech.com

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Ms. Rebecca Hoffman, rhoffmann@hornershifrin.com
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Ms. Amy Cotter, Engineer II, ADEQ Water Division, cotter@adeq.state.ar.us
Mr. Bill Pretsch, [redacted]
Mr. Tommy Mallard, Survey Servicees Manager, Fisher & Arnold, Inc., tmallard@fisherarnold.com
Mr. Gene M. Bailey, P.E., Principal, Fisher & Arnold Environmental, gbailey@fisherarnold.com
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Mr. Kenneth Roberts, President, Valley Products Company, kroberts@valproco.com
Mr. Christopher Provost, CDM, provostca@cdm.com
Axel Ringe, Vice Conservation Chair, Sierra Club,[redacted]
Ms. Stephanie Matheny, Staff Attorney, Tennessee Clean Water Network, stephanie@tcwn.org
Mr. Dwan L. Gilliom, Director, City of Memphis, Division of Public Works, Dwan.Gilliom@memphistn.gov
Ms. Mary Wilder, , [redacted]
Mr. Michael Scott, Partner, Nutter McClennen & Fish LLP, mscott@nutter.com
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J. E. Holmes,[redacted]
Mr. James H. Baker, Chickasaw Group-TN Chapter Vice-Chair and TN Water Sentinels Project Leader, Tennesse Chapter-Sierra Club-Chickasaw Group, tn_water_sentinel@yahoo.com
Mr. Brandon W. Neuschafer, Bryan Cave LLP, bwneuschafer@bryancave.com
Mr. Peter Alfonso, Plant Manager, Memphis Utilities, peter.alfonso@memphistn.gov

STATE OF TENNESSEE

NPDES PERMIT

No. TN0020729

Authorization to discharge under the
National Pollutant Discharge Elimination System (NPDES)

Issued By

Tennessee Department of Environment and Conservation
Division of Water Pollution Control
401 Church Street
6th Floor, L & C Annex
Nashville, Tennessee 37243-1534

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the delegation of authority from the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.)

Discharger:	**Memphis-T. E. Maxson STP**
Is authorized to discharge:	**treated municipal wastewater from Outfall 001**
From a facility located:	**in Memphis, Shelby County, Tennessee**
To receiving waters named:	**Mississippi River at Mile 725.0**

In accordance with effluent limitations, monitoring requirements and other conditions set forth herein.

This permit shall become effective on:	**January 1, 2012**
This permit shall expire on:	**December 31, 2016**
Issuance date:	**December 6, 2011**

[redacted]

Paul E. Davis, Director
Division of Water Pollution Control

CN-0759
(Template Rev. 1-05)

RDAs 2352 and 2366

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GMDa
TN0020729

1.0. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1.1. NUMERIC AND NARRATIVE EFFLUENT LIMITATIONS

The permittee is authorized to discharge its T.E. Maxson STP treated wastewater from Outfall 001 to the Mississippi River at Mile 725.0 via the local Cooling Water Channel (a wet weather conveyance) pursuant to the permit limitations and monitoring requirements specified in this section. The T.E. Maxson STP has a design capacity of 90 MGD.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
BOD_5	42	31,525	85	63	47,288	84		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	48	36,029	85	72	54,043	96		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Organic-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a) - during compliance schedule	Report					Report			Daily	grab	effluent
E. coli, cfu/100 ml (a) - following compliance schedule	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits following the compliance schedule presented in section 3.6 of this permit.
(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
Organic Pesticide Chemicals (b)	Report					Report			Annually	grab	effluent
Total Dioxin	0.000000001					0.000000001			Annually	composite	effluent
Heptachlor Epoxide	0.00019					0.00019			Annually	composite	effluent
Total Polychlorinated Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	composite	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Methyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexachlorobenzene	Report					Report			Annually	grab	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report (Survival for serial effluent dilutions)								Annually	grab	effluent
Outfall Observation, Visual (e)	Report								Daily	visual	(d)
Flow (MGD)	Report			Report		Report			Daily	continuous	influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewer Overflows, Total Occurrences	Report								continuous	visual	NA
Sewer Backups in Buildings Total Occurrences	Report								continuous	visual	NA
Dry Weather Overflows, Total Occurrences	Report								continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I, endosulfan II; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; PCBs, total chlordane; and toxaphene).
(d) Per Section 3.4.
(e) Permittee shall complete its visual observations pursuant to Section 3.5 of this permit

Total residual chlorine (TRC) and oxidants (TRO) monitoring shall be applicable when chlorine, bromine, or any other oxidants are added. The acceptable methods for analysis of TRC are any methods specified in Title 40 CFR, Part 136, as amended.

The permittee may collect more Outfall 001 discharge samples than specified as the monitoring frequency. *E. coli* samples may not be collected at intervals of less than 12 hours. For the purpose of determining the geometric mean, individual samples having an *E. coli* group concentration of less than one (1) cfu per 100 ml shall be considered as having a concentration of one (1) cfu per 100 ml.

There shall be no distinctly visible floating scum, oil or other matter contained in the wastewater discharge.

The wastewater discharge must not cause an objectionable color contrast in the receiving stream.

The wastewater discharge shall not contain pollutants in quantities that will be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.

Sludge or any other material removed by any treatment works must be disposed of in a manner that prevents its entrance into or pollution of any surface or subsurface waters. Additionally, the disposal of such sludge or other material must be in compliance with the Tennessee Solid Waste Disposal Act, TCA 68-31-101 et seq. and the Tennessee Hazardous Waste Management Act, TCA 68-46-101 et seq.

For the purpose of evaluating compliance with the permit limits established herein, where certain limits are below the state of Tennessee published required detection levels (RDLs) for any given effluent characteristics, the results of analyses below the RDL shall be reported as Below Detection Level (BDL), unless in specific cases other detection limits are demonstrated to be the best achievable because of the particular nature of the wastewater being analyzed. The BDL value shall be reported in the DMR “Comments” section.

For BOD_5 and TSS, the treatment facility shall demonstrate a minimum of 85% removal efficiency on a monthly average basis. The minimum removal efficiencies shall be calculated by determining an average of all daily influent concentrations and comparing this to an average of all daily effluent concentrations. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{average of daily effluent concentrations}}{\text{average of daily influent concentrations}} \right] \right] \times 100\% = \%\ \text{removal}$$

The treatment facility will also demonstrate 40% minimum removal of the BOD_5 and TSS based upon each daily composite sample. The formula for this calculation is as follows:

$$\left[1 - \left[\frac{\text{daily effluent concentrations}}{\text{daily influent concentrations}} \right] \right] \times 100\% \quad = \%\ \text{removal}$$

1.2. MONITORING PROCEDURES

1.2.1. Representative Sampling

Appropriate flow measurement devices and/or division-approved methods consistent with accepted scientific practices shall be used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements is consistent with accepted capability of that type of device. Devices and methods used shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes.

Samples and measurements taken in compliance with the monitoring requirements specified above shall be representative of the volume and nature of the monitored discharge, and shall be taken at the following location(s):

Influent samples must be collected prior to mixing with any other wastewater being returned to the head of the plant, such as return sludge. Those systems with more than one influent line must collect samples from each and proportion the results by the flow from each line. However, as long as the sludge lagoon supernatant is discharged into interceptors ahead of the STP, the influent samples may be collected after the sludge lagoon supernatant return. The permittee must submit an Influent Flow Assessment Report to the division, which relates the quality and quantity of the supernatant stream within sixty (60) days of permit effective date. Otherwise, the influent samples must be collected ahead of the influent's mixing with any other wastestreams being returned to the head of the plant. Additionally, systems with more than one influent line must collect samples from each and proportion the results by the flow from each line.

Effluent samples must be representative of the wastewater being discharged and collected prior to mixing with any other discharge or the receiving stream. This can be a different point for different parameters, but must be after all treatment for that parameter or all expected change:

a. If chlorination is used for disinfection, final effluent BOD_5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD_5 testing procedures approved by the division for its treated effluent analyses.

b. The chlorine residual must be measured after the chlorine contact chamber and any dechlorination. It may be to the advantage of the permittee to measure at the end of any long outfall lines.

c. Samples for *E. coli* can be collected at any point between disinfection and the actual discharge.

d. The dissolved oxygen can drop in the outfall line; therefore, D.O. measurements are required at the discharge end of outfall lines greater than one mile long. Systems with outfall lines less than one mile may measure dissolved oxygen as the wastewater leaves the treatment facility. For systems with dechlorination, dissolved oxygen must be measured after this step and as close to the end of the outfall line as possible.

e. Total suspended solids and settleable solids can be collected at any point after the final clarifier.

f. Biomonitoring tests shall be conducted on final effluent.

1.2.2. Sampling Frequency

Where the permit requires sampling and monitoring of a particular effluent characteristic(s) at a frequency of less than once per day or daily, the permittee is precluded from marking the “No Discharge” block on the Discharge Monitoring Report if there has been any discharge from that particular outfall during the period which coincides with the required monitoring frequency; i.e. if the required monitoring frequency is once per month or 1/month, the monitoring period is one month, and if the discharge occurs during only one day in that period then the permittee must sample on that day and report the results of analyses accordingly.

1.2.3. Test Procedures

a. Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304 (h) of the Clean Water Act (the "Act"), as amended, under which such procedures may be required. The treated effluent total mercury shall be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630. For monitoring PCBs the permittee shall use EPA Method 1668B.

b. Unless otherwise noted in the permit, all pollutant parameters shall be determined according to methods prescribed in Title 40 CFR Part 136, as amended, promulgated pursuant to Section 304 (h) of the Act, using sufficiently sensitive testing to demonstrate permit compliance, and/or best achievable methods for permit reporting requirements. The permittee shall obtain written division approval for using analytical procedures not provided in Title 40 CFR Part 136 for permit compliance.

c. Composite samples must be proportioned by flow at time of sampling. Aliquots may be collected manually or automatically. The sample aliquots must be maintained at less than or equal to 6 degrees Celsius during the compositing period.

1.2.4. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date and time of sampling;

b. The exact person(s) collecting samples;

c. The dates and times the analyses were performed;

d. The person(s) or laboratory who performed the analyses;

e. The analytical techniques or methods used, and;

f. The results of all required analyses.

1.2.5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation shall be retained for a minimum of three (3) years, or longer, if requested by the Division of Water Pollution Control.

1.3. REPORTING

1.3.1. Monitoring Results

Monitoring results shall be recorded monthly and submitted monthly using Discharge Monitoring Report (DMR) forms or an electronic program supplied by the Division of Water Pollution Control. Submittals shall be postmarked or sent electronically no later than 15 days after the completion of the reporting period. The top two copies of each report are to be submitted. A copy should be retained for the permittee's files. DMRs and any communication regarding compliance with the conditions of this permit must be sent to:

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
COMPLIANCE REVIEW SECTION
401 CHURCH STREET
L & C ANNEX 6TH FLOOR
NASHVILLE TN 37243-1534

The first DMR is due on the 15th of the month following permit effectiveness.

DMRs and any other report or information submitted to the division must be signed and certified by a responsible corporate officer as defined in 40 CFR 122.22, a general partner or proprietor, or a principal municipal executive officer or ranking

elected official, or his duly authorized representative. Such authorization must be submitted in writing and must explain the duties and responsibilities of the authorized representative.

The electronic submission of DMRs will be accepted only if approved in writing by the division. For purposes of determining compliance with this permit, data submitted in electronic format is legally equivalent to data submitted on signed and certified DMR forms.

1.3.2. Additional Monitoring by Permittee

If the permittee monitors any pollutant specifically limited by this permit more frequently than required at the location(s) designated, using approved analytical methods as specified herein, the results of such monitoring shall be included in the calculation and reporting of the values required in the DMR form. Such increased frequency shall also be indicated on the form.

1.3.3. Falsifying Results and/or Reports

Knowingly making any false statement on any report required by this permit or falsifying any result may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Water Pollution Control Act, as amended, and in Section 69-3-115 of the Tennessee Water Quality Control Act.

1.3.4. Monthly Report of Operation

Monthly operational reports (MORs) shall be submitted on standard forms to the appropriate Division of Water Pollution Control Environmental Field Office in Jackson, Nashville, Chattanooga, Columbia, Cookeville, Memphis, Johnson City, or Knoxville. Reports shall be submitted by the 15th day of the month following data collection.

1.3.5. Bypass and Overflow Reporting

1.3.5.1. Report Requirements

A summary report of known or suspected instances of overflows in the collection system or bypass of wastewater treatment facilities shall accompany the Discharge Monitoring Report. The report must contain the date and duration of the instances of overflow and/or bypassing and the estimated quantity of wastewater released and/or bypassed. The report must separately list which overflows flowed into buildings.

The report must also detail activities undertaken during the reporting period to (1) determine if overflow is occurring in the collection system, (2) correct those known or suspected overflow points and (3) prevent future or possible overflows and any resulting bypassing at the treatment facility.

On the DMR, the permittee must report the number of sanitary sewer overflows, dry-weather overflows and in-plant bypasses separately. Three lines must be used on the DMR form, one for sanitary sewer overflows, one for dry-weather overflows and one for in-plant bypasses.

1.3.5.2. Anticipated Bypass Notification

If, because of unavoidable maintenance or construction activities, the permittee has a need to create an in-plant bypass which would cause an effluent violation, the permittee must notify the division as soon as possible (the division requires 10 days prior to bypass notification, unless it is not possible e.g., pipe break, in which case, as soon as possible notification is warranted).

1.3.6. Reporting Less Than Detection

A permit limit may be less than the accepted detection level. If the samples are below the detection level, then report “BDL” or “NODI =B” on the DMRs. The permittee must use the correct detection levels in all analytical testing required in the permit. The required detection levels are listed in the Rules of the Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3-.05(8).

For example, if the limit is 0.02 mg/l with a detection level of 0.05 mg/l and detection is shown; 0.05 mg/l must be reported. In contrast, if nothing is detected reporting “BDL” or “NODI =B” is acceptable.

1.4. COMPLIANCE WITH SECTION 208

The limits and conditions in this permit shall require compliance with an area-wide waste treatment plan (208 Water Quality Management Plan) where such approved plan is applicable.

1.5. REOPENER CLAUSE

This permit shall be modified, or alternatively revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under Sections 301(b)(2)(C) and (D), 307(a)(2) and 405(d)(2)(D) of the Clean Water Act, as amended, if the effluent standard, limitation or sludge disposal requirement so issued or approved:

a. Contains different conditions or is otherwise more stringent than any condition in the permit; or

b. Controls any pollutant or disposal method not addressed in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

The division shall be able to modify this permit to incorporate appropriate changes based on Outfall 001 treated effluent ammonia-nitrogen, chlorinated byproducts, total residual chlorine/oxidants and acute biomonitoring results. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. Pursuant to the permittee's request/justification the division may modify the permit if appropriate to limit the TRO to halogenated oxidants only.

All permit modifications shall be subject to applicable public participation requirements.

2.0 GENERAL PERMIT REQUIREMENTS

2.1. GENERAL PROVISIONS

2.1.1. Duty to Reapply

Permittee is not authorized to discharge after the expiration date of this permit. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information and forms as are required to the Director of Water Pollution Control (the "director") no later than 180 days prior to the expiration date. Such forms shall be properly signed and certified.

2.1.2. Right of Entry

The permittee shall allow the director, the Regional Administrator of the U.S. Environmental Protection Agency, or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or where records are required to be kept under the terms and conditions of this permit, and at reasonable times to copy these records;

b. To inspect at reasonable times any monitoring equipment or method or any collection, treatment, pollution management, or discharge facilities required under this permit; and

c. To sample at reasonable times any discharge of pollutants.

2.1.3. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, as amended, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division of Water Pollution Control. As required by the Federal Act, effluent data shall not be considered confidential.

2.1.4. Proper Operation and Maintenance

a. The permittee shall at all times properly operate and maintain all facilities and systems (and related appurtenances) for collection and treatment which are installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance also includes adequate laboratory and process controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems, which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit. Backup continuous pH and flow monitoring equipment are not required.

b. Dilution water shall not be added to comply with effluent requirements to achieve BCT, BPT, BAT and or other technology based effluent limitations such as those in State of Tennessee Rule 1200-4-5-.09.

2.1.5. Treatment Facility Failure (Industrial Sources)

The permittee, in order to maintain compliance with this permit, shall control production, all discharges, or both, upon reduction, loss, or failure of the treatment facility, until the facility is restored or an alternative method of treatment is provided. This requirement applies in such situations as the reduction, loss, or failure of the primary source of power.

2.1.6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state, or local laws or regulations.

2.1.7. Severability

The provisions of this permit are severable. If any provision of this permit due to any circumstance, is held invalid, then the application of such provision to other circumstances and to the remainder of this permit shall not be affected thereby.

2.1.8. Other Information

If the permittee becomes aware of failure to submit any relevant facts in a permit application, or of submission of incorrect information in a permit application or in any

report to the director, then the permittee shall promptly submit such facts or information.

2.2. CHANGES AFFECTING THE PERMIT

2.2.1. Planned Changes

The permittee shall give notice to the director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants, which are subject neither to effluent limitations in the permit, nor to notification requirements under 40 CFR 122.42(a)(1).

2.2.2. Permit Modification, Revocation, or Termination

a. This permit may be modified, revoked and reissued, or terminated for cause as described in 40 CFR 122.62 and 122.64, Federal Register, Volume 49, No. 188 (Wednesday, September 26, 1984), as amended.

b. The permittee shall furnish to the director, within a reasonable time, any information which the director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the director, upon request, copies of records required to be kept by this permit.

c. If any applicable effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established for any toxic pollutant under Section 307(a) of the Federal Water Pollution Control Act, as amended, the director shall modify or revoke and reissue the permit to conform to the prohibition or to the effluent standard, providing that the effluent standard is more stringent than the limitation in the permit on the toxic pollutant. The permittee shall comply with these effluent standards or prohibitions within the time provided in the regulations that establish these standards or prohibitions, even if the permit has not yet been modified or revoked and reissued to incorporate the requirement.

d. The filing of a request by the permittee for a modification, revocation, reissuance, termination, or notification of planned changes or anticipated noncompliance does not halt any permit condition.

2.2.3. Change of Ownership

This permit may be transferred to another party (provided there are neither modifications to the facility or its operations, nor any other changes which might affect the permit limits and conditions contained in the permit) by the permittee if:

a. The permittee notifies the director of the proposed transfer at least 30 days in advance of the proposed transfer date;

b. The notice includes a written agreement between the existing and new permittees containing a specified date for transfer of permit responsibility, coverage, and liability between them; and

c. The director, within 30 days, does not notify the current permittee and the new permittee of his intent to modify, revoke or reissue, or terminate the permit and to require that a new application be filed rather than agreeing to the transfer of the permit.

Pursuant to the requirements of 40 CFR 122.61, concerning transfer of ownership, the permittee must provide the following information to the division in their formal notice of intent to transfer ownership: 1) the NPDES permit number of the subject permit; 2) the effective date of the proposed transfer; 3) the name and address of the transferor; 4) the name and address of the transferee; 5) the names of the responsible parties for both the transferor and transferee; 6) a statement that the transferee assumes responsibility for the subject NPDES permit; 7) a statement that the transferor relinquishes responsibility for the subject NPDES permit; 8) the signatures of the responsible parties for both the transferor and transferee pursuant to the requirements of 40 CFR 122.22(a), “Signatories to permit applications”; and, 9) a statement regarding any proposed modifications to the facility, its operations, or any other changes which might affect the permit limits and conditions contained in the permit.

2.2.4. Change of Mailing Address

The permittee shall promptly provide to the director written notice of any change of mailing address. In the absence of such notice the original address of the permittee will be assumed to be correct.

2.3. NONCOMPLIANCE

2.3.1. Effect of Noncompliance

All discharges shall be consistent with the terms and conditions of this permit. Any permit noncompliance constitutes a violation of applicable state and federal laws and is grounds for enforcement action, permit termination, permit modification, or denial of permit reissuance.

2.3.2. Reporting of Noncompliance

a. 24-Hour Reporting

In the case of any noncompliance which could cause a threat to public drinking water supplies, or any other discharge which could constitute a threat to human health or the environment, the required notice of non-compliance shall be provided to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24-hours from the time the permittee becomes aware of the circumstances. (The Environmental Field Office should be contacted for names and phone numbers of environmental response team).

A written submission must be provided within five days of the time the permittee becomes aware of the circumstances unless the director on a case-by-case basis waives this requirement. The permittee shall provide the director with the following information:

i. A description of the discharge and cause of noncompliance;

ii. The period of noncompliance, including exact dates and times or, if not corrected, the anticipated time the noncompliance is expected to continue; and

iii. The steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. Scheduled Reporting

For instances of noncompliance which are not reported under subparagraph 2.3.2.a above, the permittee shall report the noncompliance on the Discharge Monitoring Report. The report shall contain all information concerning the steps taken, or planned, to reduce, eliminate, and prevent recurrence of the violation and the anticipated time the violation is expected to continue.

2.3.3. Overflow

a. "**Overflow**" means any discharge of sewage from any portion of the collection, transmission, or treatment system other than through permitted outfalls.

b. Overflows are prohibited.

c. The permittee shall operate the collection system so as to avoid overflows. No new or additional flows shall be added upstream of any point in the collection system, which experiences chronic overflows (greater than 5 events per year) or would otherwise overload any portion of the system.

d. Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after: 1) an authorized representative of the Commissioner of the Department of Environment and Conservation has approved an engineering report and construction plans and

specifications prepared in accordance with accepted engineering practices for correction of the problem; 2) the correction work is underway; and 3) the cumulative, peak-design, flows potentially added from new connections and line extensions upstream of any chronic overflow point are less than or proportional to the amount of inflow and infiltration removal documented upstream of that point. The inflow and infiltration reduction must be measured by the permittee using practices that are customary in the environmental engineering field and reported in an attachment to a Monthly Operating Report submitted to the local TDEC Environmental Field Office. The data measurement period shall be sufficient to account for seasonal rainfall patterns and seasonal groundwater table elevations.

e. In the event that more than 5 overflows have occurred from a single point in the collection system for reasons that may not warrant the self-imposed moratorium or completion of the actions identified in this paragraph, the permittee may request a meeting with the Division of Water Pollution Control EFO staff to petition for a waiver based on mitigating evidence.

2.3.4. Upset

a. "***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. An upset shall constitute an affirmative defense to an action brought for noncompliance with such technology-based permit effluent limitations if the permittee demonstrates, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   i. An upset occurred and that the permittee can identify the cause(s) of the upset;

   ii. The permitted facility was at the time being operated in a prudent and workman-like manner and in compliance with proper operation and maintenance procedures;

   iii. The permittee submitted information required under "Reporting of Noncompliance" within 24-hours of becoming aware of the upset (if this information is provided orally, a written submission must be provided within five days); and

   iv. The permittee complied with any remedial measures required under "Adverse Impact."

2.3.5. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to the waters of Tennessee resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2.3.6. Bypass

a. "***Bypass***" is the intentional diversion of wastewater away from any portion of a treatment facility. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which would cause them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

b. Bypasses are prohibited and the division may take enforcement action, unless all of the following 3 conditions are met:

   i. The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

   ii. There are no feasible alternatives to bypass, such as the construction and use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass, which occurred during normal periods of equipment downtime or preventative maintenance;

   iii. The permittee submits notice of an unanticipated bypass to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours of becoming aware of the bypass (if this information is provided orally, a written submission must be provided within five days). When the need for the bypass is foreseeable, prior notification shall be submitted to the director, if possible, at least 10 days before the date of the bypass.

c. Bypasses not exceeding permit limitations are allowed **only** if the bypass is necessary for essential maintenance to assure efficient operation. All other bypasses are subject to the prohibition in subsection (b) above. Allowable bypasses not exceeding limitations are not subject to the reporting requirements of 2.3.6.b.iii, above.

2.3.7. Washout

a. For domestic wastewater plants only, a "washout" shall be defined as loss of Mixed Liquor Suspended Solids (MLSS) of 30.00% or more. This refers to the MLSS in the aeration basin(s) only. This does not include MLSS decrease due to

solids wasting to the sludge disposal system. A washout can be caused by improper operation or from peak flows due to infiltration and inflow.

b. A washout is prohibited. If a washout occurs the permittee must report the incident to the Division of Water Pollution Control in the appropriate Environmental Field Office within 24 hours by telephone. A written submission must be provided within five days. The washout must be noted on the discharge monitoring report. Each day of a washout is a separate violation.

2.4. LIABILITIES

2.4.1. Civil and Criminal Liability

Except as provided in permit conditions for "***Bypassing***," "***Overflow,***" and "***Upset***," nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance. Notwithstanding this permit, the permittee shall remain liable for any damages sustained by the State of Tennessee, including but not limited to fish kills and losses of aquatic life and/or wildlife, as a result of the discharge of wastewater to any surface or subsurface waters. Additionally, notwithstanding this Permit, it shall be the responsibility of the permittee to conduct its wastewater treatment and/or discharge activities in a manner such that public or private nuisances or health hazards will not be created.

2.4.2. Liability Under State Law

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or the Federal Water Pollution Control Act, as amended.

3.0. PERMIT SPECIFIC REQUIREMENTS

3.1. CERTIFIED OPERATOR

The waste treatment facilities shall be operated under the supervision of a certified wastewater treatment operator and the collection system shall be operated under the supervision of a certified collection system operator in accordance with the Water Environmental Health Act of 1984.

3.2. POTW PRETREATMENT PROGRAM

As an update of information previously submitted to the division, the permittee will undertake the following activity.

a. The permittee has been delegated the primary responsibility and therefore becomes the "control authority" for enforcing the 40 CFR 403 General Pretreatment Regulations. Where multiple plants are concerned the permittee is

responsible for the Pretreatment Program for all plants within its jurisdiction. The permittee shall implement and enforce the Industrial Pretreatment Program in accordance with Section 403(b)(8) of the Clean Water Act, the Federal Pretreatment Regulations 40 CFR 403, Tennessee Water Quality Control Act Part 63-3-123 through 63-3-128, and the legal authorities, policies, procedures, and financial provisions contained in its approved Pretreatment Program, except to the extent this permit imposed stricter requirements. Such implementation shall require but not limit the permittee to do the following:

i. Carry out inspection, surveillance, and monitoring procedures, which will determine, independent of information supplied by the industrial user (IU), whether the IU is in compliance with the pretreatment standards;

ii. Require development, as necessary, of compliance schedules for each IU for the installation of control technologies to meet applicable pretreatment standards;

iii. Require all industrial users to comply with all applicable monitoring and reporting requirements outlined in the approved pretreatment program and IU permit;

iv. Maintain and update, as necessary, records identifying the nature and character of industrial user discharges, and retain such records for a minimum of three (3) years;

v. Obtain appropriate remedies for noncompliance by an IU with any pretreatment standard and/or requirement;

vi. Publish annually, pursuant to 40 CFR 403.8 (f)(2)(viii), a list of industrial users that have significantly violated pretreatment requirements and standards during the previous twelve-month period.

vii. Maintain an adequate revenue structure for continued operation of the pretreatment program.

viii. Update its Industrial Waste Survey at least once every five years. Results of this update shall be submitted to the Division of Water Pollution Control, Pretreatment Section within 120 days of the effective date of this permit.

ix. Submit a written technical evaluation of the need to revise local limits within 120 days of the effective date of this permit to the state pretreatment program coordinator. The evaluation should consider the most recent pass-through limits proposed by the division. The technical evaluation shall be based on practical and specialized knowledge of the local program and not be limited by a specified written format.

b. The permittee shall enforce 40 CFR 403.5, "prohibited discharges". Pollutants introduced into the POTW by a non-domestic source shall not cause pass through or interference as defined in 40 CFR Part 403.3. These general

prohibitions and the specific prohibitions in this section apply to all non-domestic sources introducing pollutants into the POTW whether the source is subject to other National Pretreatment Standards or any state or local pretreatment requirements.

Specific Prohibitions. Under no circumstances shall the permittee allow introduction of the following wastes in the waste treatment system:

i. Pollutants which create a fire or explosion hazard in the POTW;

ii. Pollutants which will cause corrosive structural damage to the treatment works, but in no case discharges with pH less than 5.0 unless the system is specifically designed to accept such discharges.

iii. Solid or viscous pollutants in amounts which will cause obstruction to the flow in the treatment system resulting in interference.

iv. Any pollutant, including oxygen-demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause interference with the treatment works.

v. Heat in amounts which will inhibit biological activity in the treatment works resulting in interference, but in no case heat in such quantities that the temperature at the treatment works exceeds 40°C (104°F) unless the works are designed to accommodate such heat.

vi. Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal.

vii. Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through;

viii. Pollutants which result in the presence of toxic gases, vapors or fumes within the POTW in a quantity that may cause worker health and safety problems;

ix. Any trucked or hauled pollutants except at discharge points designated by the POTW.

c. The permittee shall notify the Tennessee Division of Water Pollution Control of any of the following changes in user discharge to the system no later than 30 days prior to change of discharge:

i. New introductions into such works of pollutants from any source which would be a new source as defined in Section 306 of the Act if such source were discharging pollutants.

ii. New introductions of pollutants into such works from a source which would be subject to Section 301 of the "Federal Water Pollution Control Act" if it were discharging such pollutants.

iii. A substantial change in volume or character of pollutants being introduced into such works by a source already discharging pollutants into such works at the time the permit is issued.

This notice will include information on the quantity and quality of the wastewater introduced by the new source into the publicly owned treatment works, and on any anticipated impact on the effluent discharged from such works. If this discharge necessitates a revision of the current NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization.

d. Reporting Requirements

The permittee shall provide an annual report briefly describing the permittee's pretreatment program activities over the previous calendar year. The report shall be submitted to the Division of Water Pollution Control, Central Office and a copy to the appropriate Environmental Field Office no later than the 50 days after the end of the reporting period. For control authorities with multiple STPs, one report should be submitted with a separate Form 1 for each STP. Each report shall conform to the format set forth in the state's POTW Pretreatment Semiannual Report Package which contains information regarding (note that the permittee is required to complete and submit an "Annual" rather than a "Semiannual" report):

i. An updated listing of the permittee's industrial users (including information required pursuant to 403.12(i)(1) (e.g., deletions and additions, categorical standards applied, local standards more stringent than categorical standards, and standards applied to each industrial user).

ii. Results of sampling of the influent and effluent of the wastewater treatment plant. At least semiannually during each calendar year, the permittee shall analyze the wastewater treatment plant influent and effluent for the following pollutants, using the prescribed sampling procedures:

Pollutant	**Sample Type**
chromium, trivalent	24-hour composite
chromium, hexavalent	24-hour composite
copper	24-hour composite
lead	24-hour composite
nickel	24-hour composite
zinc	24-hour composite
cadmium	24-hour composite
mercury	24-hour composite
silver	24-hour composite
total phenols	grab
cyanide	grab

If any particular pollutant is analyzed more frequently than is required, the permittee shall report the maximum and average values in its annual report. All upsets, interferences, and pass-through violations must also be reported in the annual report, the actions that were taken to determine the causes of the incidents, and the steps taken to prevent the incidents from recurring.

At least once during the term of the permit, the permittee shall analyze the effluent from the STP (and report the results in the corresponding annual report) for the following pollutants:

chromium, total	silver	phthalates, sum of the following: bis (2-ethylhexyl) phthalate butyl benzylphthalate di-n-butylphthalate diethyl phthalate
copper	benzene	
lead	carbon tetrachloride	
nickel	chloroform	
zinc	ethylbenzene	
cadmium	methylene chloride	tetrachloroethylene
mercury	naphthalene	toluene
phenols, total	1,1,1 trichloroethane	trichloroethylene
cyanide	1,2 trans-dichloroethylene	chromium, hexavalent
		chromium, trivalent

iii. Compliance with categorical and local standards, and review of industrial compliance, which includes a summary of the compliance status for all permitted industries. Also included is information on the number and type of major violations of pretreatment regulations, and the actions taken by the POTW to obtain compliance. The effluent from all significant industrial users must be analyzed for the appropriate pollutants at least once per reporting period.

iv. A list of industries in significant non-compliance as published in local newspapers in accordance with the requirements set forth in 40 CFR 403.8(f)(2)(viii).

v. A description of all substantive changes made to the permittee's pretreatment program. Any such changes shall receive prior approval. Substantive changes include, but are not limited to, any change in any ordinance, major modification in the program's administrative structure, local limits, or a change in the method of funding the program.

vi. Summary of permittee's industrial user inspections, which includes information on the number and type of industry inspected. All significant industrial users must be inspected at least once per year.

3.3. SLUDGE MANAGEMENT PRACTICES

a. The permittee must comply with 40 CFR 503 et seq. Sludge shall be sampled and analyzed at a frequency dependant both on the amount of sludge generated annually and on the disposal practice utilized. Whenever sampling and analysis

are required by 40 CFR 503, the permittee shall report to the division the quantitative data for the following parameters:

1)	Arsenic	7)	Nickel
2)	Cadmium	8)	Selenium
3)	Copper	9)	Zinc
4)	Lead	10)	Nitrite plus Nitrate, NO_2, + NO_3 as N
5)	Mercury	11)	Total Kjeldahl Nitrogen, as N
6)	Molybdenum	12)	Ammonia, NH_3, as N

This sludge analysis must be submitted by February 19th of each calendar year. This information shall be submitted to the Division of Water Pollution Control, Central Office, 401 Church Street, 6th Floor Annex, Nashville TN 37243-1534, Attention: Sludge Coordinator, Municipal Facilities Section.

b. Land application of sludge shall halt immediately if any of the following concentrations are exceeded:

POLLUTANT	CONCENTRATION (mg/kg[1])
Arsenic	75
Cadmium	85
Zinc	7500
Copper	4300
Lead	840

POLLUTANT	CONCENTRATION (mg/kg[1])
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100

1) Concentration on a Dry Weight Basis

Monthly average pollutant concentrations shall not exceed Table 3 of 40 CFR §503.13. If they are exceeded cumulative pollutant loading rates are to be calculated and recorded and shall not exceed Table 2 of 40 CFR §503.13 for the life of the land application site.

c. If land application is the final disposition of the wasted sludge, the permittee shall provide pathogen reduction, sludge stabilization and comply with land and crop usage controls as listed in 40 CFR Part 503, as authorized by the Clean Water Act. Records must be maintained by the permittee that indicate compliance or non-compliance with this rule. If the permittee is required to report to EPA, copies of all reports should be sent to the division, at the address listed in paragraph 1 of this section.

d. Before land applying municipal sludge the permittee must obtain approvals for each site(s) in writing from the division using the latest revision of Guidelines for Land Application or Surface Disposal of Biosolids, unless the sludge being land applied meets the pollutant concentrations of 40 CFR 503.13(b)(3), the Class A pathogen requirements in 40 CFR 503.32(a), and one of the vector attraction reduction requirements in 40 CFR 503.33 (b)(1) through (b)(8).

e. Reopener: If an applicable "acceptable management practice" or numerical limitation for pollutants in sewage sludge promulgated under Section 405(d)(2) of the Clean Water Act, as amended by the Water Quality Act of 1987, is more stringent than the sludge pollutant limit or acceptable management practice in this permit, or controls a pollutant not limited in this permit, this permit shall be promptly modified or revoked and reissued to conform to the requirements promulgated under Section 405(d)(2). The permittee shall comply with the limitations by no later than the compliance deadline specified in the applicable regulations as required by Section 405(d)(2) of the Clean Water Act.

f. Notice of change in sludge disposal practice: The permittee shall give prior notice to the director of any change planned in the permittee's sludge disposal practice. If land application activities are suspended permanently and sludge disposal moves to a municipal solid waste landfill, the permittee shall contact the local Division of Solid Waste Management office address for other permitting and approvals (see table below):

Division of Solid Waste Management			
Office	**Location**	**Zip Code**	**Phone No.**
Chattanooga	540 McCallie Avenue, Suite 550	37402-2013	(423) 634-5745
Jackson	1625 Hollywood Drive	38305	(731) 512-1300
Cookeville	1221 South Willow Avenue	38506	(931) 432-4015
Columbia	1421 Hampshire Pike	38401	(931) 380-3371
Johnson City	2305 Silverdale Road	37601	(423) 854-5400
Knoxville	2700 Middlebrook Pike, Suite 220	37921	(865) 594-6035
Memphis	8383 Wolf Lake Dr., Bartlett	38133	(901) 371-3000
Nashville	711 R.S. Gass Boulevard	37243-1550	(615) 687-7000

3.4. BIOMONITORING REQUIREMENTS

Pursuant to the Outfall 001 treated effluent monitoring presented in this permit, Section 1.1, the permittee shall complete 48-hour LC_{50} (acute toxicity testing annually) per to the requirements shown below within 120 days from the permit's effective date. Additionally, the permittee shall provide the division its permit renewal application at least four IC_{25} (chronic toxicity biomonitoring) scans using the dilution presented in this section. (Based on the permittee's written request and with prior division written approval, Mississippi River dilution water may be used for the acute and chronic whole effluent toxicity testing.)

3.4.1. 48-Hour LC_{50} Acute Biomonitoring Requirements

The permittee shall conduct a 48-hour static acute toxicity test on two test species on samples of final effluent from Outfall 001 within 120 days from the permit's effective date. The test species to be used are Water Fleas (*Ceriodaphnia dubia*) and Fathead Minnows (*Pimephales promelas*). The measured endpoint for toxicity will be the concentration causing 50% lethality (LC_{50}) of the test organisms. The LC_{50} shall be determined based on a 50% lethality as compared to the controls, and as derived from linear interpolation.

Tests shall be conducted and results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for 48-Hour LC50 Acute Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	**50**	**25**	**12.5**	**6.25**	**0**

The dilution/control water used will be hard water as described in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition). An acute standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests shall be conducted using four separate grab samples of final effluent, to be used in four separate tests, and shall be collected at evenly spaced (6-hour) intervals over a 24-hour period. The minimum 48-hr LC_{50} value (maximum acute toxicity) for the four separate tests shall be reported (for each species).

The test control (i.e., dilution water only) results will be considered a failure and its results invalid, if more than 10% of the test organisms die in 48 hours, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012 (or the most current edition), if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated within 2 weeks. Any test initiated, but terminated before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee must start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices and determination of effluent lethality values will be made in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analysis shall be compiled in a report. The report shall be written in accordance with Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, EPA-821-R-02-012, or the most current edition.

Two copies of biomonitoring reports (including follow-up reports) shall be submitted to the division. One copy of the report shall be submitted along with the discharge monitoring report (DMR). The second copy shall be submitted to the local Division of Water Pollution Control office address (see table below):

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER POLLUTION CONTROL
MEMPHIS ENVIRONMENTAL FIELD OFFICE
8383 WOLF LAKE DRIVE
BARTLETT TN 38133

3.4.2. Chronic Biomonitoring Requirements (For Permit Renewal Application)

For its permit renewal application, the permittee shall conduct four separate IC_{25} tests. Each test must be based on the 3-Brood Water Fleas (*Ceriodaphnia dubia)* survival and reproduction test) and the 7-Day Fathead Minnows *(Pimephales promelas)* larval survival and growth test using Outfall 001 final effluent samples.

The measured endpoint for toxicity will be the inhibition concentration causing 25% reduction in survival, reproduction and growth (IC_{25}) of the test organisms. The IC_{25} shall be determined based on a 25% reduction as compared to the controls, and as derived from linear interpolation. The average reproduction and growth responses will be determined based on the number of *Ceriodaphnia dubia* or *Pimephales promelas* larvae used to initiate the test.

Test shall be conducted and its results reported based on appropriate replicates of a total of five serial dilutions and a control, using the percent effluent dilutions as presented in the following table:

Treated Effluent Serial Dilutions for Chronic Whole Effluent Toxicity (WET) Testing					
% Effluent					
100	**50**	**25**	**12.5**	**6.25**	**0**

The dilution/control water used will be hard water as described in Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition). A chronic standard reference toxicant quality assurance test shall be conducted with each species used in the toxicity tests and the results submitted with the discharge monitoring report. Additionally, the analysis of this multi-concentration test shall include review of the concentration-response relationship to ensure that calculated test results are interpreted appropriately.

All tests will be conducted using a minimum of three 24-hour flow-proportionate composite samples of final effluent collected on days 1, 3 and 5. If, in any control more than 20% of the test organisms die in 7 days, the test (control and effluent) is considered a test control failure and invalid, and the test shall be repeated within two (2) weeks. Furthermore, if the results do not meet the acceptability criteria in Short-

Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013 (or the most current edition), or if the required concentration-response review fails to yield a valid relationship per guidance contained in Method Guidance and Recommendations for Whole Effluent Toxicity (WET) Testing, EPA-821-B-00-004 (or the most current edition), that test shall be repeated. Any test initiated but terminated before completion must also be reported along with a complete explanation for the termination.

In the event of a test control failure, the permittee shall start a follow-up test within 2 weeks and submit results from a follow-up test within 30 days from obtaining initial WET testing results. The follow-up test must be conducted using the same serial dilutions as presented in the corresponding table above. The follow-up test will not negate an initial failed test.

Test procedures, quality assurance practices, determinations of effluent survival/reproduction and survival/growth values, and report formats will be made in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Results of all tests, reference toxicant information, copies of raw data sheets, statistical analysis and chemical analyses shall be compiled in a report. The report will be written in accordance with Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms, EPA-821-R-02-013, or the most current edition.

Three copies of biomonitoring reports (including follow-up reports) shall be submitted to the division, included with the permittee's permit renewal application

3.5 VISUAL OUTFALL OBSERVATIONS

On a daily basis, when safety considerations reasonably permit a person to stand of top of the outfall structure, an observation shall be made and noted in an operations log, which would be maintained on site. The operations log should allow the operator to check the following boxes:

- Unsafe to make observation (yes/no)

Only if the answer to the above question is no, answer the following:

- Floatables present (yes/no)
- Scum present (yes/no)
- Foam present (yes/no)
- Oily slick present (yes/no)

3.6. OUTFALL 001 TREATED EFFLUENT *E. coli* COMPLIANCE ELEMENTS AND SCHEDULE

The following schedule provides the treated effluent *E.coli* disinfection work tasks, milestones and schedule:

Disinfection Compliance Schedule

Work Task	Milestone (a)	Submittal/ Completion (b)	Task Duration (c) (Months)	Division Review (Months)	Total (c) Per Task (Months)	Total (c) Overall (Months)
1. Develop disinfection investigation work plan						
	Disinfection Work Plan	No. 1	2	0.5	2.5	2.5
2. Conduct disinfection investigation (non-chlorination based)						
	Disinfection Report (if chlorination not selected)	No. 2A (d)	6	0.5	6.5	9
3. Conduct chlorination disinfection Investigation						
	Chlorination Disinfection Report	No. 2B (d)	6	0.5	6.5	15.5
4. Develop Disinfection Report						
	Disinfection Report (if chlorination selected)	No. 2C (d)	3	0.5	3.5	19
5. Design Disinfection System						
	Disinfection System Plans and Specs	No. 3	12	0.5	12.5	31.5
6. Develop Bid Documents/Bid						
	Bidding	No. 4	4	0.5	4.5	36
7. Disinfection System Facilities Construction						
	Construction	No. 6	18	0.5	18.5	54.5
8. Disinfection System Startup/Achieve Permit Limits						
	Functional Disinfection System	No. 7	3	0.5	3.5	58
	Total		**54**	**4**	**58**	

(a) The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved.

(b) The permittee shall provide the division with a written progress status report every 6 months pursuant this disinfection compliance schedule starting with the permit's effective date.

(c) Duration assuming sequential work task processing based on permit's effective date.

(d) As appropriate the Nos. 2A, 2B and 2C submittals must address results from the dechlorination investigations, antidegradation evaluations, and determinations as required pursuant to Section 3.6.1.

As shown in the above schedule, the permittee shall provide the division with a disinfection report that includes antidegradation documentation, including alternatives analyses, for any newly-formed Outfall 001 contaminants expected to be present above a *de minimis* amount.

3.6.1. Additional Permittee Submittals (If Chlorination Disinfection System Selected)

Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly-generated byproducts are related to TRC according to the compliance schedule provided in the table above (section 3.6).

3.7. PLACEMENT OF SIGNS

Within sixty (60) days of the effective date of this permit, the permittee shall place and maintain signs at the Outfall 001 treated effluent discharge point to the Cooling Water Channel, confluence with the Mississippi River, and any bypass/overflow point in the collection system. For the purposes of this requirement, any bypass/overflow point that has discharged five (5) or more times in the last year must be so posted. The sign(s) should be clearly visible to the public from the bank and the receiving stream. The minimum sign size should be two feet by two feet (2' x 2') with one-inch (1") letters. The sign should be made of durable material and have a white background with black letters.

The signs are to provide notice to the public as to the nature of the discharge and, in the case of the permitted outfalls, that the discharge is regulated by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control.

NPDES Permitted CSO or Unpermitted Bypass/Overflow Point:

UNTREATED SANITARY SEWER OVERFLOW WASTEWATER DISCHARGE POINT
Memphis - T.E. Maxson STP
(901) 576-4300
NPDES Permit NO. TN0020729
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

NPDES Permitted Municipal/Sanitary Outfall 001:

OUTFALL 001 DISCHARGE IS NON-DISINFECTED TREATED INDUSTRIAL/MUNICIPAL WASTEWATER WITH ELEVATED *E. coli*
Memphis-T.E. Maxson STP
(901) 576-4300
NPDES Permit NO. TN0020729
TENNESSEE DIVISION OF WATER POLLUTION CONTROL
1-888-891-8332 ENVIRONMENTAL FIELD OFFICE - Memphis

No later than sixty (60) days from the permit's effective date, the permittee shall have the above sign(s) on display at locations specified by the division's WPC Memphis Environmental Field Office.

3.8. WASTEWATER TREATMENT FACILITIES INTEGRITY EVALUATION

Within eighteen months from the permit's effective date the permittee shall submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities including any waterborne wastes and sludge storage/disposal units that are constructed of earthen material.

The structural integrity evaluation shall be completed by a professional engineer licensed in the State of Tennessee, an environmental management professional, or other expert who is qualified by education and/or experience to perform and/or oversee such evaluations. The report shall document that the permittee has evaluated the unit's structural integrity and shall include the permittee's planned structural integrity improvements, if warranted. The report shall also address measures implemented and planned by the permittee as appropriate to reduce the chances that said wastewater treatment facilities/units failure would result in an uncontrolled discharge to the receiving stream(s) under normal conditions.

Structural integrity evaluations of earthen basins and/or surface impoundments performed for compliance with other regulatory programs (e.g., Hazardous Waste Management under 1200-1-11, Solid Waste Management under 1200-1-7, or the Safe Dams Act) satisfy the provisions of this permit requirement.

3.9. ANTIDEGRADATION

Tennessee's Antidegradation Statement per Rule 1200-4-3-.06 provides for protecting existing receiving stream uses. The rule states that:

> "Where the quality of Tennessee waters is better than the level necessary to support propagation of fish, shellfish, and wildlife, and recreation in or on the water, that quality will be maintained and protected unless the state finds that, after intergovernmental coordination and public participation, that lowering water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

Evaluation of compliance with this rule shall be made on an individual parameter (pollutant) basis considering such factors as:

- The discharge quantity and/or pollutant loading represents a new condition, an expanded condition, or an existing condition;
- The receiving stream has unavailable conditions (is at or exceeds water quality criteria), available conditions (quality is better than the water quality criteria) or is defined as an Exceptional Tennessee Water or Outstanding Natural Resource Water;
- The discharge impact on the assimilative capacity of the receiving stream is considered *de minimis* or not *de minimis*.

The Mississippi River is considered an Exceptional Tennessee Water due to the presence of the federal endangered Pallid Sturgeon and the state threatened Blue Sucker. The T.E. Maxson STP is an existing discharger and this permit renewal includes no new or expanded flow quantity or pollutant loadings. Therefore, the discharge allowed by this permit is determined not to cause degradation and is not subject to alternatives analysis or socio-economic consideration required under the antidegradation rule. No future increase in design flow or pollutant loading will be allowed without compliance with the above analysis requirements and a determination that such increase is consistent with the above antidegradation rule. However, if the new end-of-pipe disinfection system will result in newly-formed Outfall 001 discharge contaminants above a *de minimis* amount (e.g., chlorinated byproducts if chlorination disinfection system used) the permittee must provide the division with appropriate antidegradation information.

4.0. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

4.1. DEFINITIONS

A "***bypass***" is defined as the intentional diversion of waste streams from any portion of a treatment facility.

A "***calendar day***" is defined as the 24-hour period from midnight to midnight or any other 24-hour period that reasonably approximates the midnight to midnight time period.

A "***composite sample***" is a combination of not less than 4 influent or effluent portions, of at least 100 ml, collected over a 24-hour period. Under certain circumstances a lesser time period may be allowed, but in no case, less than 8 hours.

The "***daily maximum concentration***" is a limitation on the average concentration in units of mass per volume (e.g. milligrams per liter), of the discharge during any calendar day. When a proportional-to-flow composite sampling device is used, the daily concentration is the concentration of that 24-hour composite; when other sampling means are used, the daily concentration is the arithmetic mean of the concentrations of equal volume samples collected during any calendar day or sampling period.

"***Degradation***" means the alteration of the properties of waters by the addition of pollutants or removal of habitat. Alterations not resulting in the condition of pollution that are of a temporary nature or those alterations having de minimis impact (not measurable or less than 5 percent loss of assimilative capacity) will not be considered degradation. Degradation will not be considered de minimis if a substantial loss (more than 50 percent) of assimilative capacity has already occurred.

"***Discharge***" or "discharge of a pollutant" refers to the addition of pollutants to waters from a source.

A "***dry weather overflow***" is a type of sanitary sewer overflow and is defined as one day or any portion of a day in which unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall occurs and is not directly related to a rainfall event. Discharges from more than one point within a 24-hour period shall be counted as separate overflows.

An "***ecoregion***" is a relatively homogeneous area defined by similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables.

The "***geometric mean***" of any set of values is the nth root of the product of the individual values where "n" is equal to the number of individual values. The

geometric mean is equivalent to the antilog of the arithmetic mean of the logarithms of the individual values. For the purposes of calculating the geometric mean, values of zero (0) shall be considered to be one (1).

A "***grab sample***" is a single influent or effluent sample collected at a particular time.

The "***instantaneous maximum concentration***" is a limitation on the concentration, in milligrams per liter, of any pollutant contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***instantaneous minimum concentration***" is the minimum allowable concentration, in milligrams per liter, of a pollutant parameter contained in the wastewater discharge determined from a grab sample taken from the discharge at any point in time.

The "***monthly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

The "***monthly average concentration***", other than for *E. coli* bacteria, is the arithmetic mean of all the composite or grab samples collected in a one-calendar month period.

A "***one week period***" (or "***calendar-week***") is defined as the period from Sunday through Saturday. For reporting purposes, a calendar week that contains a change of month shall be considered part of the latter month.

"***Pollutant***" means sewage, industrial wastes, or other wastes.

A "***quarter***" is defined as any one of the following three-month periods: January 1 through March 31, April 1 through June 30, July 1 through September 30, and/or October 1 through December 31.

A "***rainfall event***" is defined as any occurrence of rain, preceded by 10 hours without precipitation that results in an accumulation of 0.01 inches or more. Instances of rainfall occurring within 10 hours of each other will be considered a single rainfall event.

A "***rationale***" (or "fact sheet") is a document that is prepared when drafting a NPDES permit or permit action. It provides the technical, regulatory and administrative basis for an agency's permit decision.

A "***reference site***" means least impacted waters within an ecoregion that have been monitored to establish a baseline to which alterations of other waters can be compared.

A "***reference condition***" is a parameter-specific set of data from regional reference sites that establish the statistical range of values for that particular substance at least-impacted streams.

A **"*sanitary sewer overflow (SSO*)"** is defined as an unpermitted discharge of wastewater from the collection or treatment system other than through the permitted outfall.

"***Sewage***" means water-carried waste or discharges from human beings or animals, from residences, public or private buildings, or industrial establishments, or boats, together with such other wastes and ground, surface, storm, or other water as may be present.

"***Severe property damage***" when used to consider the allowance of a bypass or SSO means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass or SSO. Severe property damage does not mean economic loss caused by delays in production.

"***Sewerage system***" means the conduits, sewers, and all devices and appurtenances by means of which sewage and other waste is collected, pumped, treated, or disposed.

A "***subecoregion***" is a smaller, more homogenous area that has been delineated within an ecoregion.

"***Upset***" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

The term, "***washout***" is applicable to activated sludge plants and is defined as loss of mixed liquor suspended solids (MLSS) of 30.00% or more from the aeration basin(s).

"***Waters***" means any and all water, public or private, on or beneath the surface of the ground, which are contained within, flow through, or border upon Tennessee or any portion thereof except those bodies of water confined to and retained within the limits of private property in single ownership which do not combine or effect a junction with natural surface or underground waters.

The "***weekly average amount***", shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar week when the measurements were made.

The "***weekly average concentration***", is the arithmetic mean of all the composite samples collected in a one-week period. The permittee must report the highest weekly average in the one-month period.

4.2. ACRONYMNS AND ABBREVIATIONS

1Q10 – 1-day minimum, 10-year recurrence interval
30Q5 – 30-day minimum, 5-year recurrence interval
7Q10 – 7-day minimum, 10-year recurrence interval
BAT – best available technology economically achievable
BCT – best conventional pollutant control technology
BDL – below detection level
BOD_5 – five day biochemical oxygen demand
BPT – best practicable control technology currently available
$CBOD_5$ – five day carbonaceous biochemical oxygen demand
CEI – compliance evaluation inspection
CFR – code of federal regulations
CFS – cubic feet per second
CFU – colony forming units
CIU – categorical industrial user
CSO – combined sewer overflow
DMR – discharge monitoring report
D.O. – dissolved oxygen
E. coli – *Escherichia coli*
EFO – environmental field office
LB (lb) - pound
IC_{25} – inhibition concentration causing 25% reduction in survival, reproduction and growth of the test organisms
IU – industrial user
IWS – industrial waste survey
LC_{50} – acute test causing 50% lethality
MDL – method detection level
MGD – million gallons per day
MG/L (mg/l) – milligrams per liter
ML – minimum level of quantification
ml – milliliter
MLSS – mixed liquor suspended solids
MOR – monthly operating report
NODI – no discharge
NOEC – no observed effect concentration
NPDES – national pollutant discharge elimination system
PL – permit limit
POTW – publicly owned treatment works
RDL – required detection limit
SAR – semi-annual [pretreatment program] report
SIU – significant industrial user
SSO – sanitary sewer overflow
STP – sewage treatment plant
TCA – Tennessee code annotated

TDEC – Tennessee Department of Environment and Conservation
TIE/TRE – toxicity identification evaluation/toxicity reduction evaluation
TMDL – total maximum daily load
TRC – total residual chlorine
TSS – total suspended solids
WQBEL – water quality based effluent limit

ADDENDUM TO RATIONALE

Memphis-T.E. Maxson STP
NPDES Permit No. TN0020729
Permit Writer: Gary Davis

This Addendum to Rationale includes the draft permit written comments (provided in the following appendices). To finalize the new permit, the division has abbreviated the comments and provided a response presented in **bold *italics*** font. The Rationale cannot be changed as a result of comments received during the public notice period. This "Addendum to Rationale" provides the basis for augmenting the draft permit's "Rationale" and finalizing the new permit.

A1. Permit Expiration Date should be 5 years from the issuance date – ***the division agrees and the new permit is issued on a 5 year term***.

A2. Section 1.1 – BOD & TSS – monthly and weekly mass limits are not necessary – ***the division agrees with the permittee's request; minimum percent removal of BOD and TSS on a monthly average and daily basis will be retained in the final permit.***

A3. Section 1.1 – E. coli Permit Limits – daily max should not be required since there's no bathing beach downstream of discharge – ***the division considers a daily maximum E. coli discharge limit to be appropriate since the relevant water quality requirements are for all receiving stream recreational usages. As such, the E. coli discharge limits are not subject to the existence of downstream bathing beaches.***

A4. Section 1.1 – Effective Date of E. coli Permit Limits and Monitoring Requirements - per permit footnote, must comply with limits within 36 months which does not say no monitoring required. Memphis wants "During the interim period, there are no E. coli limitations nor monitoring requirements." – ***the division considers its E. coli database to be very limited and E. coli monitoring will be required pursuant the new permit. E. coli discharge limits will be applicable following the permittee's disinfection system installation/startup/stabilization period. The permittee must inform the division in writing that it disinfection system is functional and it treated effluent is subject to the new permit's E. coli discharge limits.***

A5. Section 1.1 – Total Residual Chlorine or Oxidant Limits – premature to include TRC or TRO limits – wants limits removed/reopener for appropriate limit based on selected disinfectant & TRC calculated acute & chronic -> not TDEC's std technology–based TRC of 2.0 mg/L. – ***the division has finalized the permit to provide for its reopening for the inclusion of appropriate discharge parameter(s) limits/monitoring requirements pursuant to the specific disinfection system selected. Reopening the permit is subject to the division's applicable public participation procedures.***

A6. Section 1.1 – Addition of Benzidine and Hexachlorobenzene Monitoring – no basis for including parameters in permit. – ***the division has finalized the new permit to include***

annual monitoring requirements for Outfall 001 treated effluent benzidine and hexachlorobenzene. Benzidine is used in some dyes/pigments manufacturing/usage and the permittee has many relevant industrial users, which may be discharging benzidine. Hexachlorobenzene can be formed as a byproduct during solvents, pesticides and other chemicals manufacturing, and is required to be limited pursuant to OSPSF categorical pretreatment standards for toxic pollutants. The permittee has many industrial dischargers subject to OSPSF categorical pretreatment standards.

A7. Section 1.1- Addition of Visual Outfall Observations – daily observations to include "distinctly visible matter and/or objectionable instream color" standard is vague and subjective. Therefore, if not unsafe and if outfall pipe is not underwater, record yes/no for presence of floatables, scum, foam, oily slick. – ***the division agrees with the permittee request and the monitoring requirements are described in section 3.5 of the final permit.***

A8. Section 1.1 - Addition of Effluent Flow Monitoring – current permit influent only, effluent monitoring considered unnecessary and extremely difficult/expensive. – ***the current permit does include influent monitoring, however, per its Part I.B.1 the current permit also includes the following requirement: "Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated and maintained to insure that the accuracy of the measurements are consistent with accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of less than plus or minus 10% from the true discharge rates throughout the range of expected discharge volumes." As such, the new permit includes a requirement for the permittee to investigate the correlation between the "actual" influent and effluent flow rates. The permittee must determine options for actually monitoring effluent flow. The division understands that the permittee currently considers its influent flow rate to represent its effluent value. The permittee must submit to the division its influent/effluent flow report, including recommendations within 6 months from the new permit's effective date, upon which the division may reopen the permit for modification. The new permit's reopener clause was supplemented with the prior sentence to allow the division to make permit modifications if warranted, based on the permittee's influent/effluent flow report.***

A9. Section 1.1 – TRC Monitoring, p. 3 – would include H_2O_2 as other oxidants – too broad (want when chlorine, bromine or other halogenated oxidants added). – ***the new permit's reopener clause was changed to allow the division to account for the permittee's selected disinfection system and make appropriate permit adjustments.***

A10. Section 1.1 - Narrative standards, p. 3 – color/foam and other visible materials – related to designated uses and cannot omit qualifying language (e.g., "considering the nature and location of the water") – thus, TDEC - incumbent to include numerical color limit(s) and if not feasible then BMPs. – ***the division must apply narrative standard consistent with its rules for all permittees. Certainly, equivalent/more stringent***

permitting requirements can be applicable per the specific situation, e.g., to provide for warranted water quality improvements.

A12. Section 1.2.1.a – BOD5 effluent sampling location p. 5 – permittee wants to be able to collect final effluent BOD5 sample before disinfection for any disinfectant used. – ***Section 1.2.1.(a) of the final permit states: "If chlorination is used for disinfection, final effluent BOD5 samples can be collected before disinfection to avoid having to dechlorinate and seed the samples. If a non-chlorination-based oxidation process is used for effluent disinfection, the permittee shall use BOD5 testing procedures approved by the division for its treated effluent analyses.***"

A13. Section 1.2.3.a – mercury and methyl mercury analytical methods – requires non-routine techniques and additional expenses – considers it on-going research. – ***The designated uses of the receiving stream are not fully supported due to mercury in fish tissue. For that reason, the new permit simply requires annual monitoring of mercury and methyl-mercury.***

A14. Section 1.2.3.a – PCBs analytical method – low detection method not warranted as PCBs not found in 9 years of annual monitoring/not manufactured/used in US for decades. – ***The designated uses of the receiving stream are not fully supported due to presence of PCBs in the sediment and is subject to <u>TMDL requirements</u>. A more sensitive analytical method is required in order to confirm that facility is not contributing PCBs to the receiving stream.***

A15. Reporting requirements –Section 1.3.5.1 summary report to ID number of sanitary sewer overflows, dry weather overflows and in-plant bypasses and basement backups separately. DMR reporting only provides for sanitary sewer overflows, dry weather overflows and in-plant bypasses. "Suspected" instances should be deleted. – ***The division agrees to include a "Sewer Backups to Buildings" monitoring parameter in the new permit. The "Suspected" permit provision will be retained, since the division considers the requirement to be consistent with its other permits. The overflow permit language will not be based on a single rain event, as proposed by the permittee.***

A16 Section 1.5 – Reopener provisions – unclear why TDEC may want to be able to reopen permit to make changes to <u>E. coli</u> compliance schedule. – ***The language regarding E. Coli compliance schedule has been removed from the reopener provision.***

A17. Section 2.1.4 Proper Operation and Maintenance, p. 10 – the "standard" permit condition regulation does not address the "collection" system and can't be referenced/included since this would amount to a change from "standard". – ***The collection system is considered an integral part of the POTW. This language is consistent with all other municipal permits and will remain in the final permit.***

A18. Section 2.3.2 Reporting of Noncompliance, p. 13 – notification to state with 24 hr for "…threat to drinking water supplies, … threat to human health or the environment" - permittee wants clarification to note that such notice not required if overflow has been addressed within 24 hr. – ***The permit allows the permittee discretion to determine***

whether or not non-compliance remedied within 24 hours pose a threat to human health and environment.

A19. Section 2.3.3 – Overflow, p. 13 – overflow per rule based on "discharge" not "release" as in draft permit. Other "releases" not addressed by standard permit conditions nor rules. New permit must provide compliance schedule (requesting 20 years) if no feasible alternative to overflow. State has established a new zero discharge technology-based standard for the collection system. – ***The word "release" was replaced with the word "discharge" in the final permit.***

A20. Section 2.3.6.c – Bypasses, p. 16 – "All other bypasses are prohibited" should be changed to "All other bypasses are subject to the prohibition in subsection (b) above." Which permittee notes say they are only prohibited if they do not meet the subsection (b)(i) through (iii) criteria. – ***The proposed language was included in the final permit.***

A21. Section 3.2(a)(ix) – Local Limit Evaluation, p. 18 – division's pass through limits have not been established by regulation/should be deleted – no document explaining the derivation of such limits and why those are appropriate for municipalities. – ***The language in Section 3.2.(a)(ix) of the final permit was changed to state: "The evaluation should consider the most recent pass-through limits proposed by the division."***

A22. Section 3.2(b)(vi) – Pretreatment, p. 18 – prohibit the IU discharge of "any priority pollutant in amounts that will contaminate the treatment works sludge" should be deleted as it is already addressed by the general prohibitions. - ***The language in Section 3.2.(b)(vi) of the final permit was changed to state: "Any priority pollutant in amounts that will cause interference with the treatment works sludge processes, use or disposal."***

A23. Section 3.2(c) – POTW Pretreatment Program, p. 19 – thirty day notification "If this discharge necessitates a revision of the NPDES permit or pass-through guidelines, discharge by this source is prohibited until the Tennessee Division of Water Pollution Control gives final authorization." - permittee wants quoted sentence deleted because no regulation basis. TDEC has failed to adopt it so-called "pass through guidelines" as a rule instead of using internal TDEC policy, therefore cannot be used to establish industrial user "violations". – ***Permit modification requirements are described in TN Rules, Chapter 1200-4-5-.08(2), which states: "All discharges authorized by the permit shall be consistent with the terms and conditions of the permit; that facility expansions, production increases, or process modifications which result in new or increased discharges of pollutants must be reported by submission of a new application or, if such discharge does not violate effluent limitations specified in the permit, by submission to the commissioner of notice of such new or increased discharges of pollutants; that the discharge of any pollutant more frequently than or at a level in excess of that identified and authorized by the permit shall constitute a violation of the terms and conditions of the permit." Therefore, the language in section 3.2(c) does not have its basis in pretreatment rules, but is derived from the requirement that all pollutant sources must be***

adequately identified and authorized through an NPDES permit prior to commencement of discharge.

A24. Section 3.4.1 and 3.4.2 Frequency of WET testing, pp. 23-27, wants automatic WET testing reduction to 2x/yr if 4 consecutive compliances reported. – ***the new permit includes report-only for WET testing, with 48-hr LC50 acute monitoring on an annual basis. The new permit's IC25 WET chronic testing (scans) is for the permit renewal application. Therefore, the division does not consider WET monitoring frequency reductions to be applicable.***

A26. Section 3.5 (section 3.6 in the final permit)

a) Bacteria compliance schedule – While the permittee agrees that compliance schedule for the treated effluent *E. coli* disinfection is necessary, the timeline should be reasonable so to encourage completion of project consistent with sound engineering practices and reflective of administrative procedures associated with a major financial commitment. – ***The division has accepted permittee's proposed disinfection compliance schedule, albeit with minor modifications, so that the project completion is not outside of mandatory 5 year permit issuance restriction. Pursuant to the permittee's request, the division agrees that a single sign at the Outfall 001 discharge will be required rather than the several signs as described in the draft permit.***

b) Disinfection byproducts research (draft requests Memphis to investigate universe of potential halogenated compounds, rather than a proposed disinfection byproducts list pursuant to known effects regarding designated river usages which are determined before studies are initiated and should be identified in (draft) permit. – ***the division considers newly-generated disinfection byproducts to potentially adversely impact the receiving stream's water quality. Also, the byproducts may increase the amounts of chemicals already identified as needing additional controls (e.g., dioxin, and chloroform) for the receiving stream. The division requires that the permittee identify for its selected E. coli control method, the resulting types/amount of newly-generated disinfection byproducts, and corresponding water quality/antidegradation (pursuant to the division's Chapter 1200-4-3-.06(4)(f)) implications. The list of disinfection byproducts of concern should, at a minimum, consider pollutants with published water quality criteria (TN Rules, Chapter 1200-4-3).***

c) effluent transport/dispersion study (Memphis studies not needed/should be deleted/no rationale, study requirements to vague/broad, any in-stream effluent plume definition should await modifications to existing outfall structure. Study monitoring plan/modeling approach, etc. should be defined and agreed upon and timeframe needed. – ***Considering that end-of-pipe water quality criteria is imposed on E. Coli (following compliance schedule) and other pollutants of concern, the division agrees that effluent transport/dispersion study does not have to be included in this permit. However, such study may be required in the next permit cycle, if deemed necessary.***

d) effluent diffuser (Memphis says that based on discussion w/ACOE diffuser is not feasible – per July 2011 mtg w/TDEC diffuser requirement removed) – ***based on the permittee's effluent diffuser infeasible determination the division agrees not to include the diffuser requirement in the new permit. Thus, "This summary must also address an Outfall 001 diffuser(s)." from the draft permit was not included in the new permit.***

e) antidegradation analysis if newly-formed disinfection contaminants above *de minimis* amounts (antidegradation analysis should not be required/adding treatment. If antidegradation analysis is required, Memphis wants TDEC guidance for what is required to pass *de minimis* test and newly-formed contaminants to be limited to only Rule 1200-4-3 parameters. Memphis says TDEC agreed contaminants based on existing WQ per TN regulations.) – ***the division has finalized the permit to include permittee's antidegradation assessment requirements focused on the newly-formed chemicals which would be discharge pursuant to the permittee's selected disinfection system e.g., total residual chlorine, disinfection byproducts. Certainly the permittee must use the water quality criteria/chemicals included based on narrative criteria (including human health consideration). Also, the division expects that the permittee must use its knowledge regarding its industrial discharger wastestreams in its disinfection byproducts investigations. The permittee must address pollutants included in TN Rules, Chapter 1200-4-3 per the receiving stream's designated usages. The receiving stream is classified as an "Exceptional Tennessee Water" and the division's antidegradation requirements are provided in Rule 1200-4-3-.06, which addresses non-degradation due to de minimis contaminant discharge and social/economic justification requirements pursuant to contaminants resulting in receiving stream degradation. The division may not renew/finalize a discharge permit that results in receiving stream pollution.***

EPA's comments (as summarized by the division) and division's responses:

TDEC should clarify if Allan Steam Plant cooling water channel is "waters of the state." – ***The division does not consider Allan Steam Plant cooling water channel to be "waters of the state."***

Re: Section 1.1 - EPA recommends that composites instead of grabs be used for monitoring organic pesticide chemicals, heptachlor and total chlordane. ***The division agrees with EPA's request.***

Re: Section 1.1 - EPA recommends that the division provide clarification regarding monitoring total mercury using composite sampling and grabs for methyl mercury. ***The division considers composite sampling for total mercury testing to be appropriate since the permittee's wastewater treatment system has a relatively short hydraulic detention time and expects significant raw wastewater variability (due to the numerous/diverse industrial user wastewater inputs). Since methyl mercury is volatile, grab sampling is required. However, the new permit's reopener clause has been revised to include the following provision: "The permit may also be reopened if the total mercury results appear much***

lower than expected in comparison with the methyl mercury grab data. If so, the division may require the permittee to determine the total mercury based on grab samples."

Re: Section 1.1 – Total Mercury should be monitored on semi-annual basis to coincide with pretreatment monitoring frequency in section 3.2.d.ii. ***Monitoring frequencies for the pretreatment program and the NPDES point source discharges do not have to coincide. Annual frequency for total mercury, as proposed in the draft permit, is adequate to characterize the discharge.***

Re: Section 1.1 – EPA noted that the total chlordane footnoted as "technical" chlordane. ***The division agrees with EPA and has changed the footnote to by deleting "technical" to be consistent with EPA's "Persistent Chlorinated Hydrocarbon Pesticides" classification.***

Re: Section 1.2.3.a - EPA noted the transposition "PBCs" for "PCBs". ***The division agrees and has made the correction.***

Re: Section 3.5 – EPA notes that any compliance schedule must be justified pursuant to 40 CFR 122.47(a), require the permittee to provide the division written progress notifications within 14 days of each interim milestone or final compliance with a written statement as to whether compliance dates achieved. ***The division agrees with EPA's comment and has supplemented the schedule with the statement "The permittee must provide the division written progress notification within 14 days of each milestone and specifically address whether permit's compliance requirements were achieved." (See disinfection compliance schedule table, note (a))***

Re: Section 3.5.1 – EPA recommends that specific dates for each report be included. ***The division does not agree that dates must be included and has included a enhanced disinfection compliance schedule that incorporates specific work tasks, milestones, timing elements and the supplementary requirement (permittee must provide the division with progress status reports every 6 months, starting with the permit's effective date and continuing until the permittee's disinfection treatment system is functional.***

Re: Section 6.3.4 – EPA recommends that the division specify if chronic toxicity (IC25) monitoring and/or limits are appropriate based on a reasonable potential evaluation. ***The dilution factor (DF) outfall 001 is outside of a range of dilution factors for which WET testing is required per EPA's guidance. However, the final permit does require annual acute testing and one chronic test to be submitted with the permit application.***

Re: Rationale 8.10 – EPA recommends that the new permit include a date for the permittee to submit the chlorinated byproducts information to the division. ***See response (above) to comment number A26.***

Re: Rationale 9.1 - EPA recommends that the new permit include a date for the permittee to submit the treated effluent transport/dispersion within the receiving stream information to the division. ***The division removed the requirement for the treated effluent transport/dispersion study from the final permit.***

Re: Rationale 10 – EPA recommends that the division discuss how the TMDL wasteload allocations for chlordane, dioxins and PCBs are consistent with the new permit's requirements and deleting/clarifications for the 3rd paragraph's last sentence. ***The TMDL for chlordane, dioxins and PCBs states, in Part 9 (Implementation Plan):***

"9.1 Point Sources
There are currently no NPDES permitted facilities in the Mississippi River Watershed with an existing allocation to discharge chlordane, dioxins, or PCBs to the Mississippi River."

Therefore, there are no wasteload allocations for chlordane, dioxins, or PCBs in the final permit, but annual monitoring is required to evaluate consistency with the TMDL.

Re: Appendix 2e (treated effluent biomonitoring), Appendix 2f (landfill groundwater monitoring results – mercury) and Appendix 2g (sludge mercury content) EPA recommends that the division obtain more recent data (effluent data limit is 4.5 years). ***The effluent data was timely submitted when the division started this multiple-year complex permit renewal process and plans to finalize the permit using the best information available. The new permit requires that the treated effluent mercury must be analyzed using more sensitive analytical methods.***

TCWN/Sierra Club's draft permit comments (as summarized by the division) and division's responses:

1. Foam and color
   Request division specifically address foam – proposes "There shall be no distinctly visible floating scum, oil, foam, or other matter contained in the wastewater discharge." TDEC & EPA have noted the discharge of foam from plants, therefore a WQBEL limit warranted due to reasonable potential to violate instream water quality criteria. ***The final permit addresses these discharge parameters using a narrative WQBEL approach.***
2. Imposing E. coli limits long overdue – final permits should be issued w/o compliance schedules. If schedule included, ASAP compliance w/3 yrs max. for WQBEL compliance. ***The division concluded that a compliance is appropriate. The final permit requires the permittee to complete parallel work tasks and simplifications such that E. coli compliance must be achieved within the new permit's duration.***
3. TN & TP – drafts fail per WQ for nutrients (per … Ecoregion 68a at the 75th percentile for nitrite + nitrate). Memphis watershed significant contributor to Gulf of Mexico hypoxic zone. ***The division does not consider the Ecoregion 68a reference stream values to be applicable to the Mississippi River (Ecoregion 73a). Therefore, the new permit retains Outfall 001 discharge total nitrogen and total phosphorus monitoring requirements from the draft permit.***
4. Mercury – numeric WQBELs should be included in the final permit - ***The receiving stream is identified as impaired for mercury (atmospheric deposition). The city has monitored its effluent for mercury, and the results have been below detection levels. However, the division is requiring the city to monitor mercury concentrations using the more sensitive method to better quantify their contribution, if any.***

5. Overflows – permits Part 2.3.3(d) unclear what "this requirement" means – ***The first sentence in paragraph d was changed to read: "Unless there is specific enforcement action to the contrary, the permittee is relieved of the requirement from paragraph c. above after […]"***
6. Dieldrin and DDT – Stiles, WQ reasonable potential is insufficient basis for limits elimination – specific exception of antibacksliding trigger needs to be presented. ***The current permit includes the following rationale for dieldrin and DDT limits "…since the ambient river concentrations of DDT and Dieldrin have been calculated to currently exceed the state water quality criteria, effluent limitations for these two pesticides are required in the permit." As such, water quality reasonable potential was the basis for including discharge limits for these treated effluent parameters, and rationale for continuing the limits does not apply. This permitting action is consistent with the division's antidegradation policy and these parameters no longer require additional controls pursuant to the division's 2008 and 2010 EPA-approved 303d lists.***

RATIONALE

Memphis-T.E. Maxson STP
NPDES Permit No. TN0020729
Permit Writer: Gary Davis

R1.0 FACILITY INFORMATION

Memphis-T.E. Maxson STP
Memphis, Shelby County, Tennessee
Treatment Plant Average Design Flow: 90 MGD
2010 Percentage Industrial Flow: 23.9 % (based on design flow)
Treatment Description: Activated Biological Filter Towers/Activated Sludge

R2.0 RECEIVING STREAM INFORMATION

Mississippi River at Mile 725.0 (Watershed Group: Mississippi)

Hydrocode (Mississippi River): 8010100
Low- Flow: 7Q10 = 70,500 MGD (109,000 CFS)
30Q5 = 89,900 MGD (139,000 CFS)

USGS Water-Resource Investigation Report 95-4293
Station #03532200

Receiving Waters: Outfall 001 Discharges to the Mississippi River via the Cooling Water Channel (A Wet Weather Conveyance)
The Mississippi River is classified as an Exceptional Tennessee Waters, (Due to the Federal Endangered Pallid Sturgeon and Tennessee Threatened Blue Sucker Fish Species)

Mississippi River Usage Designations:

Domestic Wtr Supply	Industrial	Fish & Aquatic	Recreation
--	X	X	X
Livestock Wtr & Wlife	Irrigation	Navigation	
X	X	X	

R3.0 CURRENT PERMIT STATUS

Permit Type:	Municipal
Classification:	Major
Issuance Date:	3/31/2000
Expiration Date:	3/31/2005
Effective Date:	4/1/2000

R4.0 DIVISION'S PROPOSED NEW PERMIT AND REFERENCES FOR PREVIOUSLY SUBMITTED WRITTEN COMMENTS REGARDING THE PRIOR DRAFT PERMIT

For developing the T.E. Maxson STP's (TN0020729) new proposed permit, the division received/evaluated numerous written comments for the following previously-issued draft permit:

- Draft Permit (August 30, 2010) – Initially Public Noticed (April 6, 2009) and Re-Public Noticed (October 11, 2010)

This draft permit and comments are in division's Water Pollution Control (WPC) permit file.

R5.0 T.E. MAXSON STP TREATMENT COMPONENTS AND RECEIVING WATER

The T.E. Maxson STP wastewater treatment components include preliminary treatment units, roughing trickling filter towers, an extended aeration activated sludge system, and sludge handling/disposal components. The plant includes effluent disinfection chlorine contact chambers which have been converted to clarifiers. Pursuant to its current and prior NPDES permit requirements, no treated effluent disinfection is occurring. The permittee indicated that if necessary, its chlorine contact chambers might be used for treated effluent disinfection.

Prior to flowing to the Mississippi River the permittee's Outfall 001 treated effluent is discharged to a wet weather conveyance which is called the "Cooling Water Channel". The Cooling Water Channel includes the continuous non-contact cooling water discharge from TVA's Allen Fossil Plant Outfall 003 pursuant to NPDES TN0005355. Normally, TVA only discharges from Outfall 003, however TVA also can discharge from its Outfall 002 to the Cooling Water Channel. TVA's discharges occur upstream of the permittee's Outfall 001 discharge point. Effectively, TVA's Outfall 003 discharge water serves as flow augmentation, since TVA pumps its non-cooling water directly from McKellar Lake. The division does not consider wet weather conveyances to be waters of the United States or state of Tennessee. The Cooling Water Channel is subject to a posted fishing advisory.

R6.0 PERMITTEE'S PERMIT MODIFICATIONS REQUESTED IN NPDES PERMIT RENEWAL APPLICATION

The permittee's current NPDES permit limitations/monitoring requirements and the influent monitoring schematic diagram for the permittee wastewater treatment facility are presented in Appendix R-1.

In its NPDES permit renewal application submittal the permittee requested that the division consider the following items:

- Increased treated effluent BOD_5 and TSS limits beyond federal POTW secondary treatment requirements, due to its relatively large industrial contribution. Based on the permittee's supplemental permit renewal

information, the division has included a variance from federal secondary treatment standards for the permittee's treated effluent.

- Allow higher-than-design monthly flow rates to be used for calculating treated effluent weekly effluent mass loadings. No change in the new permit is appropriate. For municipal wastewater treatment facilities renewed permits, the division determines treated effluent limitations, including maximum weekly concentrations, and uses the permittee's design not an actual flow to establish corresponding weekly mass loadings discharge requirements.

- Pesticide monitoring requirements be eliminated or frequency reduced to once per permit term. Based on the continued input from a pesticides manufacturer, several pesticides formulating and packaging industrial users, wastewater from several large grain processing manufacturing plants that may have pesticides/herbicides present in their wastestreams, the permittee's pesticides DMR monitoring results, and the July 25, 2008 Total Maximum Daily Loads (TMDLs) for chlordane, dioxins, and polychlorinated biphenyls in the Mississippi River, the division considers the permittee's treated effluent to contain pesticides that may possibly violate water quality standards and/or contribute to the receiving stream impairments. Thus, no reduction in monitoring frequency is included in the new permit.

R7.0 EVALUATION OF CURRENT NPDES PERMIT COMPLIANCE, INCLUDING RESULTS PROVIDED IN DISCHARGE MONITORING REPORTS AND NPDES PERMIT RENEWAL APPLICATION

Treated effluent monitoring results are provided in Appendix R-2. TDEC personnel completed several compliance evaluation inspections since the current permit's effective date. The following types of treated effluent monitoring results were evaluated during this permit renewal process:

- Discharge Monitoring Reports (DMRs)
- Fecal Coliform (provided in NPDES permit renewal application)
- Organic Pesticides and PCBs (DMR)
- Total Dioxin (DMR)
- Whole Effluent Toxicity – LC_{50} and NOEC (DMR) and IC_{25} (data provided in NPDES permit renewal application)
- Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus (data provided in NPDES permit renewal application)
- Other Parameters (data provided in NPDES permit renewal application)

R7.1 COMPLIANCE EVALUATION INSPECTION (CEI) RESULTS

Mr. Eddy Bouzeid (TDEC Memphis Environmental Field Office) completed CEIs on October 23, 2001, October 30, 2003, November 7, 2005, April 10, 2006, September 30, 2007, March 31, 2008, and June 4, 2010. The permittee received a satisfactory rating for each CEI evaluation. During the June 4, 2010 inspection foam was visible

at the discharge pipe, however the foam was dissipating before reaching the Mississippi River.

R7.2 DISCHARGE MONITORING REPORT (DMR) RESULTS

The DMR results for the months of April 2000 through March 2011 are provided in Appendix R-2A. As shown in the Appendix R-2A, the permittee has had consistent sanitary sewer overflows, and some effluent BOD_5 and TSS permit exceedances.

R7.3 ADDITIONAL TREATED EFFLUENT MONITORING RESULTS

This section includes monitoring results submitted pursuant to the permittee's current permit and data included in its NPDES permit renewal application, as supplemented.

R7.3.1. Fecal Coliform

The permittee's current permit does not require fecal coliform monitoring. However, in the permittee's NPDES permit renewal application fecal coliform results were provided for three treated effluent samples. The maximum fecal coliform result was 700,000 cfu/100 ml, with an average of 520,000 cfu/100 ml. These are high values because effluent disinfection is not being used. Also, as illustrated by the recent *E. coli* results presented in Appendix R-2B, it appears that elevated *E. coli* levels exist in the Mississippi River upstream of the permittee's Outfall 001 discharge point.

R7.3.2. Organic Pesticides Chemicals and PCBs

The permittee's treated effluent organic pesticide chemicals, and PCBs monitoring results summary is presented in Appendix R-2C. These results show that measurable amounts of heptachlor epoxide and 4, 4'-DDE are present in the Outfall 001 treated effluent.

R7.3.3. Total Dioxin

The permittee's total dioxin results for its Outfall 001 treated effluent are provided in Appendix R-2D. From these results it is apparent that the permittee's treated effluent contains total dioxin.

R7.3.4. Biomonitoring – LC_{50}, NOEC and IC_{25} Results

As shown in Appendix R-2E, the permittee submitted its biomonitoring LC_{50} and NOEC results for its treated effluent consistent with its current permit. Some acute aquatic toxicity was demonstrated, with 96-hour LC_{50} values of 70.7% for water fleas, and 54.4% for fathead minnows. Due to large amounts of diverse industrial wastewaters treated by the permittee, some acute toxicity was expected.

For its permit renewal the permittee submitted results for the four treated effluent IC_{25} tests, also presented in Appendix R-2E. The IC_{25} results ranged from 18.5 to 35.7% for the water fleas and 26.7 to 56.7% for the fathead minnows.

R7.3.5. Ammonia, Total Kjeldahl Nitrogen and Total Phosphorus Results

For the three values reported with its permit renewal application, the permittee reported a daily maximum ammonia-nitrogen value of 34.0 mg/l (27.1 mg/l average) and total Kjeldahl nitrogen of 39.9 mg/l (34.9 mg/l average) in its treated effluent. When compared to domestic sewage, the ammonia nitrogen results are relatively high and due to the facility's large industrial input.

The permittee reported a maximum total phosphorus result of 7.56 mg/l (5.2 mg/l average) for three treated effluent samples. This total phosphorus is relatively high compared to domestic sewage, and similar to the ammonia nitrogen, due the facilities' industrial input.

R7.3.6. Other Parameters and Toxics and Metals Results

In its permit renewal application the permittee reported its Outfall 001 treated effluent mercury to be less than 0.2 ug/L,for three samples. From these results, the actual mercury mass discharge rates can not be determined. The permittee reported 2009 influent and effluent mercury values of <0.2 ug/L, with the exception of two influent results (0.30 ug/L for 4/6-7/2009 and 0.20 ug/L for 11/12-13/2009). The permittee's cake solids mercury content is shown Appendix R-2F, which demonstrates that mercury is present in the sludge. The wastewater treatment system is not designed nor operated for mercury removal. Due to the permittee's T.E. Maxson STP facility large/diverse industrial wastewater input and measured mercury in the plant's wastewater and sludge, the division considers that additional mercury monitoring data needs to be collected for the Outfall 001 treated effluent, using more sensitive analytical testing methods, so that the mercury Outfall 001 treated effluent mercury mass loadings can be established.

R8.0. DIVISION'S DETERMINATIONS AND MAJOR CHANGES INCLUDED IN THE NEW NPDES PERMIT

The following major changes from the current permit have been incorporated into the new permit:

a. The permittee requested a variance from the minimum BOD_5 and TSS wastewater federal secondary treatment standards for POTWs (technology-based) as defined in 40 CFR 133.102. The federal secondary treatment standards are technology-based, variance changes for the proposed new permit are not subject to antibacksliding.

The permittee requested a variance from the minimum BOD_5 and TSS wastewater secondary treatment standards for POTWs as defined in 40 CFR 133.102. As shown in Appendix R-3, the division has determined that the provisions of 40 CFR 133.103(b) have been met by the permittee, and the calculated limits for treated effluent BOD_5 and

TSS concentration limits have been determined. As such, the BOD_5 concentration limits per variance follows:

	BOD_5 Limits (mg/L)		
	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	**42**	**63**	**84**
Per Variance	47.0	70.5	114.1

	TSS Limits (mg/L)		
	Monthly Avg.	Weekly Avg.	Daily Max.
Current Permit	**48**	**72**	**96**
Per Variance	52.0	77.9	129.0

Since the Mississippi River designation is an "Exceptional Tennessee Waters" and the permittee has not provided the division with antidegradation documentation (including alternative analyses with social/economic evaluations for the above increased Outfall 001 BOD and TSS concentrations per the variance), the new permit includes the most stringent discharge limits (current permit versus per variance values). The values included in the new permit are shown in bold font.

b. For the permittee's M.C. Stiles STP (TN0020711) facility, the division has received/evaluated numerous draft permit written comments. Because the permittee's M.C. Stiles STP new permit addresses issues that apply to the permit proposed by the division for the T.E. Maxson STP (TN0020729), relevant considerations were used by the division in developing the proposed permit for the T.E. Maxson STP.

c. Pursuant to the elements/timing presented in the permit's Section 3.5, the permittee must install/operate an end-of-pipe treated effluent disinfection system to demonstrate that its T.E. Maxson STP Outfall 001 discharge does not cause nor contribute to any non-attainment of the state of Tennessee's recreation *E. coli* requirements (maximum monthly geometrically mean of 126 cfu/100 ml with a maximum sample of 487 cfu/100 ml required by Tennessee's recreation water quality standards, Rule 1200-4-3.03(4)(f)).

d. Since contaminants (e.g., newly-generated chlorinated byproducts, if chlorination is used for Outfall 001 disinfection) in the permittee's treated effluent discharge mixing zones within the Mississippi River must not exceed the division's human health criteria or adversely impact reasonable uses of the area, per Rule 1200-4-3-.05(2), the new permit's Section 3.5 defines an *E. coli* compliance schedule with associated requirements. Also, the permittee must post signs noting the potential human health hazards associated with Outfall 001's discharge, including those related to the discharges' immediate instream mixing zone, for the release to the Cooling Water Channel and the Mississippi River.

R9.0 REPORT SUBMITTAL REFERENCES

The following summary provides references for selected reports that the permittee must submit to the division:

Selected Reports	Section in Permit
Influent Flow Assessment Report	1.2.1.
Discharge Monitoring Reports (DMR)	1.3.1.
Monthly Operational Reports (MOR)	1.3.4.
Bypass and Overflow Summary Reports	1.3.5.
Industrial Pretreatment Reports	3.2.
Sludge Reports	3.3.
Biomonitoring Reports	3.5.
Influent Flow Assessment Report	1.2.1
E. coli Compliance Elements/Timing Reports	3.5

R10.0. REGULATORY BASIS FOR NEW NPDES PERMIT'S MONITORING/LIMITATIONS REQUIREMENTS

Parameter	Regulatory Basis/Rationale Reference
BOD_5	Refer to Section R10.1. T.C.A. 1200-4-5-.09 (for BOD_5) and 40 CFR 133.103(b)
Total Suspended Solids (TSS)	T.C.A. 1200-4-5-.09 Refer to Section R10.2. and 40 CFR 133.103(b)
Ammonia and Organic Nitrogen	Refer to Section R10.4.
Total Nitrogen	Refer to Section R10.5.
Total Phosphorus	Refer to Section R10.5.
E. coli	T.C.A. 1200-4-3-.03, Refer to Section R10.3.
Total Chlorine Residual	Refer to Section R10.4.
Chlorinated Byproducts	Refer to Section R10.10.
Settleable Solids	T.C.A. 1200-4-5-.09 Refer to Section R10.12.
Dissolved Oxygen	D.O. protection, Refer to Section R10.1.
pH	Refer to Section R10.13.
Organic Chemicals Pesticides	Refer to Section R10.8.
Total Dioxin	Refer to Section R10.9.
Total Mercury and Methyl Mercury	Refer to Section R10.11.
Visual Observations	Refer to Section R10.14
Whole Effluent Toxicity:	
Acute Toxicity - LC_{50}	Refer to Section R10.6.
Chronic Toxicity - IC_{25}	Refer to Section R10.6. (Permit Renewal Scans)
Flow (MGD): Influent and Effluent	Used to quantify pollutant load and percentage removals
Sanitary Sewer Overflows, Total Occurrences	Refer to Section R10.15.
Dry Weather Overflows, Total Occurrences	Refer to Section R10.15.
Bypass of Treatment, Total Occurrences	Refer to Section R10.15.

Additional Permit Criteria:

Weekly limitations on BOD_5 and TSS concentrations are given as required per 40 CFR 133.102(a)(2) or 133.102(a)(4)(2) & 133.102 (b)(2) respectively; daily BOD_5 and TSS limitations are authorized by T.C.A. 1200-4-5-.09; monthly and weekly mass loads are limited per 40 CFR 122.45(f) and based on the design flow as per 40 CFR 122.45(b); monthly average percent removal rates for BOD_5 and TSS are required per 40 CFR 133.102(a)(3) or 133.102(a)(4)(iii) and 133.102 (b)(3) respectively. A minimum 40% daily removal rate is required as equivalent to a daily mass load limitation. Additionally, the permittee must also use the following provisions in achieving its new permit monitoring/limitations requirements:

(a) Since the permittee's treatment facility has multiple input streams the influent flow and resulting characteristics must be estimated. The estimated values must be used for calculating loadings and percentage removals.

(b) All sampling shall be representative.

(c) Pursuant to its current permit requirements, the permittee provided the schematic diagram included in Appendix R-1 along with a narrative in its May 26, 2000 letter submitted to the division. Within 60 days from the new permit's effective date the

permittee must submit to the division's Memphis Environment Field and Nashville Central Offices, an updated Influent Flow Assessment Report which relates the quality and quantity of contributory wastestreams (e.g., sludge handling facility supernatants) to its influent monitoring station, including a revised (if applicable) Appendix R-1 diagram. Based on the updated submittal, the division will notify the permittee in writing if additional influent monitoring requirements are necessary.

R10.1. CONTROL REQUIREMENTS FOR BOD_5, DISSOLVED OXYGEN, AND BOD_5 REMOVAL

a. Biochemical Oxygen Demand (BOD) is a measure of dissolved oxygen used when biological processes breakdown wastewater organic pollutants. The five-day biochemical oxygen demand (BOD_5) is typically used for monitoring both the wastewater's strength and treatment facility's performance.

   Limits on the treated wastewater BOD_5 (oxygen demand) is often necessary to prevent pollutants in the discharge from decreasing the oxygen in the receiving stream below levels necessary to support fish and aquatic life. Additionally, the biological oxidation of ammonia requires dissolved oxygen and therefore, exerts an oxygen demand on receiving stream. Due to the large dilution provided by the Mississippi River, estimated at 784:1 (for 7Q10 flow: STP design flow), no adverse dissolved oxygen impacts are anticipated.

   For this facility, a monthly average BOD_5 limit of 30 mg/l is the federal secondary treatment standard technology-based effluent limitation pursuant to Rule 1200-4-5-.09. However, due to the permittee's large input from major industries, the permittee has requested a federal secondary standards variance pursuant to 40 CFR 133.103(b). The results of the division's variance determination are presented in Appendix R-3 and summarized in Section R8.0.(a). As noted in Section 8.0.(a), antidegradation considerations, the BOD_5 concentrations in the permittee's current permit were included in the new permit. Sample type will be composite.

   The dissolved oxygen (D.O.) effluent limitation of 1.0 mg/l (daily minimum on an instantaneous basis) from the current NPDES permit is retained in the new permit. The new permit requires that grab samples be taken to check for D.O. compliance.

b. The current and new permits include BOD_5 and TSS percent removal requirements, based on the facility influent characteristics. This is part of the minimum requirements for all municipal treatment facilities as referenced at 40 CFR Part 133.102. The reasons stated by the U.S.E.P.A. for these requirements are to achieve these two basic objectives:

   (1) To encourage municipalities to correct excessive inflow and infiltration (I/I) problems in their sanitary sewer systems, and
   (2) To help prevent intentional dilution of the influent wastewater as a means of meeting permit limits.

The treatment facility is required to achieve its permitted BOD_5 and TSS percentage removals. The number of excursions (days when BOD_5 and/or TSS removal is less than 40%) must be reported on the Discharge Monitoring Report.

R10.2. TOTAL SUSPENDED SOLIDS (TSS) AND TSS REMOVAL REQUIREMENTS

The rationale for defining new permit TSS limitations is similar to that presented in Section R8.1. for BOD_5. The TSS technology-based effluent limit is also 30 mg/l, pursuant to federal secondary standards (Rule 1200-4-5-.09). As shown in Appendix R-3 and Section 8.0.(a), alternative TSS limitations were calculated based on secondary TSS variance due to the permittee's inputs from its major industries, per 40 CFR Part 133.102. However, as shown in Section 8.0.(a) due to antibacksliding provisions (40 CFR 122.44(l)) the TSS concentrations in the permittee's current permit will be included in the new permit.

R10.3. *E. coli* CONTROL REQUIREMENTS

Due to the known recreational activities occurring within the Cooling Water Channel and Mississippi River, the new permit requires that the permittee disinfect its treated wastewater pursuant to the permit's Section 3.5, to achieve the *E. coli* to protect human health (per Rule 1200-4-3-.05(2)). As of September 30, 2004, the criterion for fecal coliform was removed from the state of Tennessee's Water Quality Standards. The division now imposes an *E. coli* limit on discharges of treated sewage for the protection of recreational use of the stream in lieu of the fecal coliform limit. For example, the *E. coli* daily maximum limit of 487 cfu per 100 ml applies to Tennessee Exceptional Waters.

In anticipation of treated effluent disinfection requirements, the permittee had installed a chlorine contact chamber when its extended aeration activated sludge plant was built. The permittee has indicated to the division that its chlorine contact chambers have been not been used for end-of-pipe disinfection, and the facilities instead were modified for suspended solids settling/thickening. Additionally, the facility has no provisions for disinfection chemicals storage/feed and controls. Since the division recognizes that chlorine usage for disinfection may generate deleterious chlorinated byproducts with adverse water quality potential, additional investigations are warranted as presented in R8.10.

As noted in the proposed permit's Section 3.5, the permittee must post signs which warn recreational users of potential human health hazards associated with the Outfall 001 discharge.

For the T.E. Maxson STP TN0020729 draft permit *E. coli* requirements as presented in Section 3.5, the division used the *E. coli* control elements and timing as proposed by the permittee for its M.C. Stiles STP TN0020711 permit. As such, some elements/timing changes may occur for finalizing the T.E. Maxson STP TN0020729 permit.

R10.4. AQUATIC TOXICITY POTENTIAL DUE TO AMMONIA NITROGEN/ORGANIC NITROGEN, AND TOTAL RESIDUAL CHLORINE/OXIDANTS (TRC)/TRO

The potential for aquatic toxicity within the Mississippi River due to the permittee's treated effluent ammonia-nitrogen and residual oxidants (e.g., total residual chlorine) from treated effluent disinfection is discussed subsequently and in Appendix R-4. The results from the *E. coli* control evaluations (as shown in the permit's Section 3.5) will be used to identify applicable permit limits and modifications are warranted.

Ammonia-Nitrogen Aquatic Toxicity Considerations

Based on the evaluation results shown in Appendix R-4 the new permit includes monthly Outfall 001 discharge monitoring with report-only requirements for the treated effluent ammonia nitrogen and organic nitrogen. Organic nitrogen monitoring requirements are included in the new permit since it may be converted in ammonia nitrogen instream via biooxidation and hydrolysis processes. This conversion frequently occurs within activated sludge wastewater treatment plants if the facility is operated at organic loading rates which result in low treated effluent BOD5, e.g., <10 mg/l; however, as shown in Appendix R-2A, the permittee's Outfall 001 monthly average BOD5 is 30 mg/l. Based on permittee's DMR data and results from the proposed permit's Section 3.5 Outfall 001 discharge transport/dispersion within the Mississippi River, the permit may be reopened to include ammonia toxicity limits.

Total Residual Chlorine (TRC) and Total Residual Oxidant (TRO) Aquatic Toxicity Considerations

Since total residual chlorine (TRC) from a chlorination disinfection process can be toxic to aquatic life, the new permit includes a treated effluent TRC limit based on acute toxicity. TRC limits are derived using the mass balance formula and the EPA instream protection for fish and aquatic life values of 0.011 and 0.019 mg/l for chronic and acute exposure, respectively.

The treated effluent is discharged to the Mississippi River, and as shown in Appendix R-4 the new permit includes a daily maximum TRC limit of 2.0 mg/l. To achieve this TRC level, dechlorination will probably be required. The new permit includes total residual oxidant (TRO) monitoring requirements, as applicable. As such, TRC and/or TRO limits are presented in the permit's Section 1.1. Depending on the specific TRO to be used, the division may reopen the permit to include the relevant aquatic toxicity limitations and change the monitoring frequency. The results from the proposed permit's Section 3.5 will be used to make permit modifications, if warranted for Outfall 001 TRC or TRO.

R10.5. TOTAL NITROGEN AND PHOSPHORUS MONITORING REQUIREMENTS

The permittee's Outfall 001 treated effluent monitoring required in the new permit for total nitrogen and total phosphorus is imposed pursuant to the joint State/Federal Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, Action Plan for Reducing, Mitigating, and Controlling Hypoxia in the Northern Gulf of Mexico. The monitoring results from major municipal and industrial facilities discharging within the Mississippi River Basin will help assess current point source loadings to the Gulf and enable the task force to track changes in loadings across the basin with time. EPA believes that Section 308(a) of the Clean Water Act provides broad authority to

require nutrient monitoring. No ecoregion reference streams exist for the Mississippi River. Thus, references for the application of the state's narrative nutrients criteria are not available. Even where there is no reasonable potential for a particular facility to cause or contribute to excursions of criteria within the immediate receiving waterbody, nutrient monitoring is being included in permits. Additionally, the corresponding influent monitoring is incorporated by the state for use in evaluating the ability of existing technologies to remove nutrients. As such, treated effluent nutrient monitoring data is needed and included in the new permit.

R10.6. WHOLE EFFLUENT TESTING – LC50 AND IC25 MONITORING REQUIREMENTS

The acute and chronic biomonitoring requirements for the new permit are addressed in Appendix R-5. Assuming treated effluent complete dispersion under the low-flow 7Q10 conditions, the Mississippi River provides for a large dilution ratio (784:1), an instream waste concentration of 0.13 %. Therefore, under full effluent dispersion, the reasonable potential for the permittee's discharge to exceed the narrative water quality criterion, "no toxics in toxic amounts" is dramatically decreased. However, as discussed subsequently in Section 10.2, the actual transport/dispersion characteristics within the receiving stream is not well defined and pursuant to Section 3.5 investigation results, further mixing information should be available. As such, the new permit includes acute (48-hour LC_{50}) monitoring requirements, with chronic (IC_{25}) biomonitoring being required pursuant to the permittee's permit renewal application process.

The permittee monitored IC_{25} for its treated effluent once during 2003 and three times in 2004. These results are provided in Appendix R-2E. Some aquatic toxicity/inhibition was demonstrated, with IC_{25} values ranging from 18.5 to 35.7 % for water fleas, and 26.7 to 56.7 % for fathead minnows. Some effluent aquatic toxicity/inhibition was anticipated due to the large amount of industrial discharges to the treatment facility.

Based on the aquatic toxicity results variability, receiving stream characteristics, and the need for permit renewal data the 48-hour LC50 monitoring requirements in the new permit has been increased from once during the permit term to annual.

R10.7. WATER-QUALITY BASED EFFLUENT CALCULATIONS – OTHER PARAMETERS/ANTIDEGRATION CONSIDERATIONS

As shown in Appendix R-6, pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit reissuance process and/or due to changes in industrial waste contribution. The new permit requires the permittee to maintain its pretreatment program.

Based on the water quality reasonable potential calculations shown in Appendix R-6, the new permit includes annual monitoring requirements for Outfall 001 benzidine and hexachlorobenzene. For its permit renewal application the pemittee did not use sufficiently sensitive analytical procedures to demonstrate that no reasonable potential to violate water quality exists. The permittee treats industrial wastewaters from numerous dischargers that manufacture or use organic chemicals, therefore Outfall 001 monitoring for these contaminants is included in the new permit. The

permit reopener clause provides for modification based on the permittee's Outfall 001 benzidine and hexachlorobenzene DMR results.

R10.8. ORGANIC PESTICIDE CHEMICALS, (INCLUDING HEPTACHLOR EPOXIDE, AND PCB) CONTROL REQUIREMENTS

The permittee's organic pesticide chemicals, and PCBs monitoring results are presented in Appendix R-2C. The current permit includes monitoring requirements for the specific list of pesticides. Since the permittee continues to accept wastewater from several pesticides manufacturers, elevated fish tissue pesticides concentrations exist, the Mississippi River is now classified as Tennessee Exceptional Waters, and some treated effluent pesticide values were reported, the new permit requires the once/6 months Outfall 001 discharge monitoring for the organic pesticide chemicals scan and numerical limitations, based on water quality compliance for heptachlor epoxide (as shown in Appendix R-2C). Due to the water quality criteria/calculations shown in Appendix R-6, and the division's concern that some industrial users discharge wastewater containing hexachlorobenzene to the permittee's treatment system, limits are included in the new permit. As noted in the 2008 Mississippi River TMDL for PCBs and chlordane, dischargers having these chemicals in their treated wastewater must be limited to the water quality criterion. As such, the new permit includes the water quality criterion as monthly average and daily maximum values, for the Outfall 001 treated effluent PCBs and chlordane. The permittee must demonstrate compliance with the new permit PCBs using EPA Method 1668B.

The division has the ability to reopen and modify the permit for parameters presented in this section.

R10.9. TOTAL DIOXIN DISCHARGE REQUIREMENTS

"Total dioxin" is defined by the Tennessee Water Quality Criteria as the sum of the concentrations of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs) specified in the criteria. "Total dioxin" is defined by the Tennessee Water Quality Criteria as the sum of the concentrations of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs) specified in the criteria.

The current permit requires that treated effluent total dioxin be monitored annually to determine if the discharge contributes to further Mississippi River degradation. As shown in Appendix R2D the Outfall 001 treated effluent total dioxin ranged from 0.1140 to 16.9407 picograms/liter (pg/L). These results demonstrate that total dioxin is present in the discharged Outfall 001 treated effluent. Based on the 2008 Mississippi River TMDL for PCBs, chlordane and total dioxin, the new permit includes the total dioxin water quality criteria as monthly average and daily maximum limits for the Outfall 001 treated effluent.

For the new permit the total dioxin monitoring frequency will be retained at an annually frequency.

R10.10. CHLORINATED BYPRODUCTS

The division considers the permittee's Maynard C. Stiles STP and T. E. Maxson STP treatment facilities to be unique within the state of Tennessee, since these facilities

treat a higher proportion of industrial wastewater flows/contaminant loadings from numerous/diverse sources. As such, the division is concerned that chlorination of the treated effluent for disinfection, could result in high effluent concentrations of chlorinated byproducts (both inorganic and organic) which may pose a human health risk. The identification/characterization (including types and amounts) of chlorinated organics generated via chlorination-based treated effluent disinfection system is addressed in the proposed permit's Section 3.5.

Based on information to be provided by the permittee relative to chlorinated organics generated (via the proposed permit's Section 3.5 requirements), the new permit includes reopener provisions to modifying the permit to include Outfall 001 numerical limits (e.g., monthly average and daily maximum for identified harmful organic chlorinated byproducts, which may/will be generated due to chlorination for disinfection). The permittee had initially indicated to the division that if disinfection is required, chlorination would be used. However, recently, the permittee indicated that non-chlorination processes are being evaluated for Outfall 001 treated effluent disinfection also.

R10.11. TOTAL MERCURY AND METHYL MERCURY

The division added mercury as a fish-consumption advisory for the Mississippi and Wolf Rivers and McKellar Lake on April 26, 2007. The division's fish tissue trigger point for the mercury advisory is 0.3 ppm. As such, the division is including discharge limitations and/or monitoring requirements for permitted potential sources.

As noted in this Rationale's Section R6.3.6., measureable mercury was reported for the permittee's raw wastewater for two months in 2009. The permittee's permit renewal application included three treated effluent mercury results each < 0.2 ug/L. As shown in Appendix R-2F, mercury is present in the permittee's waste activated sludge (secondary cake) at concentrations ranging from 0.161 to 0.48 mg/Kg. Therefore, since mercury is present in the permittee's wastewater and sludge, the Outfall 001 discharge mercury mass loading needs to be determined. As such, the new permit includes discharge monitoring requirements for both total and methyl mercury on twice per year frequency. The treated effluent total mercury must be determined using EPA Method 245.7 or 1631E and methyl mercury analyzed using EPA Method 1630.

The permittee started using covered lagoons in May 2004 for sludge handling/stabilization. As such, under the anaerobic conditions within the lagoons, the division considers an increased potential exists for the generation of methyl mercury. The supernatant from the sludge lagoons is returned to the wastewater treatment system and some methyl mercury would be discharged via Outfall 001. Methyl mercury is the form that is bioaccumulated in fish tissue. As such, methyl mercury monitoring is included in the new permit.

R10.12. SETTLEABLE SOLIDS

Settleable solids results provide an indication of the treatment system performance. The treated effluent settleable solids limitation (1.0 ml/L) included in the permittee current permit will be used for the new permit.

R10.13. pH

The permittee's must comply with secondary treatment technology pH limitations (6.0 to 9.0 s.u.) for its treated effluent. Major variations in effluent pH can provide the permittee with an indication of industrial user spills.

R10.14. VISUAL OBSERVATIONS

As noted in the proposed permit Section 1.1 the permittee must make observations regarding the Outfall 001 discharge the presence of distinctly visual matter or an objectionable color contrast within the receiving stream. Certainly Outfall 001 discharge foam is "visual matter" and is not allowed pursuant to the permittee's current and proposed new permit. Additionally, discharged foam that results in an objectionable color contrast within the receiving stream is prohibited. The proposed permit requires the permittee to monitor/document/report the character of the Outfall 001 discharge and resulting impact, e.g., objectionable color contrast, on the Mississippi River.

R10.15. OVERFLOW AND BYPASS REPORTING

For the purposes of demonstrating proper operation of the collection, transmission, and treatment system, the new permit defines overflow as any release of sewage other than through permitted outfalls. This definition includes, but is not necessarily limited to, sanitary sewer overflows and dry weather overflows. For example, a collection system blockage or hydraulic overload that causes backup and sewage release into a building during a wet weather event may not clearly fit either the definition of a sanitary sewer overflow or a dry weather overflow. The permittee must also account for overflows that result in sewage flow into buildings. Any unpermitted release potentially warrants permittee mitigation for human health protection and/or water quality impacts via direct or indirect contact and demonstrates a hydraulic problem in the system that warrants permittee consideration as part of proper system operation and maintenance.

For the more typical, unpermitted, releases into the environment, the new permit uses interchangeablely the terms, "overflow" and "sanitary sewer overflow" for compliance reporting purposes. Sanitary sewer overflows can have an adverse impact on the permittee's overall *E. coli* control program. The permittee routinely has had sanitary sewer overflows. The permittee provides a summary of its sanitary sewer overflow sources, amounts, causes and mitigation measures taken, are submitted monthly to the division with its DMRs.

R10.16. ADDITIONAL NPDES PERMIT REQUIREMENTS AND CONDITIONS

This section presents several additional requirements and conditions incorporated into the new permit.

R10.17. CHLORINATED BYPRODUCTS

The division considers the permittee's Maynard C. Stiles STP and T. E. Maxson STP treatment facilities to be unique within the state of Tennessee, since these facilities

treat a higher proportion of industrial wastewater flows/contaminant loadings from numerous/diverse sources. As such, the division is concerned that disinfection of the wastewater using chlorination based system could result in high effluent concentrations of chlorinated byproducts (both inorganic and organic), which may pose a human health risk. The identification/characterization (including types and amounts) of chlorinated organics generated via a chlorination-based disinfection system must be addressed, per the proposed permit's Section 3.5. The permittee must provide the division with sufficient treated effluent chlorinated byproducts characterization (including a list of specific chemicals) and the discharge's instream transport/dispersion information, such that the division may define applicable treated effluent limits for obtaining receiving stream water quality standards. The permit may be reopened to include applicable chlorinated byproducts limits.

Based on information to be provided by the permittee relative to chlorinated organics generated (via the proposed permit's Section 3.5 requirements), the new permit includes reopener provisions to modifying the permit to include Outfall 001 numerical limits (e.g., monthly average and daily maximum for identified harmful organic chlorinated byproducts, which may/will be generated due to chlorination for disinfection). The permittee had initially indicated to the division that if disinfection is required, chlorination would be used. However, recently, the permittee indicated that non-chlorination processes are being evaluated for Outfall 001 treated effluent disinfection also.

R10.18. TREATED EFFLUENT TRANSPORT/DISPERSION WITHIN RECEIVING WATER

Should chlorination be selected by the permittee for Outfall 001 disinfection, as presented in the proposed permit's Section 3.5 *E. coli* compliance program, the permittee must provide the following information to the division:

a. Define the lateral, vertical, and longitudinal extent of the Outfall 001 treated effluent plume within the Cooling Water Channel and Mississippi River. The assessment must be completed for varying conditions of stage, flow, and velocities within the Mississippi River.
b. Develop, or utilize an existing, mathematical model to predict the Outfall 001 treated effluent transport/dispersion characteristics within the Cooling Water Channel and Mississippi River.

The permittee's treated effluent transport/dispersion summary shall also include the evaluation objectives, investigation procedures/protocols, data (monitoring and calculated results), mitigation measures, implementation plans, schedules, conclusions, and recommendations. The permittee must also address the applicability of an effluent diffuser(s). Based on this information the division may determine that the permit must be reopened to make changes to its permit limitations and monitoring conditions and/or other adjustments.

R10.19. WASTEWATER TREATMENT AND COLLECTION SYSTEM OPERATORS

The wastewater treatment facilities shall be operated under the supervision of a certified wastewater treatment operator. Also, the permittee's wastewater collection system shall be operated under the supervision of a certified collection system

operator. These certifications must be in accordance with the Water Environmental Health Act of 1984.

R10.20. PRETREATMENT PROGRAM

The T.E. Maxson STP has an approved pretreatment program. An updated Industrial Waste Survey must be completed within 120 days from the effective date of the new permit.

All permittees with approved pretreatment programs are required to analyze the STP influent and effluent for the following pollutant parameters: chromium, copper, lead, nickel, zinc, silver, cadmium, mercury, total phenols, and cyanide. These pollutants were selected because, historically, they are the ones that tend to be predominant in industrial wastewaters. Other pollutants may be added to the list, as required.

During preparation of this permit, data previous annual reports, as well as data from previous Toxics Release Inventory (TRI) lists, were analyzed. If any particular value of a pollutant equals or exceeds 85% of the pass-through limit, or if the TRI list indicates what may be a significant amount of other pollutants being discharged to the sewer system, the pollutant was added to the list of those that are required to be sampled. Based on our review of the annual reports and other documents, sampling for additional pollutants is not required at this time.

Pretreatment Compliance Inspections (PCIs) were completed by TDEC personnel during June, 2003, April, 2006, and July 2008, and the permittee received a satisfactory rating for its pretreatment program.

R10.21. WASTEWATER TREATMENT SYSTEM INTEGRITY EVALUATION

The permittee must within eighteen months from the permit's effective date submit to TDEC's Nashville Central and Environmental Field Offices (Division of Solid Waste Management) and Division of Water Pollution Control – Permit Section) a report which addresses the structural integrity of any earthen basins associated with its wastewater treatment facilities and any waterborne waste and sludge storage/disposal units that are constructed of earthen fill.

Upon submittal of the structural integrity assessment and based on recommendations and/or qualifiers provided in the report, TDEC and the permittee will determine what, if any, improvements will be required. Based on the potential for harm to human health as described, additional site specific evaluations may be required.

Requirements to include permit provisions deemed necessary to protect waters of the state, are based on T.C.A. § 69-3-108. It is expected that the permittee's structural integrity submittals will be reviewed by the division's Water Pollution Control and Solid Waste Management personnel. Although it has not been determined at this time, the division may request additional evaluation input from its outside consultants and/or the U.S. EPA.

R11.0. PERMIT TERM

Because the permittee's treated effluents from its M.C. Stiles STP (TN0020711) and T.E. Maxson STP (TN0020729) are the only significant discharges within the Mississippi Watershed, these permits will expire in 2015.

R12.0 RECEIVING STREAM WATER QUALITY STATUS/ANTIDEGRADATION CONSIDERATIONS

Tennessee's Antidegradation Statement is found in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06. It is the purpose of Tennessee's standards to fully protect existing uses of all surface waters as established under the Act.

Stream determinations for this permit action are associated with the waterbody segment identified by the division as segment ID# TN080100000_1000.

The division has made a determination of the receiving stream for the permittee's discharge and has found the river to be a high quality water. No permanent degradation of water quality will be allowed unless the applicant demonstrates to the Water Quality Control Board that the degradation is for necessary economic or social development and will not interfere with or become injurious to any existing uses. The specific requirements for this demonstration are described in the Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-3-.06(4).

This water does not fully support its fish/aquatic life and recreation designated uses due to mercury, dioxin, chlordane, physical substrate habitat alterations, polychlorinated biphenyls (PCBs). The proposed new permit specifically addresses the relevant contaminants (mercury via more sensitive monitoring, dioxin/chlordane/PCBs discharge limits at water quality standards pursuant to the following referenced TMDL. The division has noted sources causing this not fully supporting status as being due to dredging, contaminated sediments, grazing in riparian or shoreline zones and atmospheric deposition (toxics).

The Mississippi River is classified as Exceptional Tennessee Waters (since it provides habitat for the Pallid Sturgeon (federally endangered) and the Blue Sucker (state of Tennessee threatened) and no increase in water quality degradation will be authorized unless the permittee demonstrates to the Water Quality Control Board such degradation is economically and socially justifiable. The specific requirements for this demonstration are described in Rule 1200-4-3-.06(4).

The following TMDL has been developed and approved for the Mississippi River:

Parameters	TMDL Approval Date
Chlordane, Dioxins and Polychlorinated Biphenyls (PCBs)	July 25, 2008

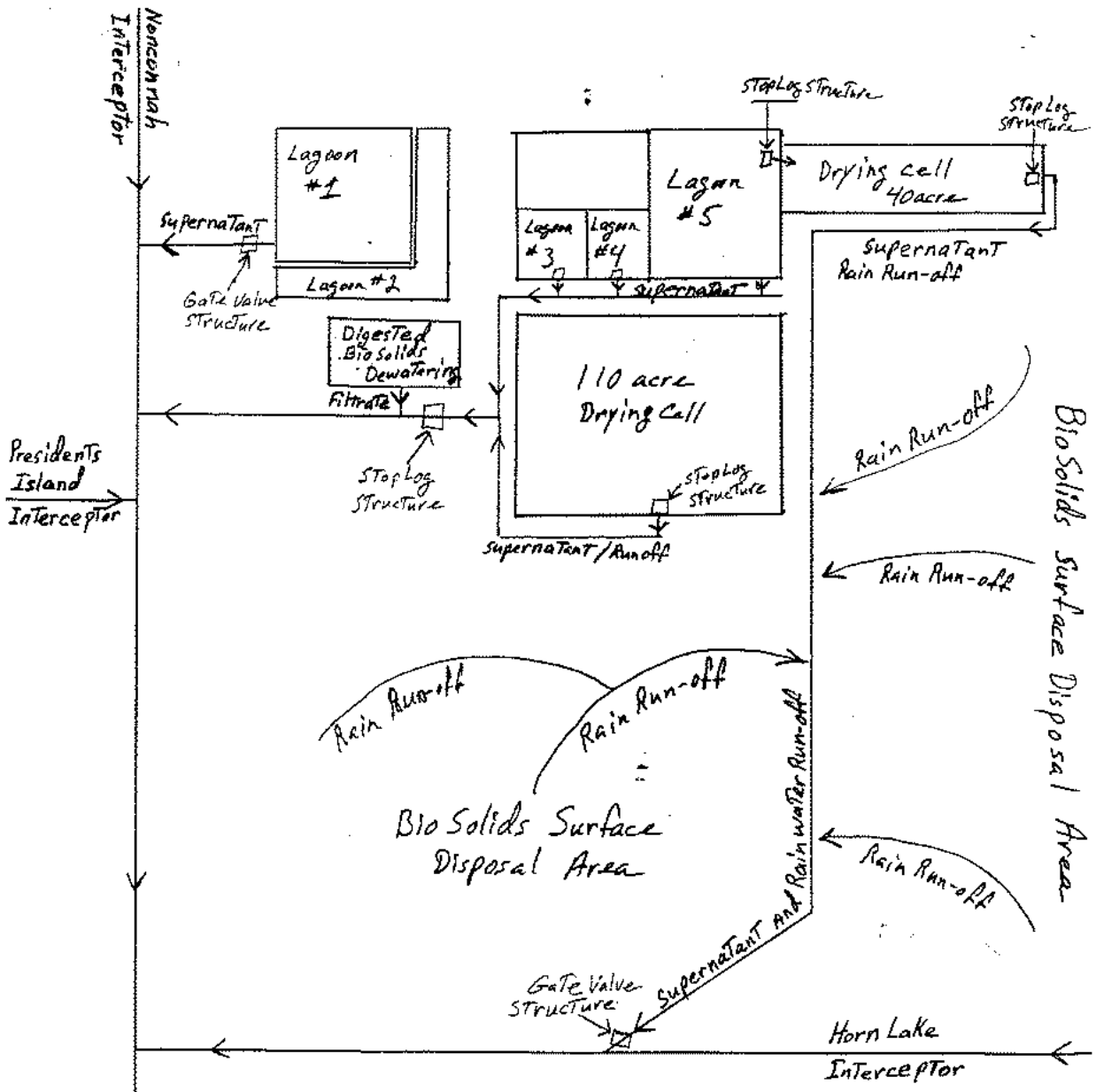
The proposed terms and conditions of this permit comply with the wasteload allocations of this TMDL.

Appendix R-1
Current NPDES Permit Requirements

T.E. Maxson STP (TN0020729) - Permit Effluent Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations									Monitoring Requirements		
	Monthly			Weekly		Daily				Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Maximum (lb/day)	Minimum	Removal (%)			
BOD_5	42	31,525	85	63	47,288	84			40	7/week	composite	effluent
	Report					Report				7/week	composite	influent
Total Suspended Solids	48	36,029	85	72	54,043	96			40	7/week	composite	effluent
	Report					Report				7/week	composite	influent
Settleable Solids (ml/l)						1.0				7/week	composite	effluent
Dissolved Oxygen						1.0 instantaneous				7/week	grab	effluent
pH (standard units)						9.0		6.0		7/week	grab	effluent
Flow (MGD)	Report					Report				7/week	continuous	influent
Organic Pesticide Chemicals (a)						Report				1/year	grab	effluent
Total Dioxin (b)						Report				1/year	composite	effluent
96-hr LC_{50} and 7-day NOEL	Report (Survival, reproduction and growth for serial effluent dilutions)									(c)	composite	effluent
Sanitary Sewer Overflows, Total Occurrences	Report									continuous	visual	NA
Dry Weather Overflows, Total Occurrences	Report									continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report									continuous	visual	NA

(a) "Pesticidies" except for PCBs that are listed in 40 CFR Part 122 (Table II of Appendix D).
(b) Summation of all dioxin and dibenzofuran isomers In Tennessee Water Quality Rule 1200-4-3-.03(4)(h).
(c) Toxicity tests shall be conducted no later than 180 days from permit effective date.


Nonconnah Interceptor
Lagoon #1
Supernatant
Gate Valve Structure
Lagoon #2
Lagoon #3
Lagoon #4
Lagoon #5
Stop Log Structure
Drying cell 40acre
Supernatant Rain Run-off
Supernatant
Digested Bio Solids Dewatering
Filtrate
110 acre Drying Cell
Stop Log Structure
Stop Log Structure
Supernatant/Runoff
Presidents Island Interceptor
Rain Run-off
Rain Run-off
Rain Run-off
Rain Run-off
Rain Run-off
Bio Solids Surface Disposal Area
Bio Solids Surface Disposal Area
Supernatant And Rain water Run-off
Gate Valve Structure
Horn Lake Interceptor

Plant Influent Sampled at half Super Bld

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Appendix R-2A

Discharge Monitoring Report (DMR) Summary

T.E. MAXSON STP - DMR SUMMARY (TN0020729)

Month Ending	Flow		D.O.	INF BOD5		EFF BOD 5					EFF pH		INF TSS		EFF TSS					Settleable	BOD5 Removal		TSS Removal		Overflows
	(MGD)	(MGD)	Min. (mg/L)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	DMin (s.u.)	DMax (s.u.)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	Solids (ml/L)	MAvg (%)	Wk Avg (%)	MAvg (%)	Wk Avg (%)	(No./Month)
4/30/2000	76.1		5.7	708	1,006	39	41	32	20,899	30,525	6.87	7.45	839	1,190	55	86	49	25,098	37,275	0.5	95	90	95	86	
5/31/2000	73.1	94.7	3.8	658	907	38	46	31	19,657	32,067	6.77	7.36	725	1,291	91	176	70	24,966	49,873	6	95	79	95	79	34
6/30/2000	72.5	93.6	5.2	8	1,140	29	37	30	18,173	19,469	6.66	7.43	706	1,063	64	64	39	17,718	24,545	0.5	96	93	96	94	24
7/31/2000	70.5	81.4	5.1	722	876	25	37	31	18,187	21,211	6.94	7.55	659	795	44	31	27	14,433	15,374	0.5	96	94	96	95	17
8/31/2000	71.4	79.2	4.3	767	1,199	28	36	30	17,783	21,288	6.79	7.55	708	913	56	50	31	16,712	19,494	0.5	96	94	96	94	
9/30/2000	71.2	76	5.1	727	990	28	30	28	16,756	17,760	7.06	7.75	675	913	52	46	30	16,752	17,768	0.5	96	93	96	94	23
10/31/2000	70.2	81.1	4.9	770	1,029	31	42	33	19,634	24,807	6.33	7.44	799	1,128	79	54	33	18,083	19,729	0.5	96	88	96	94	27
11/30/2000	75.2	113.2	5.1	691	1,035	31	35	30	19,429	22,442	6.71	7.7	715	1,300	52	64	38	20,245	24,532	0.5	95	86	95	90	24
12/31/2000	73.1	97.6	6.4	772	1,043	34	35	32	19,541	21,830	6.98	7.78	840	1,758	48	56	38	20,767	23,755	0.5	96	94	96	92	30
1/31/2001		72.7	6.0	710	883	45	47	41	25,397	27,734	6.7	7.54	864	1,281	72	132	72	27,893	42,800	0.5	94	87	95	85	49
2/28/2001	79.8	131.7	4.9	684	877	44	4	38	25,394	31,555	6.67	7.63		1,128	66	103	53	31,377	48,126	0.5	94	87	92	77	41
3/31/2001	72.3	92.3	4.4	707	844	35	38	28	16,765	24,231	7.05	7.66	668	984	43	49	50	20,918	31,899	0.5	96	93	94	91	37
4/30/2001	70.1	103.4	5.5	633	872	35	38	31	18,568	21,711	6.74	7.89	837	1,464	77	91	38	20,935	25,147	0.5	95	87	96	84	31
5/31/2001	70.4	97.2	6.1	597	787	36	30	24	14,609	19,557	6.54	7.57	830	1,236	40	59	40	21,318	25,486	0.5	96	93	96	93	29
6/30/2001	74.2	82.9	5.1	623	871	30	28	24	14,916	17,558	6.99	8.54	604	842	36	49	34	18,847	20,122	0.5	96	93	95	91	22
7/31/2001	71.5	86.3	5.1	614	847	23	31	23	13,670	18,524	6.82	7.53	555	904	58	62	30	13,324	16,927	0.5	96	90	96	92	16
8/31/2001	70.9	80.7	4.8	627	763	22	31	27	16,191	18,661	7.06	7.71	555	716	47	40	22	12,748	13,221	0.5	94	91	96	90	28
9/30/2001	69.3	88.8	5.1	675	1,060	25	30	25	14,351	17,735	6.93	7.55	549	1,011	51	61	30	14,459	16,759	0.5	96	92	95	88	26
10/31/2001	72.4	105.9	5.5	610	863	22	29	23	14,292	17,203	6.49	7.66	524	847	53	36	30	13,727	16,001	0.5	96	90	96	93	42
11/30/2001	75.1	156.1	4.0	728	1,109	28	27	27	18,225	14,957	6.56	8.94	627	985	63	71	30	19,247	16,533	0.5	95	75	95	88	45
12/31/2001	85.1	144.8	2.2	578	820	39	56	44	33,340	47,258	6.4	7.89	540	906	79	103	54	30,362	45,968	0.5	91	79	92	75	46
1/31/2002	72.6	102.4	5.6	649	801	33	47	39	23,780	30,498	6.85	8.65	639	934	82	84	47	20,299	31,229	0.5	94	85	95	86	35
2/28/2002	71.8	95.1	6.0	610	891	26	29	29	17,552	24,089	6.41	8.7	652	1,051	58	41	29	15,859	18,136	0.5	95	88	96	94	38
3/31/2002	85.3	144.2	4.1	594	913	48	60	42	31,312	54,059	6.67	7.73	563	842	79	91	67	36,653	62,434	0.5	92	81	91	66	37
4/30/2002	71.7	92.8	5.8	656	900	47	54	45	27,382	38,314	6.99	8.12	554	832	75	78	60	28,446	43,541	0.5	93	87	91	86	22
5/31/2002	75.1	93.8	5.5	589	1,036	29	33	29	18,219	22,119	6.59	8.4	683	1,014	48	48	33	18,219	22,119	0.5	95	91	95	90	22
6/30/2002	70.5	118.1	5.1	645	912	25	35	29	17,290	20,941	6.85	7.38	692	909	45	35	27	14,536	16,332	0.5	95	92	96	93	23
7/31/2002	70.4	118.9	5.3	704	897	29	35	31	18,193	20,589	6.42	7.57	701	1,180	53	59	30	16,851	17,780	0.5	96	93	96	91	19
8/31/2002	70.4	115.3	4.9	677	870	25	33	25	14,699	18,885	6.77	7.52	521	968	40	44	31	14,832	18,540	0.5	96	94	95	90	22
9/30/2002	75.8	168.5	3.1	677	904	31	45	31	20,672	33,663	6.78	7.32	468	590	76	91	47	21,017	35,517	0.05	95	82	93	84	23
10/31/2002	71.8	143.7	1.5	707	865	31	39	33	20,407	29,908	6.24	7.29	552	798	52	56	35	19,088	28,068	0.5	95	84	94	87	23
11/30/2002	67.5	95.7	4.9	691	838	35	37	34	19,268	21,104	6.99	7.39	576	904	49	48	40	19,822	22,221	0.5	95	92	94	90	31
12/31/2002	75.4	132.3	3.7	621	918	42	52	40	27,015	39,478	6.48	7.39	483	745	79	85	52	27,976	39,526	0.5	93	80	91	77	34
1/31/2003	66.3	75.1	5.7	722	920	34	40	33	18,531	22,282	6.74	7.34	539	919	61	48	36	18,583	20,181	0.5	95	90	94	90	46
2/28/2003	82	127.4	4.0	611	818	47	50	49	35,870	40,042	6.73	7.18	528	714	92	89	51	33,676	40,175	0.5	91	76	91	82	42
3/31/2003	69.7	87.8	5.6	688	872	72	114	46	24,215	48,030	6.84	7.23	568	709	55	66	45	26,106	37,530	< 0.5	93	81	92	88	25
4/30/2003	67.3	84.2	5.6	903	7,001	41	38	32	17,824	21,548	6.93	7.37	531	740	49	65	50	23,140	27,657	0	96	90	92	87	29
5/31/2003	79.6	143.6	2.3	636	935	50	46	36	25,118	38,195	6.72	7.73	546	903	64	80	62	34,144	50,898	0	94	83	91	83	33
6/30/2003	68.1	84.4	4.2	632	870	28	27	22	12,606	16,024	6.84	7.62	499	1,191	41	57	33	15,762	18,507	0	96	94	94	88	21
7/31/2003	63.5	74.2	4.4	669	888	39	45	37	19,597	24,067	6.62	7.2	535	716	61	66	51	20,714	27,666	0.5	94	92	93	86	15
8/31/2003	64.0	77.6	2.7	684	1,100	37	40	32	17,260	21,356	6.95	7.45	468	611	52	50	40	19,914	21,526	0	95	93	92	88	13
9/30/2003	61.5	83.6	4.2	695	998	39	36	30	15,676	19,147	6.89	7.31	453	711	49	59	44	19,987	22,887	0	96	89	91	84	20
10/31/2003	59.9	84.3	5.0	706	960	41	40	36	18,137	19,913	6.89	7.34	472	691	72	71	44	20,309	21,120	0	95	89	91	82	28
11/30/2003	63.0	88.3	4.8	760	1,406	44	48	40	21,153	25,001	6.38	7.33	543	912	78	73	50	23,332	26,599	0	95	82	92	83	25
12/31/2003	62.7	88.5	5.0	676	938	41	43	36	19,072	22,393	6.88	7.31	649	1,157	59	56	47	21,413	24,531	0	95	92	94	87	22
1/31/2004	63.6	100.8	4.6	718	966	39	43	36	19,081	23,956	6.64	7.33	654	1,208	57	79	43	20,915	25,478	0	95	90	94	85	42
2/29/2004	72.2	119.4	4.8	650	891	47	59	44	27,076	35,289	6.61	7.28	473	633	93	105	55	28,945	35,233	0	93	77	90	78	37
3/31/2004	77.7	112.6	5.6	643	858	35	38	33	21,416	24,376	6.71	7.51	826	1,389	67	68	37	22,918	23,497	0	95	88	96	86	54
4/30/2004	84.1	145.3	4.5	624	1,078	48	45	39	28,105	38,709	6.58	7.32	732	1,370	66	77	53	34,478	46,352	0	94	83	93	81	42
5/31/2004	86.4	117.4	4.2	628	862	35	37	26	19,052	27,827	6.81	7.7	551	907	49	62	51	25,382	38,421	0	96	90	94	86	25
6/30/2004	84.3	93.4	4.7	675	1,040	46	39	37	26,045	26,934	6.88	7.29	556	1,116	64	78	50	32,608	35,708	0	95	90	92	85	20
7/31/2004	74.4	85	3.1	743	974	46	62	38	23,795	40,845	6.81	7.25	579	855	83	80	66	28,490	43,602	0	95	88	92	81	20
8/31/2004	73.9	80.8	1.7	760	994	45	52	37	22,875	32,055	6.91	7.4	578	1,279	73	67	53	27,684	32,012	0	95	91	92	87	19
9/30/2004	73.0	80.4	4.0	837	1,109	43	38	34	20,380	23,280	6.92	7.8	540	740	52	57	47	26,266	28,961	0	96	94	92	89	23
10/31/2004	75.3	109.9	4.4	802	1,460	34	32	26	16,216	18,915	7.06	7.5	593	1,345	53	63	43	21,249	25,100	0	97	94	94	90	26
11/30/2004	84.6	143.3	1.9	702	1,130	44	36	30	21,983	27,781	6.96	7.9	545	806	50	85	47	31,760	35,747	0	96	90	92	84	18
12/31/2004	80.4	117.3	0.5	732	1,368	39	33	31	21,281	25,844	7.14	8	542	857	57	60	42	26,910	32,827	0	96	92	93	85	24
1/31/2005	82.6	109.8	3.8	762	1,216	39	36	30	21,516	30,037	7.02	7.72	570	884	69	69	44	27,657	37,756	0	96	89	93	84	33
2/28/2005	75.0	91.8	5.6	770	1,419	37	28	27	16,608	18,243	7.1	7.46	570	945	42	58	40	23,387	24,865	0	97	94	93	88	19
3/31/2005	77.0	116.8	5.2	694	1,096	34	29	27	17,671	19,690	6.93	7.44	671	1,471	79	88	36	22,332	24,580	0	96	90	95	88	31
4/30/2005	84.4	126	4.9	723	1,230	40	44	31	22,341	35,462	6.72	7.35	663	1,033	77	78	53	28,611	42,261	0	96	90	94	88	22

Month Ending	Flow		D.O.	INF BOD5		EFF BOD 5					EFF pH		INF TSS		EFF TSS					Settleable	BOD5 Removal		TSS Removal		Overflows
	(MGD)	(MGD)	Min. (mg/L)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	DMin (s.u.)	DMax (s.u.)	MAvg (mg/L)	DMax (mg/L)	Wk Avg (mg/L)	DMax (mg/L)	MAvg (mg/L)	MAvg (lb/day)	Wk Avg (lb/day)	Solids (ml/L)	MAvg (%)	Wk Avg (%)	MAvg (%)	Wk Avg (%)	(No./Month)
5/31/2005	72.8	79.3	3.5	720	1,190	37	31	27	16,256	19,436	7.05	7.55	658	1,160	63	86	46	22,750	28,758	0	96	91	94	87	26
6/30/2005	75.2	82.8	5.1	602	909	31	24	25	15,461	15,421	7.14	7.65	513	1,160	43	46	37	19,743	23,470	0	96	94	94	88	16
7/31/2005	77.9	111.7	4.8	588	819	37	39	32	20,965	27,627	6.79	7.56	529	938	61	59	43	24,121	30,427	0	95	87	93	83	20
8/31/2005	79.3	146.5	3.5	704	989	29	54	40	26,474	32,151	6.56	7.55	498	762	86	59	36	19,444	21,622	0	94	83	94	86	10
9/30/2005	79.7	94.3	3.9	787	1,222	32	35	31	20,516	27,738	7.04	7.5	508	835	51	49	33	21,129	21,836	0	96	93	94	90	10
10/31/2005	82.5	90.7	4.7	883	1,300	37	35	30	20,909	23,342	7.04	7.48	773	1,102	53	61	45	25,744	32,065	0	97	91	95	92	18
11/30/2005	84.2	98.6	5.0	857	1,147	37	38	28	19,961	28,676	7.14	7.45	680	1,044	65	73	42	25,878	31,473	0	97	92	95	89	39
12/31/2005	82.6	101.6	4.8	827	1,458	42	40	30	20,815	27,913	6.9	7.52	684	1,387	55	64	52	29,183	37,024	0	96	93	94	87	25
1/31/2006	88.6	129.9	4.9	829	1,430	42	46	35	27,318	37,707	6.72	7.41	952	1,445	113	91	51	32,096	39,644	0	96	85	96	82	32
2/28/2006	86.5	103.9	4.2	759	1,232	33	33	28	20,090	26,015	6.94	7.39	1,090	1,508	42	51	41	23,919	34,163	0	96	93	97	93	24
3/31/2006	80.9	114.3	4.4	775	1,252	48	51	44	30,306	36,303	7.07	7.48	1,353	2,126	86	113	63	32,879	45,299	0	94	88	96	91	26
4/30/2006	75.1	98.4	5.5	657	880	35	35	29	18,321	21,955	6.99	7.55	1,305	1,584	43	52	42	22,168	26,162	0	96	94	97	96	21
5/31/2006	74.1	108.3	4.5	674	1,115	39	37	31	19,350	24,840	7.09	7.5	863	1,499	57	65	44	24,283	30,376	0	95	90	96	79	25
6/30/2006	73.9	93.5	4.2	676	981	31	31	23	14,434	17,978	6.73	7.52	852	1,340	43	52	38	19,055	22,626	0	97	92	96	91	13
7/31/2006	69.6	77.1	3.0	729	1,001	33	32	25	14,362	19,238	7.11	7.54	661	1,212	35	50	45	19,303	27,190	0	97	93	95	91	
8/31/2006	69.1	79.4	3.7	682	990	19	15	14	7,797	9,086	6.85	7.47	526	691	21	28	23	10,956	12,323	0	98	97	96	93	14
9/30/2006	63.2	90.5	5.2	717	1,028	16	14	13	6,612	7,299	7.09	7.9	495	799	22	26	20	8,194	10,820	0	98	97	97	95	24
10/31/2006	63.6	79.1	1.2	711	980	24	23	20	10,456	13,135	6.77	7.4	476	713	42	41	29	12,744	15,076	0	97	94	95	87	17
11/30/2006	62.1	90.2	5.3	807	1,216	31	51	29	15,291	28,182	6.87	7.36	521	784	65	62	49	16,266	26,985	0	96	90	94	85	24
12/31/2006	68.6	108.9	2.7	684	940	30	41	29	16,846	23,776	6.63	7.3	512	766	54	49	38	17,587	21,925	0	96	90	94	90	37
1/31/2007	73.7	117.4	4.6	652	1,225	34	46	33	20,767	30,288	6.3	7.38	507	1,048	58	55	46	20,929	30,666	0	95	89	93	87	32
2/28/2007	68.9	94.9	4.0	786	1,087	41	43	42	24,462	24,738	6.79	7.3	755	954	96	74	45	23,948	25,608	0	95	82	95	88	31
3/31/2007	66.2	73.2	3.8	891	1,326	39	62	38	21,332	38,617	6.62	7.39	733	1,283	91	71	55	21,621	34,156	0	96	90	95	91	49
4/30/2007	69.3	95.7	4.9	758	1,272	27	25	20	11,661	15,863	6.68	7.54	603	976	42	50	31	15,913	19,761	0	97	94	95	90	33
5/31/2007	67.1	82.7	5.6	682	969	21	23	18	9,939	12,880	6.95	7.89	518	855	30	31	27	11,983	15,501	0	97	96	96	93	21
6/30/2007	68.0	72.7	4.5	791	1,364	29	32	24	13,386	18,338	6.91	7.6	653	3,242	51	72	40	16,627	22,446	0	97	93	96	86	16
7/31/2007	69.3	82.6	4.5	716	982	21	19	16	8,977	10,407	6.83	7.6	557	1,091	33	35	24	11,839	13,715	0	98	94	96	93	7
8/31/2007	67.8	73.5	4.6	676	1,212	18	13	12	7,071	7,859	6.61	7.37	515	874	18	27	20	10,117	11,053	0	98	97	97	94	20
9/30/2007	64.6	70.2	4.3	787	1,181	30	31	25	13,557	16,633	7.12	7.7	615	1,078	49	49	37	16,138	19,928	0	97	94	95	91	17
10/31/2007	66.9	83.6	3.6	853	1,507	37	37	29	15,951	19,217	6.99	7.54	580	919	46	57	48	20,343	25,007	0	97	94	94	88	13
11/30/2007	66.5	81.6	4.2	839	1,043	36	37	29	15,995	20,178	6.9	7.4	555	963	67	66	45	20,091	24,434	0	97	94	93	88	20
12/31/2007	69.4	90.1	5.1	754	1,124	35	47	31	18,854	30,025	6.64	7.48	606	1,122	77	65	47	20,661	30,030	0	96	87	94	87	28
1/31/2008	70.5	96.2	5.2	770	1,343	43	40	38	23,221	26,262	7.02	7.59	630	1,037	93	70	45	25,639	29,009	0	95	88	93	87	29
2/29/2008	68.5	81.2	4.0	840	1,165	66	112	56	32,107	38,316	6.54	7.42	574	895	58	81	50	26,537	37,497	<0.1	93	76	91	80	23
3/31/2008	75.8	113.2	3.8	698	1,016	44	67	42	26,469	35,987	6.34	7.61	438	681	58	61	57	27,941	30,186	0	94	91	90	85	34
4/30/2008	86.7	144.1	2.3	656	1,077	42	49	36	27,487	46,927	6.55	7.62	508	945	63	67	56	31,982	53,760	0	94	84	92	78	35
5/31/2008	74.8	116.3	4.0	712	1,359	34	45	33	21,273	28,816	6.43	7.52	563	878	79	53	38	21,381	24,370	0.1	95	89	94	90	19
6/30/2008	69.4	86.9	4.8	790	947	29	38	25	14,206	21,731	6.41	7.52	589	815	58	63	40	17,019	23,208	0	97	90	95	89	18
7/31/2008	68.1	75.9	4.9	814	1,235	24	24	22	12,596	13,716	6.68	7.81	688	1,638	35	38	27	13,883	14,778	0	97	96	96	93	13
8/31/2008	73.1	106.5	4.1	805	1,139	22	33	24	14,716	20,889	7.02	7.65	752	1,328	51	62	33	13,289	21,022	0.1	97	94	97	95	18
9/30/2008	69.3	101.6	4.4	803	1,148	21	21	20	11,307	11,830	7.15	7.53	784	1,390	35	40	23	11,983	12,994	0.1	97	94	97	94	19
10/31/2008	68.2	93.3	3.6	832	1,205	36	38	32	18,261	23,322	6.96	7.54	831	1,365	57	79	50	20,662	31,180	0.1	96	91	95	83	10
11/30/2008	64.7	82.4	4.0	783	1,262	33	40	27	14,306	21,603	6.54	7.48	739	1,971	61	53	40	17,025	21,831	0.1	96	92	95	91	16
12/31/2008	72.7	138.3	2.6	715	1,052	77	147	52	31484	40314	6.60	7.56	573	1,016	69	107	55	33007	36917	<0.1	92	79	90	82	16
1/31/2009	69.8	119.2	5.3	793	1,373	38	54	28	16,819	27,378	6.25	7.56	758	3,439	38	64	31	18,597	27,337	<0.1	96	87	95	84	20
2/28/2009		123.9	5.0	626	1,013	22	38	18	8,864	11,461	6.68	7.49	531	867	28	34	24	11,349	14,712	0.1	97	93	95	92	17
3/31/2009	75.8	119.4	2.8	598	995	57	177	39	26,296	37,880	6.24	7.42	403	62	42	62	34	22,589	33,767	0.1	93	75	91	83	21
4/30/2009	69.2	106.4	2.2	653	1,007	35	84	34	19,046	22,419	6.74	7.46	494	761	40	63	38	21,502	25,367	0.1	94	87	91	75	21
5/31/2009	78.1	124.6	2.1	596	903	42	70	32	21,363	33,166	6.31	7.26	468	1,041	52	63	39	25,802	38,231	0.1	94	87	91	84	15
6/30/2009	67.3	82.7	4.1	621	829	36	53	28	15,636	20,995	7.03	7.49	450	939	44	62	38	21,245	25,845	0.1	96	91	91	86	12
7/31/2009	70.3	110.3	2.8	583	1,002	29	44	22	12,119	15,477	6.75	7.36	421	719	40	58	31	18,862	21,588	0.1	96	92	92	81	22
8/31/2009	65.9	84.9	1.4	696	1,610	28	38	24	13,313	18,772	6.65	7.58	455	697	35	49	30	16,347	25,199	0.1	96	94	93	87	17
9/30/2009	70.7	104.2	3.0	586	1,698	21	30	14	7,865	11,659	6.98	7.63	494	921	25	43	19	11,118	16,737	0.1	98	94	96	89	11
10/31/2009	80.4	129.1	4.6	560	900	22	38	17	11,765	15,510	6.55	7.44	496	914	27	43	24	16,965	21,824	0.1	96	86	94	86	11
11/30/2009	67.1	87.7	5.5	641	906	22	54	18	9,686	381,716	7.03	8.13	647	1,042	32	41	24	13,068	18,199	0.1	97	91	96	92	18
12/31/2009	74.4	114.4	5.5	551	981	20	29	18	11,452	14,310	6.30	7.42	513	981	29	45	26	16,142	20,233	0.1	96	90	95	89	21
1/31/2010	77.4	117.3	3.1	602	792	37	56	31	20,323	25,712	6.69	7.38	526	1,020	43	66	36	23,694	33,492	0.1	95	91	93	87	27
2/28/2010	81.5	123.8	4.0	583	826	43	54	34	21,249	32,134	6.64	7.98	511	906	48	56	38	23,992	36,088	0.1	94	88	92	82	25
3/31/2010	72.4	99.2	2.2	616	789	36	50	29	17,441	23,245	6.87	7.95	653	1,286	42	54	33	20,397	27,038	0.1	95	92	95	91	31
4/30/2010	73.6	110.8	1.5	633	876	18	46	15	9,011	10,493	6.70	7.91	730	1,087	25	70	23	13,839	14,393	0	98	95	97	91	23
5/31/2010	80.1	133.8	1.8	542	764	24	47	16	11,782	17,565	6.84	7.75	657	1,047	38	56	27	19,180	27,559	0.7	97	89	96	86	16
6/30/2009	72.1	80.3	4	680	929	15	27	13	7,693	8,827	6.4	7.75	648	1,121	24	43	19	11,182	14,225	0.2	98	96	97	92	16
7/31/2009	77	115.5	2.9	620	786	26	37	17	11,166	19,172		8.34	568	1,104	37	56	27	17,508	27,762	0	97	90	95	90	17
8/31/2009	83.1	95.7	3.1	672	1,038	23	31	13	9,248	15,840	6.03	8.54	566	1,028	30	39	19	12,844	20,751	0.2	98	96	97	92	11
9/30/2009	74.9	87.5	4.1	679	992	21	27	15	8,865	13,407	7.11	7.72	574	945	17	26	14	8,314	11,191	0.5	98	96	97	96	16
10/31/2009	68.5	80.7	5	691	952	21	33	15	8,857	12,812	6.95	8.06	710	1,174	25	37	17	9,968	15,393	0	98	94	97	94	14
11/30/2009	78	110.2	2.1	705	1,040	23	57	17	10,781	14,667	7.42	8.13	928	1,665	29	63	23	14,240	18,122	0.1	97	91	97	93	26
12/31/2009	66.7	77.1	3	750	1,118	31	52	25	13,909	17,927	7.26	8.24	712	1,331	34	53	29	16,241	20,057	0.1	97	94	96	92	30
1/31/2010	68.7	98	3.2	754	913	40	56	32	18,443	23,357	7.2	8.04	689	1,108	48	65	39	22,261	27,986	0.2	96	91	94	88	26
2/28/2010	66.6	89.3	2.1	712	970	42	63	38	18,953	23,141	6.1	8	593	1,249	57	89	48	24,231	32,290	0.2	95	89	91	79	16
3/31/2010	77.9	104.9	4.9	618	1,020	33	41	29	18,784	21,257	6.29	8.3	580	968	49	59	40	25,739	31,596	0.3	95	90	93	80	35
DMR Results (Months Ending 4/2000 Through 5/2010)																									
Average	**73.0**	**102.1**	**4.2**	**695**	**1,086**	**34**	**42**	**30**	**18,293**	**26,832**	**6.77**	**7.62**	**626**	**1,067**	**54**	**63**	**40**	**20,874**	**27,074**	**0.2**	**96**	**90**	**94**	**88**	**25**
Median	**72.4**	**96.2**	**4.4**	**692**	**997**	**35**	**38**	**30**	**18,243**	**22,406**	**6.79**	**7.54**	**578**	**983**	**52**	**61**	**39**	**20,661**	**25,283**	**0.0**	**96**	**91**	**95**	**88**	**23**
Maximum	**88.6**	**168.5**	**6.4**	**903**	**7,001**	**77**	**177**	**56**	**35,870**	**381,716**	**7.42**	**8.94**	**1,353**	**3,439**	**113**	**176**	**72**	**36,653**	**62,434**	**6.0**	**98**	**97**	**97**	**96**	**54**
Minimum	**59.9**	**70.2**	**0.5**	**8**	**763**	**15**	**4**	**12**	**6,612**	**7,299**	**6.03**	**7.18**	**403**	**62**	**17**	**26**	**14**	**8,194**	**10,820**	**0.0**	**91**	**75**	**90**	**66**	**7**
Count	**130**	**121**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**132**	**131**	**132**	**131**	**132**	**132**	**132**	**132**	**132**	**132**	**128**	**132**	**132**	**132**	**132**	**129**
Permit Limits	**Report**	**Report**	**1.0**	**Report**	**Report**	**63**	**84**	**42**	**31,525**	**47,288**	**6.0**	**9.0**	**Report**	**Report**	**72**	**96**	**48**	**36,029**	**54,043**	**1.0**	**85**	**40**	**85**	**40**	**0**
Exceedances	**NA**	**NA**	**1**	**NA**	**NA**	**3**	**4**	**8**	**3**	**3**	**0**	**0**	**NA**	**NA**	**24**	**7**	**31**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**129**

Appendix R-2B

E. coli Monitoring Data

MISSISSIPPI RIVER *E. coli* DATA

4-23-07 Draft

Sampling Location	Approx. River Mile	Station ID	*E. coli* (cfu/100 mL)								
			3/24/05		5/24/05		8/25/05		11/17/05		3/29/06
River Stage (ft)			7.9		10.5		-5.7		-5.2		12.0
Approx. 1.5 miles upstream of Loosahatchie River's mouth											
About 500 ft from AR bank	742	1	15		500		32,800		73		73 (a)
About 500 ft from TN bank	742	2	100		400		36		117		-
Nos. 13 & 14 N. Plant sludge lagoons (approx. 1 mile upstream of N. Plant discharge)											
About 100 ft from AR bank	740	3	74		720		18		36		-
About mid-channel	740	4	33		200		36		91		36
About 100 ft from TN bank	740	5	86		364		18		255		109
North bank of Wolf River's mouth (approx. 1,600 ft downstream of N. Plant discharge)											
About 100 ft from AR bank	738.5	6	40		400		73		91		-
About mid-channel	738.5	7	48		327		18		109		73
About 100 ft from TN bank	738.5	8	2,200		3,260		8,600		2,600		5,000
South end of Mud Island											
About 100 ft from AR bank	736	9	70		255		36		73		-
About mid-channel	736	10	68		218		36		73		145
About 100 ft from TN bank	736	11	840		2,280		11,000		436		700
Wolf River Harbor											
Underneath Mud Island Monorail, mid-channel	-	12	256		73		1,120		600		-
Parallel Gayoso pumping station discharge, mid-channel	-	13	356		36		1,040		1,000		73
Parallel Marble pumping station discharge, mid-channel	-	14	124		36		460		418		182

(a) Mid-channel

Note - grab samples; see "Source" for sampling notes, including climatological information

Source - www.sierraclub.org/watersentinels/tennessee/

Appendix R-2C

Treated Effluent – Listed Organic Pesticide Chemicals and PCB Results

Listed Organic Pesticide Chemicals and PCBs - T.E. Maxson Treatment Plant Effluent

Pesticide	Aug. 7, 2000 (ug/l)	Dec. 20, 2001 (ug/l)	Aug. 30, 2002 (ug/l)	Dec. 17, 2003 (ug/l)	Jun. 23, 2004 (ug/l)	Oct. 13, 2005 (ug/l)	Dec. 6, 2006 (ug/l)	Dec. 3, 2007 (ug/l)	Nov. 5, 2008 (ug/l)	Nov. 10, 2009 (ug/l)	Nov. 15, 2010 (ug/l)
Alpha-BHC	<0.042										
Lindane (gamma-BHC)	<0.042	<0.500	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor	<0.042	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Aldrin	<0.042	<0.500	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Heptachlor Epoxide	<0.042	<0.080	<0.050	<0.050	<0.050	<0.05	0.73	<0.05	<0.05	<0.05	<0.004
Endosulfan I (alpha)	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
Endosulfan II (beta)	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDD	<0.042	<0.100	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
4,4'-DDE	<0.042	<0.100	<0.050	<0.050	0.07	0.07	<0.05	<0.05	<0.05	<0.05	<0.004
Methoxychlor	<0.042										
Endrin Aldehyde	<0.042										
Hexachlorobenzene	<0.042										
Hexachloro-1,3,Butadiene	<0.103										
Hexachlorocyclopentadiene	<0.042										
Hexachloronorbornadiene	<0.042										
Octachlorocyclopentene	<0.042										
Heptachloronorbornene	<0.042										
Chlordane	<0.042	<0.100	<1.00	<1.0	<1.00	<1.0	<1.0	<1.0	<1.0	<1.0	<0.004
Endrin Ketone	<0.042										
Endrin	<0.048	<0.050	<0.050	<0.050	<0.050	<0.05	<0.05	<0.05	<0.05	<0.05	<0.004
PCBs-Total		<5.0	<5.0	<1.5	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Toxaphene		<5.0	<10.0	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.03

Note: Results for grab samples, unless otherwise noted.

Permittee indicated that as a result of 2000 NPDES permit the following pesticides were removed as analytical requirements: Alpha BHC, Methoxychlor, Endrin Aldehyde, Hexachlorobenzene, Hexachloro-1-3 Butadiene, hexachlorocyclopentadiene, Hexachloronorbornadiene, Octachlorocyclopentene, Heptachloronorbornene, and Endrin Ketone.

Appendix R-2D

Treated Effluent - Total Dioxin Results

Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans
Method 1613B (9/97)

PARAMETERS	TEF	Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.		Plt. Eff.	
Sample Date		10/8/1999		06/18/2000		12/19-20/2001		8/22/2002		10/22-23/2003		3/9-10/2004		8/2-3/2005		11/29-30 /2006		12/12-13/2007		1/24-25/2008		10/21-22/2009		12/6-7/2010	
		ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD	ppq	Eq/TCDD
2,3,7,8 TCDD	1	1	0.0000	0.9	0.8700	6.5	6.5000	7.8	0.0000	5.9	0.0000	3.3	0.0000	2.1	0.0000	1.0	0.0000	0.49	0.0000	0.6	0.0000	2.3	0.0000	0.87	0.0000
1,2,3,7,8-PeCDD	0.5	1.4	0.0000	0.70	0.0000	6.7	3.3500	9.8	0.0000	5.0	0.0000	2.7	0.0000	3.6	0.0000	1.8	0.0000	1.10	0.55	0.8	0.0000	3.9	0.0000	0.87	0.0000
1,2,3,4,7,8-HxCDD	0.1	1.1	0.0000	1	0.0000	5.4	0.0000	9.2	0.0000	5.2	0.0000	2.6	0.0000	2.8	0.0000	1.1	0.0000	1.10	0.0000	0.5	0.0000	4.2	0.0000	0.88	0.0000
1,2,3,6,7,8-HxCDD	0.1	1.1	0.0000	0.90	0.0000	6.2	0.6200	8.8	0.0000	5.5	0.0000	2.2	0.0000	2.9	0.0000	1.8	0.18	0.91	0.091	0.6	0.0550	5.2	0.0000	0.64	0.0000
1,2,3,7,8,9-HxCDD	0.1	1.1	0.0000	0.9	0.0000	12	1.1700	8.5	0.0000	5.6	0.0000	2.4	0.0000	2.8	0.0000	1.1	0.0000	0.57	0.057	0.5	0.0000	4.2	0.0000	0.60	0.0000
1,2,3,4,6,7,8-HpCDD	0.01	5.9	0.0590	4.4	0.0440	12	0.1150	12	0.0000	12	0.1150	3.5	0.0000	6.3	0.0000	11.8	0.118	3.70	0.037	3.60	0.0360	9.8	0.0000	1.6	0.016
1,2,3,4,6,7,8,9-OCDD	0	39	0.0391	56	0.0559	86	0.0857	114	0.1140	76	0.0758	29.1	0.0291	65	0.0653	148	0.148	22.0	0.022	30.0	0.0300	29	0.029	13.0	0.013
2,3,7,8 TCDF	0.1	0.8	0.0000	0.4	0.0000	5.8	0.5800	6.7	0.0000	5.1	0.0000	2.3	0.0000	1.2	0.0000	0.7	0.0000	0.39	0.039	0.5	0.0000	2.0	0.0000	0.63	0.0000
1,2,3,7,8-PeCDF	0.05	0.8	0.0000	0.4	0.0000	7.8	0.3900	6.3	0.0000	3.3	0.0000	6.3	0.0000	2.1	0.0000	1.1	0.0000	0.77	0.0385	0.4	0.0190	1.6	0.0000	0.63	0.0000
2,3,4,7,8-PeCDF	0.5	0.8	0.0000	0.5	0.0000	4.6	2.3000	5.8	0.0000	3.3	0.0000	1.9	0.0000	6.5	0.0000	1.1	0.0000	0.92	0.46	0.4	0.1750	1.2	0.0000	0.55	0.0000
1,2,3,4,7,8-HxCDF	0.1	2.6	0.2600	0.8	0.0000	6.1	0.6100	5.6	0.0000	3.5	0.0000	1.4	0.0000	6.4	0.0000	0.7	0.0000	1.10	0.11	0.5	0.0510	1.6	0.0000	0.67	0.0000
1,2,3,6,7,8-HxCDF	0.1	0.8	0.0000	0.7	0.0000	6.3	0.6300	5.5	0.0000	3.9	0.0000	4.5	0.4500	1.6	0.0000	0.7	0.0000	0.90	0.09	0.4	0.0000	1.9	0.0000	0.62	0.0000
2,3,4,6,7,8-HxCDF	0.1	0.9	0.0000	0.8	0.0000	5.9	0.5900	6.4	0.0000	3.8	0.0000	5.2	0.5200	1.5	0.0000	0.7	0.0000	0.99	0.099	0.45	0.0000	1.6	0.0000	0.78	0.0000
1,2,3,7,8,9-HxCDF	0.1	0.9	0.0000	1	0.0000	1	0.0000	8.4	0.0000	4.8	0.0000	2.0	0.0000	2.2	0.0000	0.9	0.0000	0.48	0.0000	2.10	0.0210	1.9	0.0000	0.78	0.0000
1,2,3,4,6,7,8-HpCDF	0.01	1	0.0000	1	0.0000	1	0.0000	7.8	0.0000	4.2	0.0000	1.8	0.0000	2.4	0.0000	0.9	0.0000	2.10	0.021	1	0.0000	2.5	0.0000	1.70	0.0000
1,2,3,4,7,8,9-HpCDF	0.01	1.3	0.0000	1.4	0.0000	1.4	0.0000	12	0.0000	5.3	0.0000	3.1	0.0000	3.9	0.0000	1.2	0.0000	1.30	0.000	3.9	0.0000	6.6	0.0000	2.30	0.0000
1,2,3,4,6,7,8,9-OCDF	0	11	0.0112	5	0.0000	5	0.0000	16	0.0000	27	0.0271	5.3	0.0000	25	0.0246	11.2	0.0112	3.40	0.0034	4.1	0.0041	6.7	0.0000	1.50	0.0000
TOTAL			**0.3693**		**0.9699**		**16.9407**		**0.1140**		**0.2179**		**0.9991**		**0.0899**		**0.4572**		**1.6179**		**0.3911**		**0.029**		**0.029**

Note: TEF = Toxicity Equivalency Factor; Eq/TCDD = Concentration in terms of 2,3,7,8, TCDD ppq(parts per quadrilion)
1pg/L=1/1000000ug/L or 1000000pg/L=1ug/L or 1pg/L=1/1000000000 mg/L

Appendix R-2E

Treated Effluent - Biomonitoring Results

LC_{50} and NOEC Results:

LC_{50} (96 hour): (Jun. 13-14, 2000, and Jun. 18, 2000)

Ceriodaphnia dubia (water flea) = 70.7%
Pimephales promelas (fathead minnow) = 54.4%

NOEC (7 day): (Jun. 13-14, 2000, Jun. 15-16, 2000, and Jun. 18, 2000)

Ceriodaphnia dubia (water flea): Survival = 50% and Reproduction = 50%
Pimephales promelas (fathead minnow): Survival < 6.25% and Reproduction < 6.25%

IC_{25} Results:

T. E. Maxson STP IC_{25} WET Testing Results

Sample Date	*Ceriodaphnia dubia* (water flea)	*Pimephales promelas* (fathead minnow)
Dec. 9 -11, 2003	18.5%	32.9%
Feb. 9 -13, 2004	32.4%	56.7%
Apr. 26 - 30, 2004	35.7%	33.1%
Jul. 19 - 23, 2004	27.6%	26.7%

(a) Submitted with Sept. 24, 2004 Permit Renewal Application.

Appendix R-2F

Cake Solids Mercury Results

T. E. Maxson STP Sludge Mercury Content

Date	Sludge	Hg (mg/kg)
10/12/2005	Secondary Cake	0.48
9/11/2002	Secondary Cake	0.161
12/5/2001	Primary Cake	0.161

Note: 2010 biosolids/sludges Hg = 0.74 mg/kg.
2009 biosolids/sludges Hg = 0.66 mg/kg.

Appendix R-3

Calculations – Federal Secondary Treatment Standards Effluent BOD_5 and TSS Variances

T.E. MAXSON STP - SECONDARY TREATMENT STANDARDS VARIANCE, PER 40 CFR PART 133.103(b)

A. Variance possible since selected industries contributions are >10 % of flow and/or BOD5 or TSS loadings.

		Flow (mgd)	BOD5 (lb/day)	TSS (lb/day)
T.E. Maxson STP - Design Capacity		90	500,000	300,000
Grain Mills Industries (a)	40CFR Part 406			
	Subpart			
Cargill	A	4.50	97,578	46,678
Kellogg	I	1.28	20,683	5,671
Solae	(b)	5.20	205,174	123,555
Total		10.98	118,261	52,349
Grain Mills Industries Input to STP (%)		12.2	23.7	17.4

(a) Values shown based on City of Memphis' Industrial Wastewater Agreements with selected industries.
(b) Non-Categorical Industry - Best Professional Judgment (BPJ) used for BOD5 and TSS allocations

B. Selected Industrial Contributions (b)

	Actual Production	Flow	BOD5				TSS			
			Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(1,000 bushels/day)	(mgd)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)	(lb/1,000 bushels)	(lb/day)
Selected Grain Mills Industries (40 CFR Part 406)										
Cargill (c)	260	4.50	20	5,200	60	15,600	25	6,500	75	19,500
Kellogg (c)	590	1.00	0.4	236	1.2	708	0.4	236	1.2	708
Solae (d)	482	3.70	20	9,643	60	28,929	25	12,054	75	36,161
Total		9.20		15,079		45,237		18,790		56,369

(c) Values shown based on Federal Effluent Guidelines Limitations (direct dischargers) and actual production rates for selected industries
(d) For BPJ, used effluent allocations shown per footnote "c". Converted production from lb/day to lb/1,000 bushels/day based on ratio of shell corn (56 lb/bushel) to soybean (60 lb/bushel)
Solae's actual production rate equals 450,000 lb/day.

C. T.E. Maxson STP Effluent Requirements - Without and With Secondary Treatment Standards Variance

T.E. Maxson STP Effluent Requirements	Flow	BOD5				TSS			
		Monthly Avg.		Daily Max.		Monthly Avg.		Daily Max.	
	(mgd)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)	(mg/l)	(lb/day)
Without Secondary Variance	90	30	22,518	60	45,036	30	22,518	60	45,036
Corrected for Selected Industrial Flow	9.20	30	2,302	60	4,604	30	2,302	60	4,604
net	80.80		20,216		40,432		20,216		40,432
With Secondary Variance Loading Allocation			35,295		85,569		39,006		96,801
With Secondary Variance Loading Allocation - resulting concentration	90	47.0		114.1		52.0		129.0	
Resulting weekly concentration assuming 1.5 X monthly value		70.5	Weekly Avg.			77.9	Weekly Avg.		

Appendix R-4

Aquatic Toxicity Potential due to Ammonia Nitrogen and Total Residual Chlorine (TRC) - Considerations

Potential aquatic toxicity within the Mississippi River due to the permittee's Outfall 001 discharged treated effluent ammonia-nitrogen and total residual chlorine (TRC) if chlorination is used, is addressed in this section.

AMMONIA- NITROGEN AQUATIC TOXICITY CONSIDERATIONS

To access chronic aquatic toxicity impacts, the state uses the EPA document, 1999 Update to Ambient Water Quality Criteria for Ammonia and assumed stream temperatures of 25°C and 15°C and pH of 7.5 or 8.0 to derive an allowable instream protection values. A mass balance equation with permittee's discharge and stream flows and this allowable value determines the monthly average permit limit. The criteria document states that a 30Q5 flow value is protective in deriving allowable values. Where the division has 30Q5 flow values, the division may use them. Otherwise, the division utilizes the available 7Q10 or 1Q10 values that are generally more conservative. The criteria continuous concentrations (CCC) derived from assumed temperature and pH values are as follows:

CCC values based on temperature and pH, in mg/L:

Temperature (°C)	7.5 pH	8.0 pH
30	1.61	0.90

Temperature (°C)	7.5 pH	8.0 pH
20	3.06	1.71

The mass balance equation is as follows:

$$CCC = \frac{Q_S C_S + Q_{STP} C_{STP}}{Q_S + Q_{STP}} \qquad \text{or,} \qquad C_{STP} = \frac{CCC\,(Q_S + Q_{STP}) - (Q_S C_S)}{Q_{STP}}$$

where:

CCC =Criteria continuous concentration (mg/l)
Q_S =Mississippi River 7Q10 flow (70,500 MGD) and Cooling Water Channel (TVA's Allen Fossil Plant Outfalls 002 and 003, 507.6 MGD)
Q_{STP} =STP Design flow (90 MGD)
C_S =Assumed/Measured upstream NH_3 – N (0.1 mg/l)
C_{STP} =Allowable STP discharge NH_3 – N (mg/l)

Assuming Complete Treated Effluent Dispersion Within the Receiving Stream:

Within Mississippi River

(summer)

$$C_{STP} = \frac{0.90\,(70{,}500+507.6+90) - (70{,}500 \times 0.1l)}{90} = 633 \text{ mg/l}$$

(winter)

$$C_{STP} = \frac{1.71\,(70{,}500+507.6+90) - (70{,}500 \times 0.1)}{90} = 1{,}273 \text{ mg/l}$$

Based on the permittee's treated effluent discharge characteristics (as provided in the permit renewal application) and the above evaluation results, Outfall 001 NH_3-N permit limits for discharge to the Mississippi River are not warranted.

TOTAL RESIDUAL CHLORINE (TRC) TOXICITY CONSIDERATIONS

Should the permittee start using chlorination for effluent disinfection, the following approach would be applicable. An acute residual chlorine limit is determined using the following mass balance and the EPA instream protection value of 0.019 mg/l for fish and aquatic life:

Assuming Complete Treated Effluent Dispersion Within the Receiving Stream:

where:

0.019	=	instream acute protection value (mg/l)
90	=	Qd, STP design flow (MGD)
70,500	=	Qs, Mississippi River 7Q10 flow (MGD)

Within - Mississippi River

Limit (mg/l) =

$$\frac{0.019\,(Qd + Qs)}{Qd} = \frac{0.019(90+70{,}500)}{90} = 14.9 \text{ mg/l}$$

New permit TRC limit for Outfall 001 discharge = 2.0 mg/l (from industry practice for breakpoint chlorination where 2.0 mg/l of free residual chlorine is associated with a 30 minute hydraulic retention time).

Appendix R-5

Whole Effluent Toxicity - Biomonitoring (LC_{50} and IC_{25}) Considerations

The division evaluates all dischargers for reasonable potential to exceed the narrative water quality criterion, "no toxics in toxic amounts" and the division has determined that for municipal facilities with stream dilutions of less than 500:1, any of the following conditions may demonstrate reasonable potential to exceed this criterion (the T.E. Maxson STP has all three) :

a. Some toxicity is suspected or demonstrated.
b. A pretreatment program is required.
c. The design capacity of the facility is greater than 1.0 MGD.

Based on the permittee's Outfall 001 treated effluent whole effluent toxicity (WET) results, the division considers potential WET conditions exists within the Mississippi River. The permittee's 90 MGD Outfall 001 discharge translates to a 790:1 dilution for fully dispersion within the Mississippi River.

EPA's **Technical Support Document for Water Quality Based Toxics Control** (TSD) recommends that the evaluation of both acute and chronic toxicity be based on the number of observations in the data set, the coefficient of variation and an uncertainty factor. The uncertainty factor value is taken from a chart in the technical support document and the coefficient of variation (C.V.) is based on the following numbers.

Less than ten observations C.V. = 0.6
More than ten observations C.V. = Standard Deviation/Mean

Biomonitoring test results are converted to Toxic Units (TU) as follows:

$TUa = 100/LC_{50}$ (for acute test results)
$TUc = 100/NOEC$ or $100/IC_{25}$ (for chronic test results)

To determine if acute and/or chronic biomonitoring is required in the new permit, the final acute value is compared to the criteria maximum concentration (CMC) for acute toxicity (CMC = 0.3 X TUa). The CMC is defined as the highest instream concentration of an effluent to which organisms can be exposed to for a brief period of time without causing an acute effect. The final chronic value is compared to the criteria continuous concentration (CCC) for chronic toxicity (CCC = 1.0 X TUc). The CCC is defined as the highest instream concentration of an effluent to which organisms can be exposed to indefinitely without causing an unacceptable effect. In the absence of chronic data, an acute to chronic ratio (ACR) of 4.4 is assumed (TSD Appendix A.3).

WET Based on Discharge into Mississippi River

Facility	T.E. Maxson STP							
NPDES No.	TN0020711				7Q10 =	70,500	MGD	TUupstream = 0.0 acute
Q_{design} =	90	MGD			1Q10 =	N/A		TUupstream = 0.0 chronic
Sample Dates	LC_{50} (%)	*sp.*	TU_a $100/LC_{50}$		Sample Dates	*sp.*	NOEC or IC_{25} (%)	TU_c 100/NOEC or $100/IC_{25}$
Jun 13-14 & Jun 18 2000	70.7	CD	1.4					
Jun 27-28 & Jul 2 2000	54.4	PP	1.8		Jun 13-14, Jun 15-16 & Jun 18 2000	CD	50	2.0
					Jun 13-14, Jun 15-16 & Jun 18 2000	PP	< 6.25	16.0
					Dec 9-11, 2003	CD	18.5	5.4
					Dec 9-11, 2003	PP	32.9	3.0
					Feb 9-13, 2004	CD	32.4	3.1
					Feb 9-13, 2004	PP	56.7	1.8
					Apr 26-30, 2004	CD	35.7	2.8
					Apr 26-30, 2004	PP	33.1	3.0
					Jul 19-23, 2004	CD	27.6	3.6
					Jul 19-23, 2004	PP	26.7	3.7
Count			2					10
Average			N/A					4.4
Maximum			1.8					16.0
Std Dev			N/A					4.2
Coeff. Of Variation (c.v.)			0.6					0.9
Uncertainty Factor (u.f.) (a)			3.8					1.8
TU loading @ Discharge = TU*u.f.*Q_{design}			629					2,592
TU loading @ Upstream = TUupstream * 7Q10			0					0
TU @ Downstream (c)			0.009					0.037
Biomonitoring Requirement (b)			NO					NO

(a) From uncertainly factors table. If standard deviation = 0.0, then use 1.0 for uncertainly factor.
(b) Biomonitoring required if TUa ≥ 0.3 and/or if TUc ≥ 1.0.
(c) TU loading downstream/(Qdesign + 7Q10)
(d) TU loading downstream/(Qdesign + TVA Allen Fossel Plant Flow)
Note: Maximum TUa and TUc values were used for discharge TU loadings. Also, upstream TU values are assumed.

In the current permit, the division used the NOEC as the measure of chronic toxicity and coupled it with the requirement to estimate the 96-hour LC_{50} (acute toxicity) from the NOEC. However, LC_{50} values cannot be accurately calculated from the NOEC, since the test requirements are different. The chronic toxicity IC_{25} test is deemed equal to but statistically preferred to the NOEC because the IC_{25} is not readily affected by variability in the test data and it incorporates both mortality and chronic effects.

As shown in the above biomonitoring summary table for discharge to the Mississippi River, the estimated TUa and TUc values do not exceed the CMC and CCC, respectively. As such, a reasonable potential for instream acute and chronic toxicity are not demonstrated, for the Outfall 001 treated effluent fully dispersed in the Mississippi River under low-flow conditions. However, since the actual Outfall 001 discharge mixing characteristics within the Mississippi River have not been determined at this time, 48-hour LC_{50} biomonitoring testing is also required for the new permit. The division may modify the new permit acute WET requirements if warranted based the actual Outfall 001 biomonitoring results, and the Outfall 001 discharge transport/dispersion characteristics within the Mississippi River, pursuant to the new permit's Section 3.5 requirements.

Appendix R-6

Water-Quality Based Effluent Calculations- Other Parameters/Antidegradation Considerations

The following procedure is used to calculate the allowable instream concentrations within the Mississippi River for pass-through guidelines and permit limitations. Water quality assessments (acute aquatic toxicity and human health considerations) were also completed for the Outfall 001 treated effluent discharge to the Cooling Water Channel.

a. The following general approach was used for water quality calculations related to discharge to the Mississippi River, based on recent data:

   * 7Q10 of receiving stream (70,500 MGD, USGS)
   * Calcium hardness (192 mg/l)
   * Total suspended solids (71 mg/l, default)
   * Background metals concentrations (½ water quality criteria)
   * Other dischargers impacting this segment (as referenced)
   * Downstream water supplies, not applicable

b. The chronic water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel and zinc. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions.

c. The acute water quality criteria is converted from total recoverable metal at lab conditions to dissolved lab conditions for the following metals: cadmium, copper, lead, nickel, zinc, and silver. Then translators are used to convert the dissolved lab conditions to total recoverable metal at ambient conditions for the following metals: cadmium, copper, lead, nickel, and silver.

d. The chronic criteria for Chromium (T) is given in the total recoverable form and is not converted to a dissolved lab condition or to the total recoverable ambient condition.

e. A standard mass balance equation determines the total allowable concentration (permit limit) for each pollutant. This equation also includes a percent stream allocation of no more than 90%.

The following formulas are used to evaluate water quality protection:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow
Qs = stream low flow

to protect water quality:

$$Cw \leq \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

where (S_A) is the percent "Stream Allocation".

Calculations for this permit have been done using a standardized spreadsheet, titled "Water Quality Based Effluent Calculations." Division policy dictates the following procedures in establishing these permit limits:

1. The critical low flow values are determined using USGS data:

   Fish and Aquatic Life Protection
   7Q10 - Low flow under natural conditions
   1Q10 - Regulated low flow conditions

   Other than Fish and Aquatic Life Protection
   30Q5 - Low flow under natural conditions

2. Fish & Aquatic Life water quality criteria for certain Metals are developed through application of hardness dependent equations. These criteria are combined with dissolved fraction methodologies in order to formulate the final effluent concentrations.

3. For criteria that are hardness dependent, chronic and acute concentrations are based on a Hardness of 25 mg/L and Total Suspended Solids (TSS) of 10 mg/L unless STORET or Water Supply intake data substantiate a different value. Minimum and maximum limits on the hardness value used for water quality calculations are 25 mg/L and 400 mg/L respectively. The minimum limit on the TSS value used for water quality calculations is 10 mg/L.

4. Background concentrations are determined from the division database, results of sampling obtained from the permittee, and/or obtained from nearby stream sampling data. If this background data is not sufficient, one-half of the chronic "In-stream Allowable" water quality criteria for fish and aquatic life is used. If the measured background concentration is greater than the chronic "In-stream Allowable" water quality criteria, then the measured background concentration is used in lieu of the chronic "In-stream Allowable" water quality criteria for the purpose of calculating the appropriate effluent limitation (Cw). Under these circumstances, and in the event the "stream allocation" is less than 100%, the calculated chronic effluent limitation for fish and aquatic life should be equal to the chronic "In-stream Allowable" water quality criteria. These guidelines should be strictly followed where the industrial source water is not the receiving stream. Where the industrial source water is the receiving stream, and the measured background concentration is greater than the chronic "In-stream Allowable" water

quality criteria, consideration may be given as to the degree to which the permittee should be required to meet the requirements of the water quality criteria in view of the nature and characteristics of the receiving stream.

The spreadsheet has fifteen (15) data columns, all of which may not be applicable to any particular characteristic constituent of the discharge. A description of each column is as follows:

Column 1: The "Stream Background" concentrations of the effluent characteristics.

Column 2: The "Chronic" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Continuous Concentration (CCC) is calculated using the equation:

$$CCC = (\exp \{ m_C [\ln (\text{stream hardness})] + b_C \}) (CCF)$$

CCF = Chronic Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained *in The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no chronic criteria exists for silver. Published criteria are used for non-metal parameters.

Column 3: The "Acute" Fish and Aquatic Life Water Quality criteria. For Cadmium, Copper, Lead, Nickel, Silver, and Zinc, this value represents the criteria for the dissolved form at laboratory conditions. The Criteria Maximum Concentration (CMC) is calculated using the equation:

$$CMC = (\exp \{ m_A [\ln (\text{stream hardness})] + b_A \}) (ACF)$$

ACF = Acute Conversion Factor

This equation and the appropriate coefficients for each metal are from Tennessee Rule 1200-4-3-.03 and the EPA guidance contained in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996). Values for other metals are in the total form and are not hardness dependent; no acute criteria exists for Total Chromium. Published criteria are used for non-metal parameters.

Column 4: The “Fraction Dissolved” converts the value for dissolved metal at laboratory conditions (columns 2 & 3) to total recoverable metal at in-stream ambient conditions (columns 5 & 6). This factor is calculated using the linear partition coefficients found in *The Metals Translator: Guidance For Calculating A Total Recoverable Permit Limit From a Dissolved Criterion* (EPA 823-B-96-007, June 1996) and the equation:

$$\frac{C_{diss}}{C_{total}} = \frac{1}{1 + \{ [K_{po}] [ss^{(1+a)}] [10^{-6}] \}}$$

ss = in-stream suspended solids concentration [mg/l]

Linear partition coefficients for streams are used for unregulated (7Q10) receiving waters, and linear partition coefficients for lakes are used for regulated (1Q10) receiving waters. For those parameters not in the dissolved form in columns 2 & 3 (and all non-metal parameters), a Translator of 1 is used.

Column 5: The "Chronic" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 2 by the value in column 4.

Column 6: The "Acute" Fish and Aquatic Life Water Quality criteria at in-stream ambient conditions. This criteria is calculated by dividing the value in column 3 by the value in column 4.

Column 7: The "Chronic" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the chronic limit.

Column 8: The "Acute" Calculated Effluent Concentration for the protection of fish and aquatic life. This is the acute limit.

Column 9: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Organism Consumption (Recreation).

Column 10: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Water and Organism Consumption. These criteria are only to be applied when the stream use classification for the receiving stream includes both “Recreation” and “Domestic Water Supply.”

Column 11: The In-Stream Water Quality criteria for the protection of Human Health associated with the stream use classification of Domestic Water Supply.

Column 12: The Calculated Effluent Concentration associated with Organism Consumption.

Column 13: The Calculated Effluent Concentration associated with Water and Organism Consumption.

Column 14: The Calculated Effluent Concentration associated with Domestic Water Supply.

Column 15: The Effluent Limited criteria. This upper level of allowable pollutant loading is established if (a) the calculated water quality value is greater than accepted removal efficiency values, (b) the treatment facility is properly operated, and (c) full compliance with the pretreatment program is demonstrated. This upper level limit is based upon EPA's 40 POTW Survey on levels of metals that should be discharged from a POTW with a properly enforced pretreatment program and considering normal coincidental removals.

The most stringent water quality effluent concentration from Columns 7, 8, 12, 13, 14, and 15 is applied if the receiving stream is designated for domestic water supply. Otherwise, the most stringent effluent concentration is chosen from columns 7, 8, 12, and 15 only.

PASS-THROUGH LIMITATIONS

Pass-through limitations for heavy metals and other toxic substances have been recalculated as part of the permit issuance process and/or due to changes in industrial waste contribution to the POTW. This POTW is required to implement/maintain a pretreatment program. More frequent monitoring will be required in the permit if (a) the reported concentrations approach or exceed calculated allowable values, (b) significant amounts of particular pollutants are present which may impact the treatment process sludge character or the receiving stream, or (c) minimum information is lacking to accurately calculate water quality protection values, in which case additional stream monitoring may also be required.

Based on the permittee's annually reported data and the Mississippi River flow, the Outfall 001 treated effluent does not indicate that the potential exists for the water quality criteria for any parameter to be exceeded.

VOLATILE ORGANIC, ACID-EXTRACTABLE, AND BASE-NEUTRAL COMPOUNDS

The division evaluated effluent concentrations of volatile organic, acid-extractable, and base-neutral compounds and antimony, arsenic, beryllium, selenium and thallium for potential to violate water quality criteria using the following mass balance equation:

$$Cm = \frac{QsCs + QwCw}{Qs + Qw}$$

where:

Cm = resulting in-stream concentration after mixing
Cw = concentration of pollutant in wastewater
Cs = stream background concentration
Qw = wastewater flow, (STP design flow)
Qs = stream low flow

to protect water quality:

$$Cw \leq Ca$$

where:

Ca = STP effluent concentration allowable

$$= \frac{(S_A)\,[Cm\,(Qs + Qw) - QsCs]}{Qw}$$

and (S_A) = the percent "Stream Allocation".

The reasonable potential evaluation uses the following assumptions and procedures:

a. Stream background concentrations, Cs, for all volatile organic, acid-extractable, and base-neutral compounds equal zero unless actual stream data exists to show otherwise. Use of the effluent concentrations of such pollutants contributed by upstream dischargers as background is not justifiable due to the volatility and reactivity of these pollutants.

b. The stream allocation, S_A , is 90% and is used as a factor of safety.

c. A mass balance uses the STP design flow, the receiving stream critical low flow (7Q10 or 1Q10), the state water quality numeric criteria, and the stream allocation safety factor to derive the allowable effluent concentrations.

d. When pollutants have potential to violate standards because the concentrations are below the scan detection levels but could be above the allowable water quality based effluent concentrations, the pollutants are handled one of three (3) ways:

i. Additional testing of detected and non-detected pollutants is required if contributing industrial processes are likely to contain them and the effluent scans have not met the minimum required detection levels (RDL) in the state water quality standards or approximated the method detection limits (MDL) of the approved test methods for the pollutants in 40 CFR Part 136.

ii. If the required RDL has been used and resulted in non-detection, or if an MDL has been used with non-detection and the contributing industrial processes do not reasonably contain that pollutant, the division drops the pollutant from further consideration.

iii. Pollutants detected at levels high enough to violate standards are limited in the permit to the allowable concentration, Cw, based on STP design flow.

Calculations for this permit have been done using a standardized spreadsheet, titled "WQ Based Effluent Calculations- Other Compounds".

The evaluation indicates that volatile organic, acid extractable, and base neutral compounds and antimony, arsenic, beryllium, selenium, and thallium do not exhibit the potential to violate water quality criteria within the Mississippi River, and thus will

not be given effluent limitations and monitoring requirements in the permit from a pass – through standpoint.

2007 WQC

PASS-THROUGH LIMITATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

Calculations for nickel, cadmium, zinc, and cyanide

FACILITY:	PERMIT #:	DATE:	CALC BY:
Memphis - TE Maxson STP	TN0020729	6/1/2009	YLM

non-regulated stream worksheet (7Q10)

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	90	71	192	50

Mississippi River is considered non-wadeable

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
	Stream	Fish/Aqua. Life (F & AL) WQC			F & AL- instream allowable		Calc. Effluent Concentration		Human Health Water Quality Criteria *						effluent	
	Bckgrmd.	lab conditions		Fraction	ambient conditions (Tot)		based on F & AL		In-Stream Criteria			Calc. Effluent Concentration **			limited	
	Conc.	Chronic	Acute	Dissolved	Chronic	Acute	Chronic	Acute	Organisms	Water/Organisms	DWS	Organisms	Water/Organisms	DWS	case	
PARAMETER	[ug/l]	[ug/l]	[ug/l]	[Fraction]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	ug/l	**PARAMETER**
Copper (a,b)	5.500	15.638	24.848	0.244	64.153	101.937	**23004.65**	**37822.29**	N/A	N/A	N/A	**N/A**	N/A	N/A	**80.0**	**Copper (a,b)**
Chromium III	349.040	126.452	972.116	0.181	698.081	5366.573	**137056.55**	**1967883.53**	N/A	N/A	N/A	**N/A**	N/A	N/A		**Chromium III**
Chromium VI	5.500	11.000	16.000	1.000	11.000	16.000	**2159.67**	**4120.50**	N/A	N/A	N/A	**N/A**	N/A	N/A		**Chromium VI**
Chromium, Total	1.000	N/A	N/A	N/A	N/A	N/A	**N/A**	**N/A**	N/A	N/A	100.0	**N/A**	N/A	49495.00	**60.0**	**Chromium, Total**
Nickel (a,b)	5.000	90.309	813.088	0.248	364.751	3283.999	**141084.83**	**1285916.78**	4600.0	610.0	100.0	**2297247.22**	302468.89	47497.22	**180.0**	**Nickel (a,b)**
Cadmium (a,b)	0.500	0.387	3.795	0.304	1.273	12.492	**303.56**	**4703.25**	N/A	N/A	5.0	**N/A**	N/A	2250.00	**5.0**	**Cadmium (a,b)**
Lead (a,b)	2.500	5.080	130.362	0.132	38.444	986.532	**14097.19**	**385905.85**	N/A	N/A	5.0	**N/A**	N/A	1251.11	**45.0**	**Lead (a,b)**
Mercury (T) (c,e)	0.720	0.770	1.400	1.000	0.770	1.400	**19.97**	**267.03**	0.051	0.05	2.0	**-334.10**	-334.60	640.29	**0.4**	**Mercury (T) (c,e)**
Silver (a,b,f)	4.939	N/A	9.879	1.000	N/A	9.879	**N/A**	**1939.50**	N/A	N/A	N/A	**N/A**	N/A	N/A	**5.0**	**Silver (a,b,f)**
Zinc (a,b)	18.000	205.321	203.656	0.185	1112.488	1103.462	**429230.78**	**425690.98**	N/A	N/A	N/A	**N/A**	N/A	N/A	**200.0**	**Zinc (a,b)**
Cyanide (d)	2.600	5.200	22.000	1.000	5.200	22.000	**1020.93**	**7609.33**	140.0	140.0	200.0	**68693.67**	68693.67	98690.33	**230.0**	**Cyanide (d)**
Toluene	0.000								15000.0	1300.0	1000.0	**7499166.67**	649927.78	499944.44	**15.0**	**Toluene**
Benzene	0.000								510.0	22.0	5.0	**254971.67**	10998.78	2499.72	**3.0**	**Benzene**
1,1,1 Trichloroethane	0.000								N/A	N/A	200.0	**N/A**	N/A	99988.89	**30.0**	**1,1,1 Trichloroethane**
Ethylbenzene	0.000								2100.0	530.0	700.0	**1049883.33**	264970.56	349961.11	**4.0**	**Ethylbenzene**
Carbon Tetrachloride	0.000								16.0	2.3	5.0	**7999.11**	1149.87	2499.72	**15.0**	**Carbon Tetrachloride**
Chloroform	0.000								4700.0	57.0	N/A	**2349738.89**	28496.83	N/A	**85.0**	**Chloroform**
Tetrachloroethylene	0.000								33.0	6.9	5.0	**16498.17**	3449.62	2499.72	**25.0**	**Tetrachloroethylene**
Trichloroethylene	0.000								300.0	25.0	5.0	**149983.33**	12498.61	2499.72	**10.0**	**Trichloroethylene**
1,2 trans Dichloroethylene	0.000								10000.0	140.0	100.0	**N/A**	69992.22	49994.44	**1.5**	**1,2 trans Dichloroethylene**
Methylene Chloride	0.000								5900.0	46.0	N/A	**2949672.22**	22997.44	N/A	**50.0**	**Methylene Chloride**
Total Phenols	0.000								N/A	N/A	N/A	**N/A**	N/A	N/A	**50.0**	**Total Phenols**
Naphthalene	0.000								N/A	N/A	N/A	**N/A**	N/A	N/A	**1.0**	**Naphthalene**
Total Phthalates	0.000								N/A	N/A	N/A	**N/A**	N/A	N/A	**64.5**	**Total Phthalates**
Chlorine (T. Res.)	5.500	11.000	19.000	1.000	11.000	19.000	**4319.33**	**10594.00**	N/A	N/A	N/A	**N/A**	N/A	N/A	**N/A**	**Chlorine (T. Res.)**

a Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.
b The criteria for this metal is in the dissolved form at lab conditions. The calculated effluent concentration is in the total recoverable form.
c The chronic criteria for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity.
d The criteria for this parameter is in the total form.
e Previously, the Division established that 0.006 ug/L would be maximum background default if no sample data available or if all samples were <RDL (<0.2 ug/L), based on reference stream monitoring by DOE.
f Silver limit is daily max if column 8 is most stringent.
g When columns 7 or 8 result in a negative number, use results from columns 5 or 6, respectively.
h When columns 12, 13 or 14 result in a negative number, use results from columns 9, 10 or 11, respectively, as applicable.
* Domestic supply included in river use so pick from columns 7,8,12,13,14,15 or Domestic supply not included in river use so pick from columns 7, 8, 12 or 15.
** Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow.

T.E. Maxson	PTL 2/6/1998	85% PTLs	Proposed 6/1/2009	Jan-Dec 09	Jan-Dec 08	Jan-Dec 07	Jan-Dec 06	Jan-Dec 05	Jan-Dec 04	Jan-Dec 03	Jan-Dec 02	Oct-00 AR - Feb 01	Apr-00
COPPER	**0.0800**	**0.0680**	**0.0800**	0.00438	0.02110		0.00560	0.00698	0.01053	0.07160	0.00800	0.00779	0.00859
CHROMIUM, III	**N/A**	**N/A**	**report**										
CHROMIUM, VI	**N/A**	**N/A**	**report**										
CHROMIUM, TOTAL	**0.0600**	**N/A**	**N/A**	0.00170	0.00821		0.00257	0.00261	0.00320	0.03030	0.00400	0.00180	0.00170
NICKEL	**0.1800**	**0.1530**	**0.1800**	0.01607	0.03830		0.02516	0.01717	0.02070	0.01797	0.02800	0.02135	0.02000
CADMIUM	**0.0050**	**0.0043**	**0.0050**	0.00101	0.00202		0.00101	0.00101	0.00101	0.00005	0.00050	0.00002	0.00002
LEAD	**0.0450**	**0.0383**	**0.0450**	0.00050	0.00146		0.00200	0.00200	0.00200	0.00200	0.00200	0.00052	0.00060
MERCURY	**0.000400**	**0.000043**	**0.000051**									0.00020	0.00020
SILVER	**0.0050**	**0.0043**	**0.0050**									0.00001	0.00008
ZINC	**0.2000**	**0.1700**	**0.2000**	0.01364	0.08200		0.01671	0.01818	0.02627	0.01478	0.02300	0.03425	0.02965
CYANIDE	**0.2300**	**0.1955**	**0.2300**	0.00438	0.01000		0.00001	0.01010	0.01007	0.01010	0.01010	0.00001	0.00001
TOLUENE	**0.0150**	**0.0128**	**0.0150**		0.00163							0.00500	0.00500
BENZENE	**0.0030**	**0.0026**	**0.0030**		0.00100							0.00100	0.00100
1,1,1 TRICHLOROETHANE	**0.0300**	**0.0255**	**0.0300**		0.00100							0.00100	0.00100
ETHYLBENZENE	**0.0040**	**0.0034**	**0.0040**		0.00100							0.00100	0.00100
CARBON TETRACHLORIDE	**0.0150**	**0.0128**	**0.0150**		0.00100							0.00100	0.00100
CHLOROFORM	**0.0850**	**0.0723**	**0.0850**		0.00069							0.00100	0.00100
TETRACHLOROETHYLENE	**0.0250**	**0.0213**	**0.0250**		0.00100							0.00100	0.00100
TRICHLOROETHYLENE	**0.0100**	**0.0085**	**0.0100**		0.00100							0.00100	0.00100
1,2 TRANSDICHLOROETHYL	**0.0015**	**0.0013**	**0.0015**		0.00100							0.00160	0.00160
METHYLENE CHLORIDE	**0.0500**	**0.0425**	**0.0500**		0.00100							0.00200	0.02000
TOTAL PHENOLS	**0.0500**	**0.1190**	**0.1400**	0.05000	0.05000		0.00556	0.00556	0.00959	0.00808	0.02420	0.02550	**0.06900**
NAPHTHALENE	**0.0010**	**0.0009**	**0.0010**		0.00100							0.00200	0.00200
TOTAL PHTHALATES	**0.0645**	**0.0548**	**0.0645**		0.02545							0.03966	0.03960

Bolded in effluent data exceeds 85% of proposed PTLs
Shaded means detection level

First Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	90	71	192	50

	1	2	3	5	6	7	8	9	10	11	12	13	14	15
	Stream	Dectection Levels		Fish/Aqua. Life		Calculated Effluent		Human Health Water Quality Criteria (30Q5)						Permit Renewal
	Bckgrnd.	Scan	WQC RDL	Water Quality Criteria		Concentration		In-Stream Criteria			Calculated Effluent Concentration			Application (3 Values)
PARAMETER	Conc. [ug/l]	MDL [ug/l]	*EPA MDL [ug/l]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Avg/Max [ug/l]
HEPTACHLOR EPOXIDE			0.08	0.0038	0.52	1.49	204	0.00039	0.00039	0.2	0.19	0.2	100.0	0.73 (12/6/2006)
4,4'-DDE			0.1					0.0022	0.0022		1.1	1.1		0.07 (6/23/2004 &10/13/2005)
ANTIMONY		5.0	3.0					640.0	5.6	6.0	319964.4	2799.7	2999.7	8.4/9.09
ARSENIC		2.0	1.0	150.0	340.0	58825.0	133336.7	10.0	10.0	10.0	4999.4	4999.4	4999.4	<2.0/<2.0
BERYLLIUM		1.0	1.0							4.0			1999.8	<1.0/<1.0
SELENIUM		3.0	2.0	5.0	20.0	1960.8	7843.3			50.0			24997.2	<3.0/<3.0
THALLIUM		10.0	*					0.47	0.24	2.0	235.0	120.0	999.9	<10/<10
ACROLEIN	0.0	10.0	1.0					290.0	190.0		144983.9	94989.4		<10/<10
ACRYLONITRILE	0.0	10.0	1.0					2.5	0.51		1249.9	255.0		<10/<10
BENZENE	0.0	5.0	1.0					510.0	22.0	5.0	254971.7	10998.8	2499.7	<5/<5
BROMOFORM	0.0	5.0	1.0					1400.0	43.0		699922.2	21497.6		<5/<5
CARBON TETRACHLORIDE	0.0	5.0	1.0					16.0	2.3	5.0	7999.1	1149.9	2499.7	<5/<5
CHLOROBENZENE	0.0	5.0	*					1600.0	130.0	100	799911.1	64992.8	49994.4	<5/<5
CHLORODIBROMO-METHANE	0.0	10.0	*					130.0	4.0		64992.8	1999.8		<10/<10
CHLOROETHANE	0.0	10.0	*											<10/<10
2-CHLORO-ETHYLVINYL ETHER	0.0	10.0	*											<10/<10
CHLOROFORM	0.0	5.0	0.5					4700.0	57.0		2349738.9	28496.8		<5/<5
DICHLOROBROMO-METHANE	0.0	5.0	1.0					170.0	5.5		84990.6	2749.7		<5/<5
1,1-DICHLOROETHANE	0.0	5.0	1.0					NA	NA	NA	NA	NA	NA	<5/<5
1,2-DICHLOROETHANE	0.0	5.0	1.0					370.0	3.8	5.0	184979.4	1899.8	2499.7	<5/<5
TRANS 1,2-DICHLORO-ETHYLENE	0.0	5.0	*					10000	140.0	100.0	4999444.4	69992.2	49994.4	<5/<5
1,1-DICHLOROETHYLENE	0.0	5.0	1.0					7,100	330	7.0	3549605.6	164981.7	3499.6	<5/<5
1,2-DICHLOROPROPANE	0.0	5.0	*					150.0	5.0	5.0	74991.7	2499.7	2499.7	<5/<5
1,3-DICHLORO-PROPYLENE	0.0	5.0	1.0					210.0	3.4		104988.3	1699.8		<5/<5
ETHYLBENZENE	0.0	5.0	1.0					2100	530.0	700.0	1049883.3	264970.6	349961.1	<5/<5
METHYL BROMIDE	0.0	10.0	*					1500.0	47.0		749916.7	23497.4		<10/<10
METHYL CHLORIDE	0.0	10.0	1.0											<10/<10
METHYLENE CHLORIDE	0.0	5.0	1.0					5900.0	46.0		2949672.2	22997.4		<5/<5
1,1,2,2-TETRACHLORO-ETHANE	0.0	5.0	0.5					40.0	1.7		19997.8	849.9		<5/<5
TETRACHLORO-ETHYLENE	0.0	5.0	0.5					33.0	6.9	5.0	16498.2	3449.6	2499.7	<5/<5
TOLUENE	0.0	5.0	1.0					15000	1300.0	1000.0	7499166.7	649927.8	499944.4	<5/<5
1,1,1-TRICHLOROETHANE	0.0	5.0	1.0							200.0			99988.9	<5/<5
1,1,2-TRICHLOROETHANE	0.0	5.0	0.2					160.0	5.9	5.0	79991.1	2949.7	2499.7	<5/<5
TRICHLORETHYLENE	0.0	5.0	1.0					300.0	25.0	5.0	149983.3	12498.6	2499.7	<5/<5
VINYL CHLORIDE	0.0	10.0	2.0					24.0	0.25	2.0	11998.7	125.0	999.9	<10/<10
P-CHLORO-M-CRESOL	0.0	10.0	*											<10/<10
2-CHLOROPHENOL	0.0	10.0	*					150.0	81.0		74991.7	40495.5		<10/<10
2,4-DICHLOROPHENOL	0.0	10.0	*					290.0	77.0		144983.9	38495.7		<10/<10
2,4-DIMETHYLPHENOL	0.0	10.0	*					850.0	380.0		424952.8	189978.9		<10/<10
4,6-DINITRO-O-CRESOL	0.0	10.0	24.0					280.0	13.0		139984.4	6499.3		<20/<20
2,4-DINITROPHENOL	0.0	10.0	42.0					5300.0	69.0		2649705.6	34496.2		<10/<10
2-NITROPHENOL	0.0	10.0	*											<10/<10
4-NITROPHENOL	0.0	10.0	*											<10<10
PENTACHLOROPHENOL	0.0	20.0	5.0	15	19	5882.5	7451.2	30.0	2.7	1.0	14998.3	1349.9	499.9	<20/<20
PHENOL	0.0	20.0	*					1700000	21000.0		849905555.6	10498833.3		<20/<20

Second Part of Summary

WATER QUALITY BASED EFFLUENT CALCULATIONS
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Margin of Safety [%]
70,500	89,900	90	71	192	50

	1	2	3	5	6	7	8	9	10	11	12	13	14	15
	Stream	Dectection Levels		Fish/Aqua. Life		Calculated Effluent		Human Health Water Quality Criteria (30Q5)						Permit Renewal
	Bckgrnd.	Scan	WQC RDL	Water Quality Criteria		Concentration		In-Stream Criteria			Calculated Effluent Concentration			Application (3 Values)
PARAMETER	Conc. [ug/l]	MDL [ug/l]	*EPA MDL [ug/l]	Chronic [ug/l]	Acute [ug/l]	Chronic [ug/l]	Acute [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Organisms [ug/l]	Water/Org [ug/l]	DWS [ug/l]	Avg/Max [ug/l]
2,4,6-TRICHLOROPHENOL	0.0	10.0	2.7					24.0	14.0		11998.7	6999.2		<10<10
ACENAPHTHENE	0.0	10.0	*					990.0	670.0		494945.0	334962.8		<10<10
ACENAPHTHYLENE	0.0	10.0	2.3											<10<10
ANTHRACENE	0.0	10.0	0.7					40000	8300.0		19997777.8	4149538.9		<10/<10
BENZIDINE	0.0	50.0	*					0.0020	0.00086		1.000	0.4		<10/<10
BENZO(A)ANTHRACENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BENZO(A)PYRENE	0.0	10.0	0.3					0.18	0.038	0.2	90.0	19.0	100.0	<10/<10
3,4 BENZO-FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BENZO(GHI)PERYLENE	0.0	10.0	*											<10/<10
BENZO(K)FLUORANTHENE	0.0	10.0	0.3					0.18	0.038		90.0	19.0		<10/<10
BIS (2-CHLOROETHOXY) METHANE	0.0	10.0	*											<10/<10
BIS (2-CHLOROETHYL)-ETHER	0.0	10.0	1.0					5.3	0.30		2649.7	150.0		<10/<10
BIS (2-CHLOROISO-PROPYL) ETHER	0.0	10.0	*					65000	1400.0		32496388.9	699922.2		<10/<10
BIS (2-ETHYLHEXYL) PHTHALATE	0.0	10.0	2.5					22.0	12.0	6.0	10998.8	5999.3	2999.7	<10/<10
4-BROMOPHENYL PHENYL ETHER	0.0	10.0	*											<10/<10
BUTYL BENZYL PHTHALATE	0.0	10.0	*					1900.0	1500.0		949894.4	749916.7		<10/<10
2-CHLORONAPHTHALENE	0.0	10.0	*					1600.0	1000.0		799911.1	499944.4		<10/<10
4-CHLORPHENYL PHENYL ETHER	0.0	10.0	*											<10/<10
CHRYSENE	0.0	10.0	2.5					0.18	0.038		90.0	19.0		<10/<10
DI-N-BUTYL PHTHALATE	0.0	10.0	2.5					4500.0	2000.0		2249750.0	999888.9		<10/<10
DI-N-OCTYL PHTHALATE	0.0	10.0	*											<10/<10
DIBENZO(A,H) ANTHRACENE	0.0	10.0	*					0.18	0.038		90.0	19.0		<10/<10
1,2-DICHLOROBENZENE	0.0	5.0	2.0					1300.0	420.0	600	649927.8	209976.7	299966.7	<5/<5
1,3-DICHLOROBENZENE	0.0	5.0	2.0					960.0	320.0		479946.7	159982.2		<5/<5
1,4-DICHLOROBENZENE	0.0	5.0	2.0					190.0	63.0	75	94989.4	31496.5	37495.8	<5/<5
3,3-DICHLOROBENZIDINE	0.0	10.0	*					0.28	0.21		140.0	105.0		<10/<10
DIETHYL PHTHALATE	0.0	10.0	1.9					44000	17000.0		21997555.6	8499055.6		<10/<10
DIMETHYL PHTHALATE	0.0	10.0	1.6					1100000	270000.0		549938888.9	134985000.0		<10/<10
2,4-DINITROTOLUENE	0.0	10.0	1.0					34.0	1.1		16998.1	549.9		<10/<10
2,6-DINITROTOLUENE	0.0	10.0	*											<10/<10
1,2 DIPHENYLHYDRAZINE	0.0	10.0	*					2.0	0.36		999.9	180.0		<10/<10
FLUORANTHENE	0.0	10.0	2.2					140.0	130.0		69992.2	64992.8		<10/<10
FLUORENE	0.0	10.0	0.3					5300.0	1100.0		2649705.6	549938.9		<10/<10
HEXACHLOROBENZENE	0.0	10.0	1.9					0.0029	0.0028	1.0	1.450	1.4	499.9	<10/<10
HEXACHLOROBUTADIENE	0.0	10.0	5.0					180.0	4.4		89990.0	2199.8		<10/<10
HEXACHLOROCYCLO-PENTADIENE	0.0	50.0	*					1100.0	40.0	50.0	549938.9	19997.8	24997.2	<50/<50
HEXACHLOROETHANE	0.0	10.0	0.5					33.0	14.0		16498.2	6999.2		<10/<10
INDENO(1,2,3-CD)PYRENE	0.0	10.0	*					0.18	0.038		90.0	19.0		<10/<10
ISOPHORONE	0.0	10.0	*					9600	350.0		4799466.7	174980.6		<10/<10
NAPHTHALENE	0.0	10.0	*											<10/<10
NITROBENZENE	0.0	10.0	10.0					690.0	17.0		344961.7	8499.1		<10/<10
N-NITROSODI-N-PROPYLAMINE	0.0	10.0	*					5.1	0.050		2549.7	25.0		<10/<10
N-NITROSODI- METHYLAMINE	0.0	10.0	*					30.0	0.0069		14998.3	3.4		<10/<10
N-NITROSODI-PHENYLAMINE	0.0	10.0	*					60.0	33.0		29996.7	16498.2		<10/<10
PHENANTHRENE	0.0	10.0	0.7											<10/<10
PYRENE	0.0	10.0	0.3					4000.0	830.0		1999777.8	414953.9		<10/<10
1,2,4-TRICHLOROBENZENE	0.0	10.0	*					70.0	35.0	70.0	34996.1	17498.1	34996.1	<10/<10

a. Columns 7-8, and 12-14 are the effluent concentrations allowable to prevent exceedence of water quality criteria.
b. Potential to exceed criteria exists if the measured quantity in column 15 exceeds, or could exceed, the calculated allowable concentrations in columns 7-8, and 12-14.
c. Additional testing is required if the detection level used in the scan is higher than the state RDL and/or the MDL of the approved EPA scan method and industry is known to have that pollutant.
d. All background concentrations for these volatile organic, acid-extractable, and base-neutral compounds are assumed zero in the absence of supporting monitoring data.
e. Other metals for which data were provided on the application are evaluated on the Metals & Toxics spreadsheet.
f. Reasonable potential not demonstrated. In some cases, the MDLs are not sufficient to identify potential water quality problems.

WATER QUALITY BASED CALCULATIONS FOR METALS AND OTHER TOXIC SUBSTANCES
OUTFALL 001

FACILITY: T.E. MAXSON STP
PERMIT #: TN0020729

Stream (7Q10) [MGD]	Stream (30Q5) [MGD]	Waste Flow [MGD]	Ttl. Susp. Solids [mg/l]	Hardness (as CaCO3) [mg/l]	Stream Allocation [%]
70,500	89,900	90	71	192	50

	1	2	3	4	5	6	7	8	Permit Renewal Application Avg/Max [ug/l]
	Stream Bckgrnd. Conc.	Fish/Aqua. Life Water Quality Criteria		Effluent Fraction Dissolved	Fish & Aquatic Life Water Quality Criteria (7Q10)				
					In-Stream Allowable		Calc. Effluent Concentration		
EFFLUENT CHARACTERISTIC		Chronic	Acute		Chronic	Acute	Chronic	Acute	
	[ug/l]	[ug/l]	[ug/l]	[Fraction]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	
Cadmium *	0.193	0.387	3.795	0.304	1.273	12.492	**423.6**	**4823.3**	<0.5/<0.5
Copper *	5.500	15.638	24.848	0.244	64.153	101.937	**23004.7**	**37822.3**	7.07/10.1
Lead *	2.500	5.080	130.362	0.132	38.444	986.532	**14097.2**	**385905.9**	<2.0/<2.0
Nickel *	5.000	90.309	813.088	0.248	364.751	3283.999	**141084.8**	**1285916.8**	21.5/27.3
Silver *	4.939	NA	9.879	1.000	NA	9.879	**N/A**	**1939.6**	<1.0/<1.0
Zinc *	18.000	205.321	203.656	0.185	1112.488	1103.462	**429230.8**	**425691.0**	15.8/18.2
Mercury, (T) **	0.006	0.770	1.400	1.000	0.770	1.400	**299.62**	**546.7**	<0.2/<0.2
Chromium III	63.226	126.452	972.116	0.181	698.081	5366.573	**249000.5**	**2079827.4**	(a)
Chromium VI	5.500	11.000	16.000	1.000	11.000	16.000	**2159.7**	**4120.5**	(a)
Cyanide ***	2.600	5.200	22.000	1.000	5.200	22.000	**1020.9**	**7609.3**	<10/<10

	9	10	11	12	13	14	Permit Renewal Application Avg/Max [ug/l]
	Human Health Water Quality Criteria (30Q5)						
	In-Stream Criteria			Calculated Effluent Concentration			
EFFLUENT CHARACTERISTIC	Organisms	Water/Organisms	DWS	Organisms	Water/Organisms	DWS	
	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	
Cadmium *	NA	NA	5.0	**NA**	**NA**	**2403.1**	<0.5/<0.5
Copper *	NA	N/A	NA	**NA**	**NA**	**NA**	7.07/10.1
Lead *	NA	NA	5.0	**NA**	**NA**	**1251.1**	<2.0/<2.0
Nickel *	4600.0	610.0	100.0	**2297247.2**	**302468.9**	**47497.2**	21.5/27.3
Silver *	NA	NA	NA	**NA**	**NA**	**NA**	<1.0/<1.0
Zinc *	NA	NA	NA	**NA**	**NA**	**NA**	15.8/18.2
Mercury, (T) **	0.051	0.05	2.0	**22.5**	**22.0**	**996.9**	<0.2/<0.2
Chromium III	NA	NA	100.0	**NA**	**NA**	**18416.5**	(a)
Chromium VI	NA	NA	100.0	**NA**	**NA**	**47247.5**	(a)
Cyanide ***	140.0	140.0	200.0	**68693.7**	**68693.7**	**98690.3**	<10/<10

(a) Total chromium, avg/max = 3.03/4.04

* Denotes metals for which Fish & Aquatic Life Criteria are expressed as a function of total hardness.The Fish & Aquatic Life criteria for this metal are in the dissolved form at laboratory conditions. The in-stream allowable criteria and calculated effluent concentrations are in the total recoverable form.

** The chronic criterion for mercury is not converted to dissolved, since it is based on fish tissue data rather than toxicity.

*** The criteria for this parameter are in the total recoverable form.

NOTE: Water Quality criteria for stream use classifications other than Fish & Aquatic Life are based on the 30Q5 flow.

Appendix R-7

New NPDES Permit Limitations and Monitoring Requirements

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
BOD_5	42	31,525	85	63	47,288	84		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Total Suspended Solids (TSS)	48	36,029	85	72	54,043	96		40	Daily	composite	effluent
	Report					Report			Daily	composite	influent
Ammonia-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Organic-Nitrogen (as N)	Report	Report				Report			Monthly	composite	effluent
Total Nitrogen (as N)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
Total Phosphorus (as P)	Report	Report	Report			Report			Monthly	composite	effluent
	Report	Report				Report			Monthly	composite	influent
E. coli, cfu/100 ml (a)	126					487			Daily	grab	effluent
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (b)						2.0			Daily	grab	effluent
Settleable Solids (ml/l)						1.0			Daily	composite	effluent
Dissolved Oxygen (mg/l)							1.0		Daily	grab	effluent
pH (standard units)						9.0	6.0		Daily	grab	effluent

(a) The permittee must comply with the *E. coli* limits within 36 months from the permit's effective date.

(b) The TRC limit will be applicable if and when when the permittee installs/operates a chlorination disinfection system. If a TRO system is installed/operated for disinfection, the division will reopen the permit to include an applicable TRO limit.

T.E. Maxson STP (TN0020729) - Outfall 001 Discharge Limitations and Monitoring Requirements (Continued)

Effluent Characteristics	Effluent Limitations								Monitoring Requirements		
	Monthly			Weekly		Daily			Measurement Frequency	Sample Type	Sample Point
	Average (mg/l)	Average (lb/day)	Removal (%)	Average (mg/l)	Average (lb/day)	Maximum (mg/l)	Minimum	Removal (%)			
Organic Pesticide Chemicals (b)	Report					Report			Annually	grab	effluent
Total Dioxin	0.000000001					0.000000001			Annually	composite	effluent
Heptachlor Epoxide	0.00019					0.00019			Annually	grab	effluent
Total Polychlorinated Biphenyls (PCBs)	0.00000064					0.00000064			Annually	composite	effluent
Total Chlordane	0.0000081					0.0000081			Annually	grab	effluent
Total Mercury	Report					Report			Annually	composite	effluent
Methyl Mercury	Report					Report			Annually	grab	effluent
Benzidine	Report					Report			Annually	grab	effluent
Hexachlorobenzene	Report					Report			Annually	grab	effluent
Acute Aquatic Toxicity - 48 hour LC_{50} (d)	Report								Annually	grab	effluent
Outfall Observation, Visual (e)	Report								Daily	visual	(d)
Flow (MGD)	Report			Report		Report			Daily	continuous	influent
	Report			Report		Report			Daily	continuous	effluent
Sanitary Sewer Overflows, Total Occurrences (f)	Report								continuous	visual	NA
Dry Weather Overflows, Total Occurrences (f)	Report								continuous	visual	NA
Bypass of Treatment, Total Occurrences	Report								continuous	visual	NA

(c) The permittee shall also report the individual organic pesticide chemicals (4,4'-DDD; 4,4'DDE; aldrin; endosulfan I, endosulfan II; endrin; endrin; gamma-BHC (Lindane); heptachlor epoxide; heptachlor; PCBs, total; technical chlordane; and toxaphene).

(d) Per Section 3.4.

(e) Permittee shall provide in the DMR comments section or as an attachment a listing of its visual observations including distinctly visible matter and/or objectionable instream color.

(f) Permittee shall provide with its DMRs a listing of sewage overflows that flowed into buildings.

MEMPHIS CODE OF ORDINANCES NO 5356

A SUBSTITUTE ORDINANCE TO AMEND CHAPTER 33, CODE OF ORDINANCES SO AS TO INCREASE THE SEWER FEE

WHEREAS, the sewer fee was increased from 95.8 cents to 105.3 cents per 1000 gallons on July 1, 2009, and

WHEREAS, in order to maintain the stability of Sewer Fund, the sewer fees need to be increased.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF MEMPHIS THAT SECTION 1: CHAPTER 33 ARTICLE III, DIVISION 2, SEWER FEES AND CHARGES, SECTION 33-131(b)(1) AND DIVISION 4 BILLING PROCEDURES SECTION 33-156(g) ARE HEREBY AMENDED AND RESTATED IN THEIR ENTIRETY TO READ AS FOLLOWS:

Sect. 33-131(b)

(1) Volumetric charges. All customers will be charged a volumetric charge based on the equivalent strength of domestic sewage (BOD5 of two hundred fifty (250) milligrams per liter, SS of three hundred (300) milligrams per liter). Since seven and forty-eight one hundredths (7.48) gallons equals one cubic foot, one thousand (1,000) gallons equals 133.689 cubic feet (cf) or one thousand (1,000) gallons equals 1.33689 hundred cubic feet (ccf). The volumetric charge per one thousand (1,000) gallons is to be based on the annual debt service, capital costs, treatment and operations and maintenance costs, and all other charges assigned to the sewer fund. The volumetric charge will be $2.267 per one thousand (1,000) gallons of flow until changed by amendment to this section. A residential maximum volume fee of fifty dollars ($50.00) and a minimum of two dollars and fifty cents ($2.50) per month per individual dwelling unit is herewith established.

Commencing and retroactive to July 1, 2010, the $2.267 flow charge fee shall be assessed against the name in which a meter has been installed; provided, further, however, in the case of multifamily dwellings a portion of this cost may be recovered through a monthly flat rate per customer charge. The charge, as determined by the Director of Public Works, shall not exceed eight dollars and eighty-five cents ($8.85) per monthly flat rate charge per customer. Amounts collected through any monthly flat rate charge shall be credited in accordance with section 33-156.

Commencing and retroactive to 1 July 2010, all citizens who qualify for the Solid Waste Fee Discount Program as delineated in Chapter 15, Section 12, Code of Ordinances, City of Memphis (as codified in ordinance 5112) shall be charged $1.66 per one thousand gallons until changed by amendment to this section.

#31

Commencing July 1, 2010 all industrial customers assigned an industrial discharge agreement will be charged a volumetric sewer fee of $2.267 per one thousand (1,000) gallons of flow for the first five million gallons per month discharged by each industrial customer. For volumes in excess of five million gallons per month, each industrial customer will be charged a volumetric sewer fee according to the attached schedule:

From 1 July 2010 through 30 June 2011:	$1.458 per 1,000 gallons
From 1 July 2011 through 30 June 2012:	$1.862 per 1,000 gallons
Beginning 1 July 2012:	$2.267 per 1,000 gallons

Effective 1 July 2010, all non-governmental industrial customers with valid City of Memphis issued Sewer Discharge Agreements having flows less than 10 million gallons per month will pay 100% of the latest adopted sewer rate for all wastewater discharged up to a fee amount of $ 500 per month. All wastewater discharge costs in excess of $ 500 per month will be charged a volumetric sewer fee according to the following schedule:

From 1 July 2010 through 30 June 2011:	$1.458 per 1,000 gallons
From 1 July 2011 through 30 June 2012:	$1.862 per 1,000 gallons
Beginning 1 July 2012:	$2.267 per 1,000 gallons

Beginning 1 July 2012, all industrial customers shall pay 100% of the then current sewer rate. This fee schedule shall remain in effect until changed by amendment to this section

Sec. 33-156

(g). In accordance with the apartment credit program the approving authority has the right to charge each tenant eight dollars and eighty-five cents ($8.85) per month if so requested in writing by the apartment owner. The total amount collected will then be credited against the amount billed from the master water meter reading each month.

SECTION 2. BE IT FURTHER ORDAINED, That the various sections of this Ordinance are severable, and that any portion declared unlawful shall not affect the remaining portions

SECTION 3. BE IT FURTHER ORDAINED, that this ordinance shall take effect from and after the date it shall have been passed by the Council, signed by the Chairman

FINAL PRELIMINARY ENGINEERING REPORT

T.E. Maxson WWTF Process Upgrades
Package 1

Prepared for:

Memphis, Tennessee

February 2017

CDM Smith Project No.:
36694-111641

CDM Smith

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Section 1

Introduction

The City of Memphis (City) retained CDM Smith Inc. to design and construct disinfection, biological treatment and hydraulic capacity improvements at the City's T.E. Maxson Wastewater Treatment Facility (WWTF) via a construction-management-at-risk (CMAR) project delivery method. These improvements include:

- Replacement of the Existing Headworks Manual Coarse Screens;
- Upgrades to the Effluent Pump Station Electrical Improvements;
- Biotower Upgrades and RAS Re-aeration Basin;
- Conversion from coarse bubble to fine bubble diffusers in the Aeration Basins;
- Addition of peracetic acid (PAA) disinfection system including Disinfection Tank;
- Demolition of the existing Clarifier 5-N and 5-S and construction of two new Clarifiers;
- Miscellaneous hydraulic improvements; and,
- Improvements to the odor control system.

These improvements will be divided into multiple design packages throughout the project duration. Package 1, as described in this Preliminary Engineering Report (PER), include construction of the Disinfection Tank, the disinfection system Integrated Power Assembly (IPA), improvements to hydraulic structures, a drain pump station and electrical improvements at the effluent pump station. This report includes:

<u>Package 1: Disinfection Improvements:</u>

- Basis of Design
- Construction Sequencing and Constraints for Package 1
- Project Schedule
- Opinion of Probable Construction Cost

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Section 2

Disinfection Tank and IPA

CDM Smith recommended that the City utilize bulk peracetic acid (PAA) disinfection at the T.E. Maxson WWTF. This section provides definition for a PAA system including initial equipment sizing, instrumentation and control requirements, and electrical modifications. The City is leasing the chemical feed, storage and control systems from a PAA Provider as part of the chemical purchase agreement, similar to what is being done at the M.C. Stiles WWTF. Thus, the basis of design for the PAA system is provided for informational purposes, as only the Disinfection Tank is to be constructed in Package 1.

2.1 PAA System Design Basis

The double exponential decay model developed from the results of the pilot and bench testing was utilized to establish the basis of design CT (Dose x contact time) values at minimum, average and peak conditions, which are shown in **Table 2-1**. The City requested that the Disinfection Tank size be designed such that quenching of the PAA was not necessary at peak flow to achieve the Project's PAA residual limit of 1 mg/L, which is half of the PAA residual value (2 mg/L) set by the State of Tennessee. The resulting optimization of the Disinfection Tank yielded a volume of 489,000 cubic feet, which was utilized to establish the contact times and PAA doses at the various flow rates. **Table 2-2** summarizes the design log inactivations, CT values, flow rates, contact times and PAA design doses at the design conditions. The basis of design for the PAA system is summarized in **Table 2-3**.

Table 2-1 Required PAA CTs and Design Points

Flow Conditions	Flow (MGD)	Required Log Inactivation	CT*
Permitted Average	90	3.92	87.1
Peak Hour	170	3.82	74.1
Daily Minimum	50	2.81	22.4

*CT results include a 1.3x safety factor for scaling up to full scale.

Table 2-2 Required PAA Doses to Achieve Disinfection Design Criteria

	Required Log Inactivation	Design CT (mg/L*min)	Flow (MGD)	Contact Time (min)	Dose mg/L (mg/L)
Peak Conditions	3.92	87.10	170	31	8.36
Average Conditions	3.82	74.10	90	59	6.73
Minimum Conditions	2.81	22.36	50	105	4.50

Table 2-3 PAA Basis of Design Summary

Design Plant Flows	
Minimum Daily Flow	50 mgd
Current Average Daily Flow	70 mgd
Permitted Average Daily Flow	90 mgd
Maximum Daily Flow	156 mgd

Peak Hour Flow	170 mgd
Disinfection Tank Criteria	
Number of Tanks	1
Tank Configuration	Parallel Halves
Overall Tank Length	298.5 feet
Overall Tank Width	159 feet
Number of Passes on Each Half of the Contact Tank	3
Side Water Depth at Peak Hour Flow (1 ft of water height over weir)	13.5 feet
Width of Each Pass	22 feet
Bottom Slab Elevation	208.00 feet
Weir Elevation	220.50
Weir Length per Half/Total	30 LF/60 LF
Tank L:W Ratio	75
Tank H:W Ratio	0.61
Total Tank Volume	489,456 cubic feet
PAA Detention Time	
Minimum Daily Flow	105 minutes
Average Daily Flow	75 minutes
Permitted Average Daily Flow	59 minutes
Maximum Daily Flow	34 minutes
Peak Hour Flow	31 minutes
PAA Feed & Pumps Design Criteria[1]	
PAA Chemical Strength[2]	12-15%
PAA Specific Gravity	1.16
PAA Doses of Active Ingredient for Feed Rate Calcs.[3]	
Minimum Daily	4.5 mg/L
Average Daily	6.6 mg/L
PAA Feed & Pumps Design Criteria[1]	
Permitted Average Daily	6.7 mg/L
Maximum	8.4 mg/L
Total Feed Rates (for 15% solution)	
Minimum flow and average dose	80 gph
Average flow and average dose	110 gph
Permitted average flow and average dose	144 gph
Peak hour flow and maximum dose	342 gph
Minimum Pump Turn Down	4.3:1 (will utilized std hose pump turn down)
Number of Dosing Locations per Half of Tank (Primary & Boost) locations)	2
Minimum # of Metering Pumps per Dose Location	2 (1 duty and 1 standby)
Minimum Total # of Metering Pumps	8 (4 duty and 4 standby)

Bulk Storage and Tanks Design Criteria	
Transfer Pumps	2
Fill Station/Piping/Valves	Per Manufacturer
Design Flow for Bulk Storage Calculations (permitted average flow)	90 mgd
Number of Day Tanks	2
Total Day Tank Size (permitted avg flow and dose, plus 10%)	3,800 gallons
PAA Volume per Truck Load	4,000 gallons
14-day Storage Volume Required at Design Flow x Permitted Ave. Dose	48,500 gallons
14-day Storage Volume Required at Design Flow x Maximum Dose	60,800 gallons
Total Storage Volume Available	52,000 gallons
Proposed Storage Volume Available per Tank	6,500 gallons
Number of Bulk Tanks	8
Proposed Storage Duration Available at Design Flow x Permitted Ave Dose	15 days
Proposed Storage Duration Available at Design Flow x Maximum Dose	12 days

Notes:
1. Basis of Design values are calculated using a 15% PAA solution. Values will change if 12% PAA solution is utilized.
2. As active ingredient.
3. Dose from PeroxyChem Bench Test (June 2014).

Process and Instrumentation Diagrams for the Disinfection Tank are included in the Package 1 design drawings. Process and Instrumentation Diagrams for PAA bulk storage and chemical feed will be provided by the PAA Provider.

2.1.1 Disinfection Tank

A new Disinfection Tank will be constructed to provide the necessary PAA contact time. The Disinfection Tank plan is included in the 90-percent design drawings submitted to the City in February 2017. The tank will be separated into two parallel halves, an east half and a west half. The design criteria for the tank are summarized in **Table 2-3**. Each half of the tank will have three PAA dose points. The first primary dose point will be at the head of each half of the tank, with the second primary dose point roughly half way through the tank. This allows the control program to select which primary dose point to use. The first primary point is utilized during high flow events when a higher CT value is required, and the second primary point is for normal flow events. This approach minimizes the opportunity for the PAA residual to get too low during high detention times in the tank when PAA is dosed just at the first primary dose point. A third dose point is included roughly two-thirds through each half of the tank in order to boost the PAA concentration to prevent regrowth at the end of the contact tank.

Each half of the tank includes a 30 foot long effluent weir, which will include two ultrasonic level element/flow indicating transmitter pairs (one duty, one standby). The level elements are utilized to determine the height of water over the effluent weir and thus, the flow rate for that half of the tank. The flow rates for each half of the tank will be added together and will be utilized as the effluent flow rate.

The tank includes an effluent channel downstream of the tank effluent weirs, which serves two purposes. The first is to convey flow to the west side of the tank, and the other is to provide supplemental storage volume for the Effluent Pump Station wet well. The effluent channel is 15 feet wide and 425 feet long. CDM Smith determined that the new effluent channel in the tank will have enough storage capacity to provide adequate cycling of the effluent pumps without considering the

volume of the new 102-inch discharge main nor the Effluent Pump Station wet well. Therefore, short cycling should not be a concern with the effluent PS. The cycle time for the existing pumps is conservatively two starts per hour. The maximum flow per effluent pump is approximately 43,000 gpm which would require a water depth of 6.7 feet in the tank effluent channel. The proposed water depth is 11 feet, providing sufficient storage for the operation of the Effluent Pump Station.

Walkways on the tank are provided as shown on the drawings to allow access to the equipment and instrumentation. In addition, stainless steel or FRP grating is provided at dose locations to allow for access to the chemical mixers. The top of the tank wall is located 12 inches above grade, so a guardrail and toeplate will provided around the perimeter of the tank to prevent falls.

Actuated slide gates will be provided at the entrance to each half of the contact tank in order to isolate it for draining purposes. Drain piping and valving will be installed to convey water from various parts of the contact tank to the new drain pump station.

2.1.2 PAA Feed System

The chemical feed system will be constructed as part of the PAA Provider's scope, which will include the construction of a new concrete equipment pad.

The contact tank is divided into two halves, with each half having two primary dosing points, and a secondary dosing point. The metering pumps will convey PAA from the storage tanks to the feed point at each dose point. The primary dosing points will share dedicated skid-mounted, pumps (one duty and one standby) as only one dosing point will be used at a time on a given half of the tank. The secondary dose point will have dedicated skid-mounted pumps (one duty and one standby). Features of the chemical feed skids will include:

- Self-contained skids with leak-detection to detect PAA leaks in the building;
- Local control panel for operator interface;
- Pump failure alarms;
- PAA flow measurement devices for tracking chemical feed rates;
- Microprocessor based motor speed control unit to modulate chemical feed rate and control the pumps; and,
- Calibration column.

2.1.3 Engineering Disciplines

2.1.3.1 Miscellaneous Process Improvements

Two eyewash/emergency shower stations will be installed near the Disinfection Tank. One will serve the primary and boost application points and the other will serve the secondary application points. Each will be located on the walkway in the center of the tank at equal distance from the application points in each channel.

Package 1 will also require the installation of a new drain pump station to drain the new Disinfection Tank, as well as Clarifiers 5-N and 5-S to be installed in a future design package. No existing gravity drains are deep enough to establish gravity drainage, and the existing clarifier drain pump station would be non-ideal to serve the Disinfection Tank due to its location away from the tank. The new station will

be a submersible duplex pump installation located at the northwest corner of the tank. The pump station will be capable of draining either one 135-foot diameter clarifier or one of the Disinfection Tank channels in 12 hours. Each pump will be rated at approximately 2,800 gallons per minute, and water will be discharge to the head of the plant via the existing plant gravity drain system. Table 2-4 presents a tentative design summary of the drain pump station.

Table 2-4 Drain Pump Station Design Summary

Drain Pump Station Design Criteria	
Service	Clarifiers 5N and 5S (2.0 MG) Drain PAA Channel 1 and 2 (1.85 MG) Drain Effluent Channel Drain (0.7 MG) Drain
Tank Empty Time (at 2.0 MG tank volume)	12 hours
Pump Type	Submersible
Number of Pumps	2 (1 duty, 1 standby)
Pump Capacity	1,900 gpm @ 41 feet TDH
Pump HP	35 HP
Max. Pump Starts per Hour	12
Wet Well Diameter	10 feet
Wet Well Active Volume	3,500 gallons
Wet Well Elevations	Top of Concrete: 225.0 Max. WSE: 203.0 Min WSE: 197.0 Bottom of Wet Well: 195.0
Wet Well Depth	32 feet
Wet Well Inlet Pipe Diameter	12 inches
Discharge Pipe Diameter	15 inches

2.1.3.2 Structural

The new Disinfection Tank will be approximately 295 feet long by 156 feet wide and 21 feet deep. The structure will be constructed of reinforced, cast in place concrete. The structure will be designed to be non-buoyant by constructing a new groundwater underdrain system. The tank will have a PAA-resistant coating applied to the interior surface.

2.1.3.3 Civil/Site Work

The PAA supplier will provide chemical piping from the PAA feed equipment to the Disinfection Tank. In addition, secondary chemical containment will be provided, with leak detection, for the piping along the entire piping run. A detailed description of the civil/site work to be performed is located in **Section 3**.

2.1.3.4 Electrical

Power to the disinfection system will be derived from the proposed new 23kV distribution loops originating from a new substation. The loops consist of a normal circuit and an emergency one circuit for redundancy. The estimated load of the PAA system equipment, the motorized slide gates at the effluent junction structure, auto sampler pump, drain pump station equipment, site lighting, and associated miscellaneous equipment is approximately 180KVA. The electrical system for the disinfection system consists of two 225kVA, 23kV-480Y/277V, pad-mounted transformers located outside the Disinfection Integrated Power Assembly (IPA) structure; a 480Y/277V, 400A automatic transfer switch (ATS), a 480Y/277V 400A panelboard, a 30kVA step-down dry-type transformer and a 208Y/120V, 100A

panelboard, all located in the new Disinfection IPA. The IPA will be air-conditioned with a Purafil air system to ensure the performance of the electrical and control equipment contained inside.

The control equipment in the Disinfection IPA include a PLC and Operator Interface Terminal (OIT) panel for connectivity to the plant wide SCADA system and to calculate the effluent flow rate at the Disinfection Tank effluent weirs, and the PAA system control panel, which is provided by the PAA provider, and will power and control all the PAA equipment.

2.1.3.5 Instrumentation and Control

Instrumentation and Control (I&C) improvements are required in order to implement the PAA system. I&C is important to the operation of the packaged PAA system, and careful coordination is required for interfacing the PAA system with the upgrades to the plant SCADA system being implemented in this project. The process and instrumentation diagrams for the PAA process are included in the Package 1 90-percent design drawings. The PAA system will be controlled by a PLC which will allow for all components to be automatically controlled and will provide the ability to alert the operator to process problems. An operator interface will provide the operator with means of monitoring and controlling the PAA system. The interface will be located in a new programmable logic controller (PLC).

All instrumentation and controls being furnished with the leased PAA system will be the standard offering from the PAA system supplier. Ethernet compatibility will be specified and will allow the PAA system to be controlled and monitored by the SCADA system via PLC. A PLC panel with an OIT will be provided in the electrical room to allow operators to interface with the plant-wide SCADA system. The new PLC will allow dedicated monitoring and flow pacing signals to the PAA system. The PLC will interface to the existing plant control system via Ethernet.

2.1.4 Construction Sequencing and Constraints

There are no major constraints that affect the construction of the Disinfection Tank. In terms of sequencing, two items will be addressed prior to Disinfection Tank construction. The existing electrical feed to the Effluent Pump Station will be relocated and the drain pump station will be installed. The Disinfection Tank construction will be conducted in concert with the constraints listed in Specification Section 01014 included in the 90-percent specifications.

Section 3

Effluent Piping and Structures

3.1 Design Basis

3.1.1 Hydraulics

The existing plant hydraulics were analyzed using a comprehensive hydraulic model that was developed for the T.E. Maxson WWTF, which included a combination of calculations and the hydraulic modeling software, Visual Hydraulics (version 4.2). As described in the Conceptual Design Report (CDR), the hydraulic model was calibrated using surface water elevations measured during field hydraulic testing.

In the existing effluent piping configuration of the T.E. Maxson WWTF, effluent flows from the north and south secondary clarifier batteries join in the Chlorine Application Structure, before flowing under a baffle wall to the existing Parshall flume. Flow exits the existing Parshall flume structure through an 8-ft by 6-ft box culvert which connects to the existing Chlorine Contact Tank Distribution Box and then to the Existing Bypass Junction Box. Based on the hydraulic restrictions identified during the existing plant's hydraulic capacity evaluation, the hydraulic requirements for the proposed improvements and changes to the plant's flow path require replacement of the existing effluent structures, including the Chlorine Application Structure, Parshall Flume, Chlorine Contact Tank Distribution Box and Bypass Junction Box.

The proposed hydraulic profile was determined based on the effluent structure modifications described above for the following design flows:

- Average Day Flow (ADF) - 90 mgd
- Max Day Flow (MDF) - 156 mgd
- Peak Hour Flow (PHF) - 170 mgd

Hydraulics modeled for the back end of the plant (downstream of the Intermediate Pump Station) are impacted by the starting water surface elevation in the receiving cooling channel downstream of the plant's outfall. In order to establish the gravity flow hydraulic profile for the back end of the plant, the water surface elevation at the plant's outfall was set to a constant elevation of 206 feet in the hydraulic model. A gravity flow condition occurs when all of the effluent pipes downstream of the Disinfection Junction Box flow as partially full, open channels. For flow and river level combinations above gravity flow conditions, portions of the effluent piping will transition from open channel flow to fully submerged pipes. Based on analysis of historic plant flow data, Mississippi River flood gage data, and the calibrated hydraulic model, it was determined that water levels up to and including 206 feet in the receiving cooling channel will allow the range of design flows to flow by gravity through the back end of the plant with ample freeboard below each of the proposed design control points and weirs. The river water elevation of 206 feet corresponds to a river gage level of approximately 22.09 feet at Memphis's Weather Bureau Gage (MS126) in the Mississippi River.

Further analysis was conducted to determine which river levels above 206 feet would impact upstream hydraulics of the proposed design (e.g. submerge control weirs) for the range of design flows, requiring use of the Effluent Pumping Station. It was determined that free discharge over the PAA effluent weirs

(defined as 0.50 ft of drop below weir inverts) would be maintained for the following flows and corresponding maximum river levels:

- 90 mgd (ADF) will flow by gravity for river levels up to approximately 217.40 feet (33.49 ft river stage).
- 125 mgd will flow by gravity for river levels up to approximately 215.20 feet (31.29 ft river stage).
- 170 mgd (PHF) will flow by gravity for river levels up to approximately 209.00 feet (25.09 ft river stage).

For flows and river levels above these points, the Effluent Pumping Station will need to be used to avoid submerging weirs in the Contact Tank and Secondary Clarifiers. Refer to the Hydraulic Analysis of Effluent Pump Station Usage Technical Memorandum for further detail on this analysis and results, which includes an expectation of how frequent the Station would need to be used based on the historical data.

All elevations are referenced to the NAVD88 datum. Refer to Figure GP-M-5 for the proposed hydraulic profile. The only changes that have been made to the proposed hydraulic profile since the CDR relate to the proposed modifications to the effluent boxes and water level impacts that resulted from the reduction of the two Disinfection Basin effluent weirs from 40 feet to 30 feet, each. These changes impacted structures and water levels between the Disinfection Tank weirs and the Secondary Clarifier Launders in the profile.

3.1.1.1 Miscellaneous Hydraulic Improvements

3.1.1.1.1 Clarifier Effluent Junction Box

In addition to unreliable flow measurements caused by the incorrect installation of the existing Parshall Flume, the flume structure is a hydraulic constraint, adding significant headloss to the plant's profile. The proposed design requires complete replacement of the flume/chlorine application structure with a new Clarifier Effluent Junction Box. The proposed junction box is presented in Drawing DIS-M-6.

The proposed Clarifier Effluent Junction Box is a cast-in-place concrete box, with interior dimensions of 20-feet wide by 20-feet long. The existing 8-ft by 6-ft effluent box culvert, two 72-inch clarifier effluent pipes and the clarifier bypass pipe will be extended into the new Junction Box. Gates will be constructed in the box to isolate the 72-inch clarifier effluent pipes and the clarifier bypass pipe. The existing 24-inch effluent water line back to the pipe gallery will be routed through a 12-foot diameter precast manhole on the south side of the Clarifier Effluent Junction Box.

3.1.1.1.2 Effluent Junction Box

The existing Chlorine Contact Tank Distribution Box currently experiences 1 to 2 feet of headloss for the range of design flows when its central control gate is fully opened. The structure represents a hydraulic choke point in the effluent flow path and replacement is necessary to alleviate this constraint for the proposed improvements. The proposed Clarifier 5 N-S Effluent Junction Box, which will replace the Chlorine Contact Tank Distribution Box is presented in Drawing DIS-M-6.

The new Effluent Junction Box is a 12-foot by 11-foot concrete box, which will connect the effluent pipes from proposed Secondary Clarifiers 5-N and 5-S to the existing 8-ft by 6-ft effluent box culvert, combining with effluent from the eight existing secondary clarifiers. The combined clarifier effluent flow will exit the new box through the existing downstream box culvert. Isolation gates will be provided on the connections to the pipes from proposed Secondary Clarifiers 5-N and 5-S.

3.1.1.1.3 Disinfection Junction Boxes

The existing Bypass Junction Box will be replaced with two proposed Disinfection Junction Boxes attached to the Contact Tank to facilitate flow diversion to and from the new Contact Tank downstream of the secondary clarifiers. The Disinfection Tank Bypass Chamber is 12-foot by 14-foot and contains 144-inch wide stop logs and a 96-inch by 72-inch slide gate to direct flow into or bypassing the Contact Tank.

The Disinfection Effluent Chamber is a 30-foot by 15-foot with motorized isolation gates for the 78-inch effluent pipe and the 84-inch pipe to the Effluent Pump Station to facilitate automated rerouting of the flow to the Effluent Pump Station during flood conditions. This will allow the PAA Contact Tank to continue operating with free discharge over its effluent weirs during flooding conditions. Refer to the Control Narrative in **Section 3.2** for more details on the flow rerouting sequence.

3.1.1.1.4 Flow Measurement Weirs in Contact Tank

As previously described, the existing Parshall flume is unreliable for accurate flow measurement. For the proposed improvements, flow measurement will be provided at the downstream end of the Contact Tank via two 30-foot effluent weirs (one per half of that tank). Head over the weirs, ranging from approximately 0.84 feet of head at the ADF, up to 1.29 feet of head at the PHF, will be measured by a level transducer sensor for measurement of effluent flow leaving the basin. Level transducer accuracy is expected to range from approximately 4 percent error at 90 mgd (ADF), down to 2 percent error at 170 mgd (PHF). Head over these weirs is expected to increase by approximate quarter-inch increments for each additional 3.7 mgd of total flow (1.85 mgd per weir) above the ADF.

3.1.1.1.5 Effluent Water Pump Station

Four effluent water (EW) pumps will be installed directly upstream of the flow measurement weir. These pumps supply disinfected effluent water to the effluent manhole directly south of the Clarifier Junction Box. These pumps are sized to provide between 800 and 1,200 gallons per minute (gpm) each (2 operating and 2 standby) of effluent water to supply the existing Non-Potable Water (NPW) Pumps located in the Aeration Building. The pumps are 25 horsepower (hp) each.

3.1.2 Site and Road

3.1.2.1 Site Improvements

Site grading will be modified as required to accommodate the new structures. Minimal grading will be required for the new junction box structures and for the new PAA equipment pad, but significant grading will be required for the new Contact Tank due to its size and location. The existing storm drain system on site will be used to the greatest extent possible to accommodate surface drainage around the new structures. Some elements of the existing storm drain system will need to be cleaned and/or repaired to restore adequate site drainage. In particular, the storm drain pipe discharging into the undeveloped area to the south is damaged and partially filled with silt.

3.1.2.2 Road Improvements

The construction of the new Contact Tank will require the relocation of the existing site drive at the southwest corner of the site. Approximately 1,000 linear feet of new paved drive will be constructed along the south and west sides of the new Contact Tank in a future package. In conjunction with this new drive construction, provisions will be made for the future PAA unloading area and equipment pad. In addition, the new drive will be designed for turning radii and wheel loads of the PAA delivery trucks. A temporary gravel service drive will be constructed as part of Package 1 to facilitate PAA deliveries until the permanent roadway is in place.

3.1.3 Engineering Disciplines

3.1.3.1 Miscellaneous Process Improvements

There will be two new automatic samplers installed at the Disinfection Junction Box. One sampler will be located on the upstream portion of the structure, and will be utilized to collect a 24-hour composite sample ahead of the PAA Contact Tank. This will allow the City to measure the BOD concentration and other water quality parameters of the secondary effluent. The second sampler will be located on the downstream portion of the structure, and will be utilized to collect a 24-hour composite sample for compliance with the WWTF's effluent permit. Both samplers will be refrigerated, dipper style and will require a dedicated pump to convey a constant flow to the sampler. In addition to power (115 V, single phase, 60 Hz), the samplers will need dedicated 4-20mA signals for the effluent flow so that samplers can adjust sampling based upon flow rate. The sampler shall be the Sentinel Model by N-CON Systems Company, Inc., or equal.

3.1.3.2 Structural

The new effluent structures will be constructed of reinforced, cast in place concrete. The structures will be designed to be non-buoyant by either dead weight or constructing a new groundwater underdrain system.

3.1.3.3 Electrical

Two effluent slide gates motors are rated at 3HP each and the effluent junction structure auto sampler pump is rated at 5HP. Power to these motors will be derived from the 480V MCC-304 located in the PAA Chemical Feed Building via underground conductors. Safety switch will be provided at each motor or pump.

3.1.3.4 Instrumentation & Controls

The automatic samplers will each need a 4-20mA signal from the effluent flow meter in order for the samplers to be flow paced.

3.2 Control Narrative

As mentioned in **Section 3.1.1.1.3**, the downstream Disinfection Tank Effluent Chamber will be outfitted with motorized isolation gates, installed on the existing 78-inch discharge pipe, 84-inch Effluent Pump Station pipe and isolating the Contact Tank. These automated gates will facilitate bypass pumping during flood conditions by rerouting flow to the Effluent Pump Station. For the duration of the flood condition, use of the Effluent Pump Station will be required to maintain free discharge over the effluent weirs of the Disinfection Basin. Keeping these weirs unsubmerged will maintain accurate level transducer readings of head over the weir for flow measurement.

A new PLC and level instrumentation will be installed at the effluent pump station to accommodate the automatic controls. The effluent pumps will be controlled based on flow over the PAA Contact Tank weirs with redundant level controls. The new controller will connect into the existing SCADA network.

The sequence of operation to reroute the disinfected effluent flow to the Effluent Pump Station will be initiated during a 'flood condition', defined as any time the water level in the effluent channel of the PAA Contact Tank reaches a height within 6 inches below the effluent weir inverts. Based on the current design, the level considered a flood condition in the effluent channel would be 220.00 feet, one-half foot below the weir invert of 220.50 feet. A level sensor, placed directly downstream of the effluent weirs in the disinfection effluent channel will detect a flood condition. When the water level in the effluent

channel exceeds 220.00 feet and an adjustable timer as expired (initial recommended setting of 2 minutes), the following flow reroute sequence will be initiated:

1. The motorized isolation gate for the 84-inch pipe to Effluent Pump Station will be signaled to open, allowing effluent to begin flowing into the Pump Station.
2. Once the 84-inch pipe is opened, pumps in the Effluent Pump Station will be signaled to begin turning on, pumping to the Pumps Station's dedicated effluent channel. The number of pumps to be started will be determined by the flow over the Disinfection Basin Effluent Weirs.
3. Once the pumps have started and an adjustable timer has expired (initial recommended setting of 1 minute), the gate to the 78-inch pipe in the Disinfection Junction Box will be signaled to close.
4. The Effluent Pumps will then be controlled by level in the Effluent Pump Station Wet Well. The station will be controlled to operate with a Lead, Lag 1, Lag 2, and Lag 3/Standby operation.

Effluent will continue to be pumped from the Effluent Pump Station until an Operator determines that the flood condition event is over. This determination will be made based on flow and flood gage data. Once the Operator has determined the flood event is over, plant effluent will be routed back to normal operation through the 78-inch pipe by the following sequence:

1. The motorized isolation gate for the 78-inch pipe will be signaled to open.
2. All Effluent Pump Station pumps other than the Lead pump will be turned off.
3. The motorized gate to the 84-inch Effluent Pump Station pipe will be signaled to close.
4. The Lead pump will dewater the Effluent Pump Station down to the all pump off level.

When the gate to the 84-inch pipe is closed and the gate to the 78-inch pipe is opened, plant effluent will continue along its normal operating flow path.

3.3 Construction Sequencing and Constraints

The proposed modifications/replacements for the existing effluent structures will require bypass operations during construction. It is recommended that this is achieved by installing bypass piping to divert flow to the existing Effluent Pump Station upstream of the existing Parshall flume structure, plus some additional bypass pumping. Use of the Effluent Pump Station during this bypass pumping period is contingent on the condition of the existing Pump Station effluent channel. This channel will need to be inspected to assess the existing structural condition and whether it is suitable to convey flow for extended bypass periods. In addition, Tennessee Department of Environmental Conservation will need to be engaged in this decision.

The proposed bypass piping connects the existing 72-inch North and South Clarifier Effluent pipes to the 66-inch Influent pipes into Clarifier No 5-N/North Effluent Wetwell and Clarifier No 5-S/South Effluent Wetwell via parallel 48-inch and temporary 54-inch pipes. The 48-inch pipes will be used in the design of the New Clarifiers No 5-N and 5-S. The parallel 54-inch temporary bypass pipes are sized based on the worst case scenario of sending the entire PHF of 170 mgd to the Effluent Pump Station Wetwell via the North and South Clarifier Effluent bypass piping. If a portion of this forward flow is pumped directly from the Clarifier No 5-S and 5-N Effluent Wetwells, upstream of the existing combined 84-inch Effluent

Pump Station pipe, these parallel 54-inch bypass pipes could potentially be downsized to 48-inch diameter pipes. This condition will be further examined as design progresses.

The plant effluent would then be pumped out of the Clarifier No 5-S and 5-N Effluent Wetwells via the Effluent Pump Station from Clarifier No 5-N/North Effluent Wetwell and Clarifier No 5-S/South Effluent Wetwell.

The proposed bypass piping can convey 85 MGD through each set of parallel pipes to the Clarifier No 5-N/North Effluent Wetwell and Clarifier No 5-S/South Effluent Wetwell for a total flow of 170 MGD. However, based on current operating data, the Effluent Pump Station is limited to pumping approximately 140 MGD with three pumps in operation. The City is conducting testing of the existing effluent pumps and are planning to have the pumps serviced/repaired as necessary to restore them to their original factory hydraulic performance. With three pumps in service based on the original factory test curves the station should be able to pump 159 MGD, and in Package 1 provision are being complete that will allow the operation of all four effluent pumps to meet a peak hour condition of 170 MGD.

During the proposed modifications, it will also be necessary to provide bypass pumping to keep the non-potable water system in operation. To do this, effluent water will be pumped from the Clarifier No 5-S/South Effluent Wetwell into the 24-inch non-potable water system supply line currently connected downstream of the Parshall flume. Two 1,000 gpm capacity self-priming pumps will be required.

Step 1

Close the 66-inch gate to the existing Clarifier No 5-S/South Effluent Wetwell in the existing Distribution Box. Disconnect the 66-inch pipe from the Distribution Box and temporally cap the 66-inch pipe remaining connected to the Distribution Box. Next connect and install the new temporary 54-inch bypass pipe between the end of the 66-inch pipe to within close proximity of the existing 72-inch South Clarifier Effluent pipe as shown in the proposed yard piping **Drawings GS-C-505, GS-C-506,** and **GS-C-507** and install a temporary line stop on the in the 54-inch pipe.

Step 2

Make a hot tap on the existing 72-inch South Clarifier Effluent pipe with a 48-inch connection that will then be connected to the existing 48-inch PCCP pipe that connects to the 66-inch pipe into Clarifier No 5-S/South Effluent Wetwell. Once that 48-inch is in place, install a temporary line stop on the 72-inch South Clarifier Effluent pipe. When this has been completed, the plant, based on the hydraulic model should pass approximately 85 MGD through the North Clarifier Effluent System and approximately 60 MGD through the 48-inch connection on the South Clarifier Effluent System downstream of the Clarifiers.

Step 3

Close the gate for the existing 72-inch South Clarifier Effluent pipe in the existing Parshall Flume Box. Next, disconnect the 72-inch South Clarifier Effluent pipe from the Parshall Flume Box and cap the portion of the pipe still connected to the Parshall Flume Box.

Connect the temporary 54-inch bypass pipe to the 72-inch South Clarifier Effluent pipe as shown in **Drawings GS-C-505, GS-C-506,** and **GS-C-507**

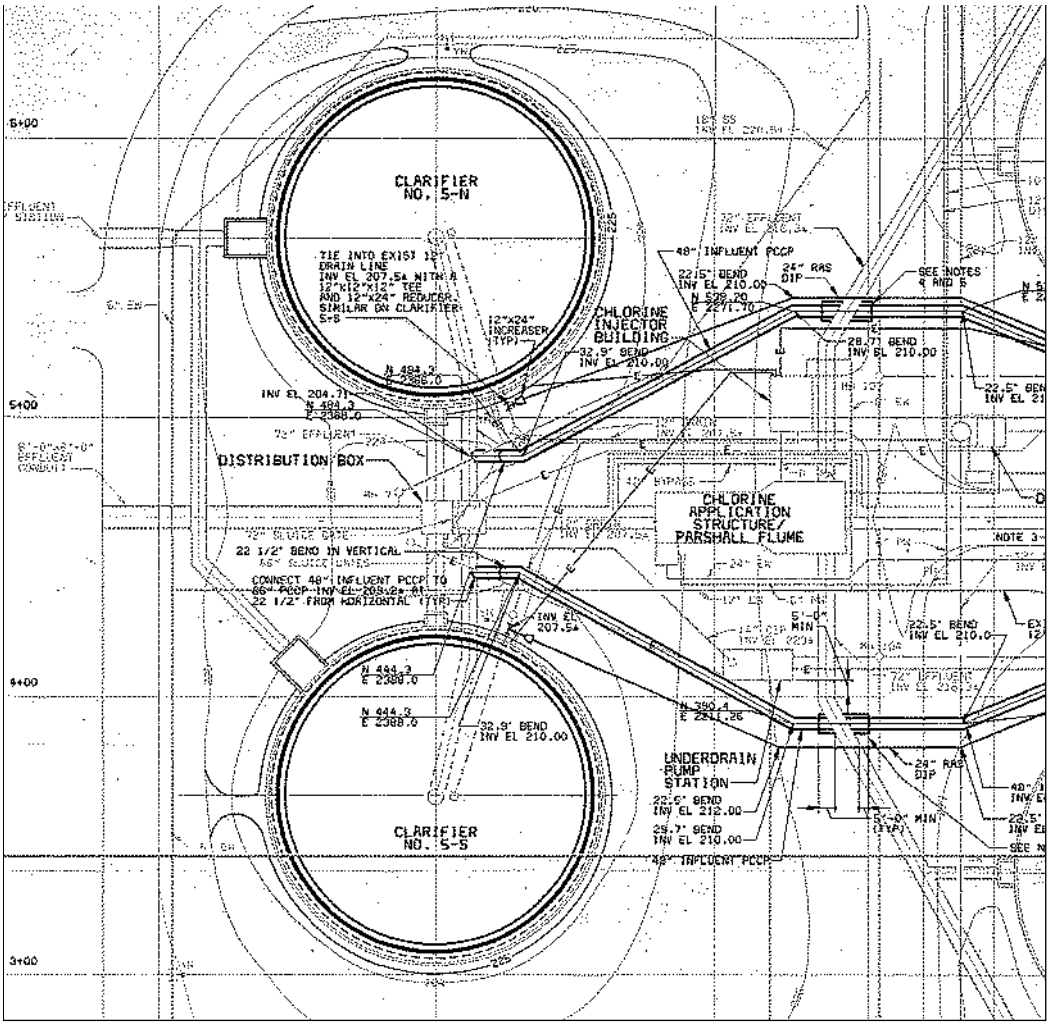

Figure 3-1 Existing Effluent System from the Parshall Flume to the Distribution Box

Step 4

Remove the temporary line stop on the 72-inch South Clarifier Effluent pipe and the 54-inch bypass piping. The flow will now be conveyed through both the 48-inch and 54-inch parallel bypass piping. When this has been completed, the plant, based on the hydraulic model should pass approximately 85 MGD through the North Clarifier Effluent System and approximately 85 MGD through the bypass piping on the South Clarifier Effluent System downstream of the Clarifiers.

Step 5

Install the bypass pumping pumps to maintain the operation of the non-potable water system in operation connected to Clarifier No 5-S/South Effluent Wetwell and connect it to the 24-inch non-potable water pipe currently connected to the Parshall Flume. Disconnect the 24-inch non-potable water pipe from the Parshall Flume by closing the 24-inch gate on the Parshall Flume.

Step 6

Repeat Steps 1 through 4 for the North Clarifier Effluent System. When this has been completed, the plant, based on the hydraulic model should pass approximately 85 MGD through the bypass piping on the South Clarifier Effluent System and approximately 85 MGD through the bypass piping on the North Clarifier Effluent System downstream of the Clarifiers.

Step 7

Proceed with all the proposed modifications/replacements for the existing effluent structures other than connecting the new 84-inch pipe to Effluent Pump Station influent pipe.

Step 8

After these modifications have been made, reinstall the temporary line stop on the 72-inch North Clarifier Effluent pipe and its associated 54-inch bypass piping and connect the 72-inch to the new Clarifier Junction Box.

Step 9

Remove the temporary line stop on the 72-inch North Clarifier Effluent pipe and begin operating the proposed modifications/replacements for the existing effluent structures for the North Clarifier Effluent System.

Step 10

Connect the 24-inch non- potable water pipe to the new Clarifier Junction Box. Then remove the two 1,000 gpm bypass pumps for the non-potable water system connected to No 5-S/South Effluent Wetwell.

Step 11

Repeat Steps 8 through 9 for the South Clarifier Effluent System.

Step 12

Connect the new 84-inch pipe to the Effluent PS to the existing Effluent PS influent piping.

Section 4

Effluent Pump Station Improvements

The Effluent Pump Station was constructed in 1984 under Contract No. 11 and contains four single stage, vertical mixed flow pumps that lift plant effluent from the wet well to the discharge channel through individual pump discharge lines. According to the record drawings, pumps 1 and 2 are rated at 350 horsepower (hp) each, while Pumps 3 and 4 are rated at 300 hp each. However, conversation with plant operations staff and field verification indicated that all four pumps are rated at 350 hp each. Original factory test curves indicate the pumps have a normal operating head of 20 to 25 feet: at 25 feet the pumps have a flow of 39,000 gallons per minute (gpm) or 56.2 million gallons per day (MGD). Firm capacity of the EPS is 168.5 MGD.

The effluent pumps are run by a 1,000 kVA transformer, Power Center 11 (PC11). The City requires that the transformer be sized to run all connected equipment simultaneously, which results in a total connected load of 1,463 kVA. During the conceptual design phase it was recommended that PC11 be upgraded to 1,500 kVA to meet the City requirement: the City agreed and replacement of the transformer is included in the base bid for this package.

Additional improvements identified in the Conceptual Design Report (CDR) for the Effluent Pump Station include replacing the primary and secondary feeders and installing a redundant alternative circuit with a second 1,500 kVA transformer and new Automatic Transfer Switch (ATS). The City has expressed interest in including these improvements in this package, but they will be considered an additive alternate item.

Plant operations staff report that the existing effluent pumps cannot achieve 56.2 MGD each when three pumps are operating. During the conceptual design phase, CDM Smith recommended that flow testing be conducted on the existing pumps and the results compared against the original factory test results to confirm if the pumps meet the original design performance requirements. The City agreed with this recommendation and they will test the existing pumps.

This section details the design basis for upgrading the Effluent Pump Station electrical system and discusses the associated construction sequencing and restraints.

4.1 Design Basis

The replacement of transformer PC11 is the base bid, and installation of new primary and secondary feeders, new ductbank, new transformer PC15 and ATS are included in the add alternate. PC11 will meet the total connected load requirements listed in **Figure 4-1** which is 1,463 kVA.

4.1.1 Engineering Disciplines

The additional improvements required to accommodate the Effluent Pump Station electrical improvements are summarized below. The partial site plan and one-line diagram for the improvements are included in the Package 1 90-percent design drawings**,** and relevant technical specifications are included in the Package 1 90-percent specifications package.

EFFLUENT PUMP STATION LOAD CALCULATION				
DESCRIPTION	CONNECTED LOAD			
	QTY	HP	FLA	KVA
EFFLUENT PUMP NO 1	1	350	46.8	337.2
EFFLUENT PUMP NO 2	1	350	46.8	337.2
EFFLUENT PUMP NO 3	1	350	46.8	337.2
EFFLUENT PUMP NO 4	1	350	46.8	337.2
XFMR FOR PANEL A	1		4.16	30.0
SUM OF CONNECTED				1378.8
25% OF LARGEST MOTOR				84.3
TOTAL DEMAND LOAD (KVA)				**1463**

Figure 4-1 PC11 Total Connected Load

4.1.1.1 Civil

The proposed base bid improvements do not require any civil related work, as PC11 will be installed on the existing transformer pad.

The additive alternate improvements will require installing new underground ductbank to accommodate the new primary and secondary feeders for both PC11 and PC15. Additionally, equipment pads for new transformer PC15 and new ATS will be installed, which will include minor excavation work.

4.1.1.2 Structural

Structural work included in this portion of the project include installing new concrete pads for PC15 and ATS as well as new concrete ductbank for the PC11 and PC15 primary and secondary feeders.

4.1.1.3 Electrical

The electrical improvements associated with this portion of the project includes replacing the existing 1,000KVA transformer with two new 1,500KVA transformers (PC-11E and PC-15N) and new ductbank, conduits and cable.

4.1.1.4 Process Improvements

There are no process improvements associated with the electrical improvements at the Effluent Pump Station. Flow testing will be performed on the existing effluent pumps by the City to compare against the original factory tests. If it is determined that current performance does not match the design requirements and original factory tests, recommendations for improving pump performance will be provided, and the necessary process improvements will be identified at that time.

4.2 Construction Sequencing and Restraints

The Effluent Pump Station will be taken out of service to facilitate final connection of the new transformer to the existing primary and secondary feeders. This effort will be closely coordinated with Plant operations staff and is anticipated to only require the Effluent Pump Station to be out of service for no more than a day. This work will be conducted during low river stage and must be approved in advance by the City. No bypass pumping will be required.

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Section 5

Schedule

A detailed project schedule has been developed for Package 1 work which includes the Contact Tank and associated piping; Disinfection Integrated Power Assembly (IPA); Effluent Hydraulics Improvements; Effluent PS piping and bypass piping/pumping; Electrical including site lighting, power and equipment; and Effluent PS redundant feeder, as described in this PER. The detailed schedule for Package 1 is shown in **Figure 5-1**, which is included at the end of this section.

The schedule shows Issued for Construction documents submitted to TDEC in March 2017, and the GMP being submitted to the City near that time. Based upon the work included on this GMP, we estimate a minimum of 15 bid packages will be developed, including equipment and subcontractors. Estimated bid packages are as follows:

- Electrical Gear
- Mechanical Sluice and Slide Gates
- FRP Weirs and Baffles
- Bypass Piping & Pumping
- Demolition Subcontractor
- Yard Piping Subcontractor
- Site Subcontractor
- Erosion and Sediment Control Subcontractor
- Miscellaneous Metals Subcontractor
- Concrete Subcontractor
- Electrical Subcontractor
- I&C Subcontractor
- Mechanical Subcontractor

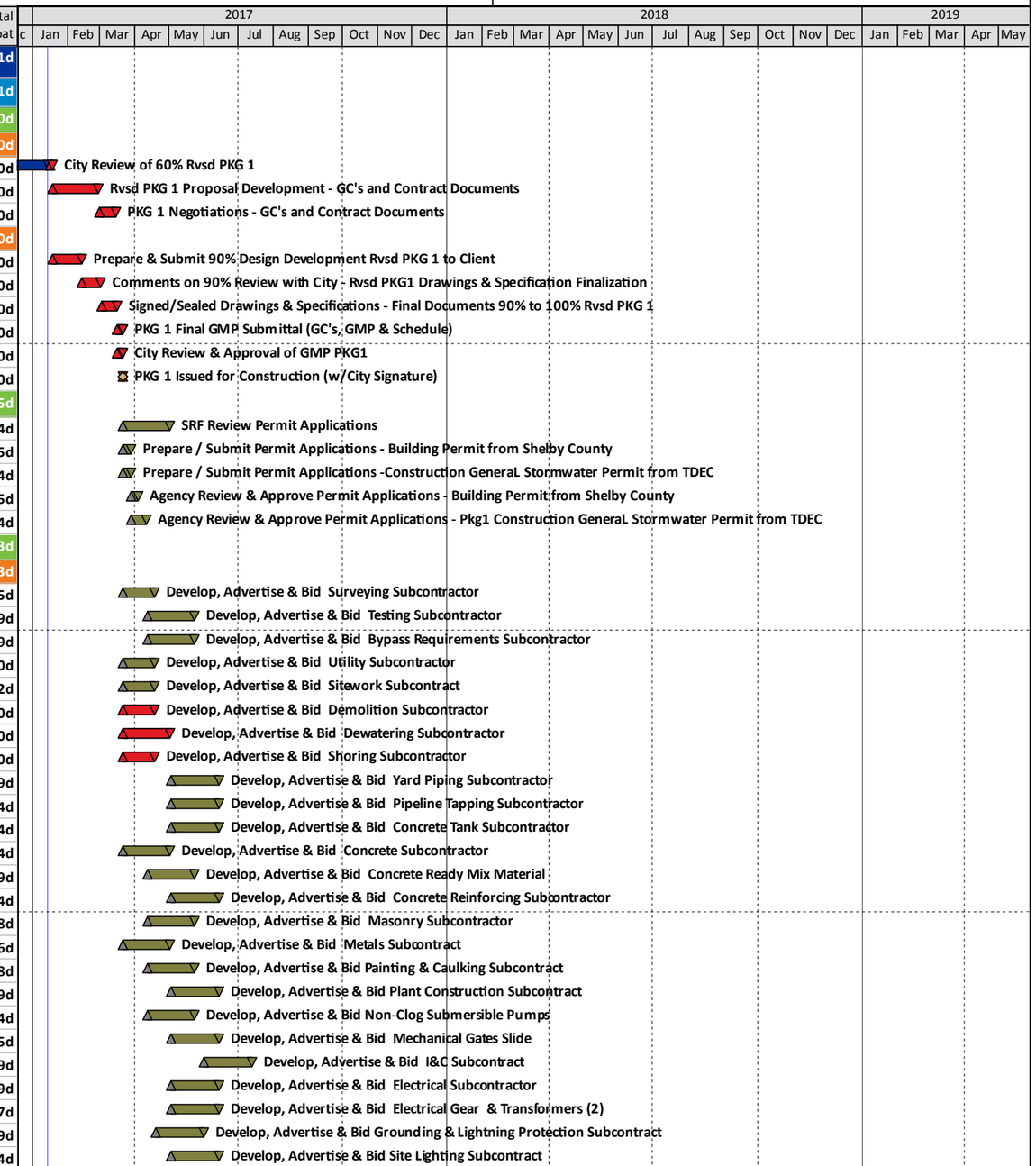
These packages are still in discussion with the City, in the attempt to maximize opportunities for Minority- and Women-Owned Businesses. Procurement for the bid packages will be done in accordance to the City's procurement requirements and in compliance with the requirements of the Clean Water State Revolving Fund.

Critical path for the Package 1 schedule runs through review and approval times for the activities that precede bid package procurement, and the bypass pumping and Disinfection Tank construction. The schedule shows field construction activities starting in April-June 2017, due to the procurement process, and ending in February 2019. This a preliminary schedule and it will be updated once Package 1 is awarded and over the course of the project for every progress meeting.

the CITY of MEMPHIS
T.E.Maxson Wastewater Treatment Plant
PROCESS UPGRADES

DATE:15-Jan-17 TIME: 22:21

Activity ID	Activity Name	Dur	Start	Finish	Total Float
T.E. Maxson WWTP Process Upgrades (Pkg#1 Rvsd)		**538d**	**16-Dec-16 A**	**12-Feb-19**	**181d**
PKG 1 MISCELLANEOUS IMPROVEMENTS		**538d**	**16-Dec-16 A**	**12-Feb-19**	**181d**
DESIGN		**64d**	**16-Dec-16 A**	**21-Mar-17**	**0d**
PKG 1 Development and Negotiation (60%)		**60d**	**16-Dec-16 A**	**15-Mar-17**	**0d**
D1.60-3062	City Review of 60% Rvsd PKG 1	21d	16-Dec-16 A	18-Jan-17	0d
D1.60-3065	Rvsd PKG 1 Proposal Development - GC's and Contract Documents	28d	19-Jan-17	28-Feb-17	0d
D1.60-3070	PKG 1 Negotiations - GC's and Contract Documents	11d	01-Mar-17	15-Mar-17	0d
PKG 1 Finalize Design		**43d**	**19-Jan-17**	**21-Mar-17**	**0d**
D1.FD-4030	Prepare & Submit 90% Design Development Rvsd PKG 1 to Client	18d	19-Jan-17	13-Feb-17	0d
D1.FD-4050	Comments on 90% Review with City - Rvsd PKG1 Drawings & Specification Finalization	13d	13-Feb-17	02-Mar-17	0d
D1.FD-4060	Signed/Sealed Drawings & Specifications - Final Documents 90% to 100% Rvsd PKG 1	10d	03-Mar-17	16-Mar-17	0d
D1.FD-4065	PKG 1 Final GMP Submittal (GC's, GMP & Schedule)	4d	16-Mar-17	21-Mar-17	0d
D1.FD-4068	City Review & Approval of GMP PKG1	4d	16-Mar-17	21-Mar-17	0d
D1.FD-4070	PKG 1 Issued for Construction (w/City Signature)	0d		21-Mar-17	0d
PERMITTING		**30d**	**22-Mar-17**	**02-May-17**	**625d**
Perm1-5000	SRF Review Permit Applications	30d	22-Mar-17	02-May-17	4d
Perm1-5010	Prepare / Submit Permit Applications - Building Permit from Shelby County	5d	22-Mar-17	28-Mar-17	55d
Perm1-5020	Prepare / Submit Permit Applications -Construction GeneraL Stormwater Permit from TDEC	5d	22-Mar-17	28-Mar-17	4d
Perm1-5030	Agency Review & Approve Permit Applications - Building Permit from Shelby County	5d	29-Mar-17	04-Apr-17	645d
Perm1-5040	Agency Review & Approve Permit Applications - Pkg1 Construction GeneraL Stormwater Permit from	10d	29-Mar-17	11-Apr-17	4d
PROCUREMENT		**220d**	**22-Mar-17**	**06-Feb-18**	**223d**
PKG 1 Develop, Advertise & Bid		**80d**	**22-Mar-17**	**13-Jul-17**	**353d**
Proc1.DAB-5502	Develop, Advertise & Bid Surveying Subcontractor	20d	22-Mar-17	18-Apr-17	5d
Proc1.DAB-5505	Develop, Advertise & Bid Testing Subcontractor	30d	12-Apr-17	23-May-17	19d
Proc1.DAB-5509	Develop, Advertise & Bid Bypass Requirements Subcontractor	30d	12-Apr-17	23-May-17	29d
Proc1.DAB-5511	Develop, Advertise & Bid Utility Subcontractor	20d	22-Mar-17	18-Apr-17	10d
Proc1.DAB-5513	Develop, Advertise & Bid Sitework Subcontract	20d	22-Mar-17	18-Apr-17	2d
Proc1.DAB-5515	Develop, Advertise & Bid Demolition Subcontractor	20d	22-Mar-17	18-Apr-17	0d
Proc1.DAB-5520	Develop, Advertise & Bid Dewatering Subcontractor	30d	22-Mar-17	02-May-17	0d
Proc1.DAB-5525	Develop, Advertise & Bid Shoring Subcontractor	20d	22-Mar-17	18-Apr-17	0d
Proc1.DAB-5530	Develop, Advertise & Bid Yard Piping Subcontractor	30d	03-May-17	14-Jun-17	379d
Proc1.DAB-5535	Develop, Advertise & Bid Pipeline Tapping Subcontractor	30d	03-May-17	14-Jun-17	14d
Proc1.DAB-5540	Develop, Advertise & Bid Concrete Tank Subcontractor	30d	03-May-17	14-Jun-17	34d
Proc1.DAB-5544	Develop, Advertise & Bid Concrete Subcontractor	30d	22-Mar-17	02-May-17	64d
Proc1.DAB-5546	Develop, Advertise & Bid Concrete Ready Mix Material	30d	12-Apr-17	23-May-17	49d
Proc1.DAB-5548	Develop, Advertise & Bid Concrete Reinforcing Subcontractor	30d	03-May-17	14-Jun-17	4d
Proc1.DAB-5550	Develop, Advertise & Bid Masonry Subcontractor	30d	12-Apr-17	23-May-17	48d
Proc1.DAB-5555	Develop, Advertise & Bid Metals Subcontract	30d	22-Mar-17	02-May-17	296d
Proc1.DAB-5560	Develop, Advertise & Bid Painting & Caulking Subcontract	30d	12-Apr-17	23-May-17	218d
Proc1.DAB-5570	Develop, Advertise & Bid Plant Construction Subcontract	30d	03-May-17	14-Jun-17	249d
Proc1.DAB-5575	Develop, Advertise & Bid Non-Clog Submersible Pumps	30d	12-Apr-17	23-May-17	4d
Proc1.DAB-5580	Develop, Advertise & Bid Mechanical Gates Slide	30d	03-May-17	14-Jun-17	255d
Proc1.DAB-5585	Develop, Advertise & Bid I&C Subcontract	30d	01-Jun-17	13-Jul-17	249d
Proc1.DAB-5590	Develop, Advertise & Bid Electrical Subcontractor	30d	03-May-17	14-Jun-17	119d
Proc1.DAB-5592	Develop, Advertise & Bid Electrical Gear & Transformers (2)	30d	03-May-17	14-Jun-17	117d
Proc1.DAB-5596	Develop, Advertise & Bid Grounding & Lightning Protection Subcontract	30d	19-Apr-17	31-May-17	249d
Proc1.DAB-5598	Develop, Advertise & Bid Site Lighting Subcontract	30d	03-May-17	14-Jun-17	334d



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Milestone
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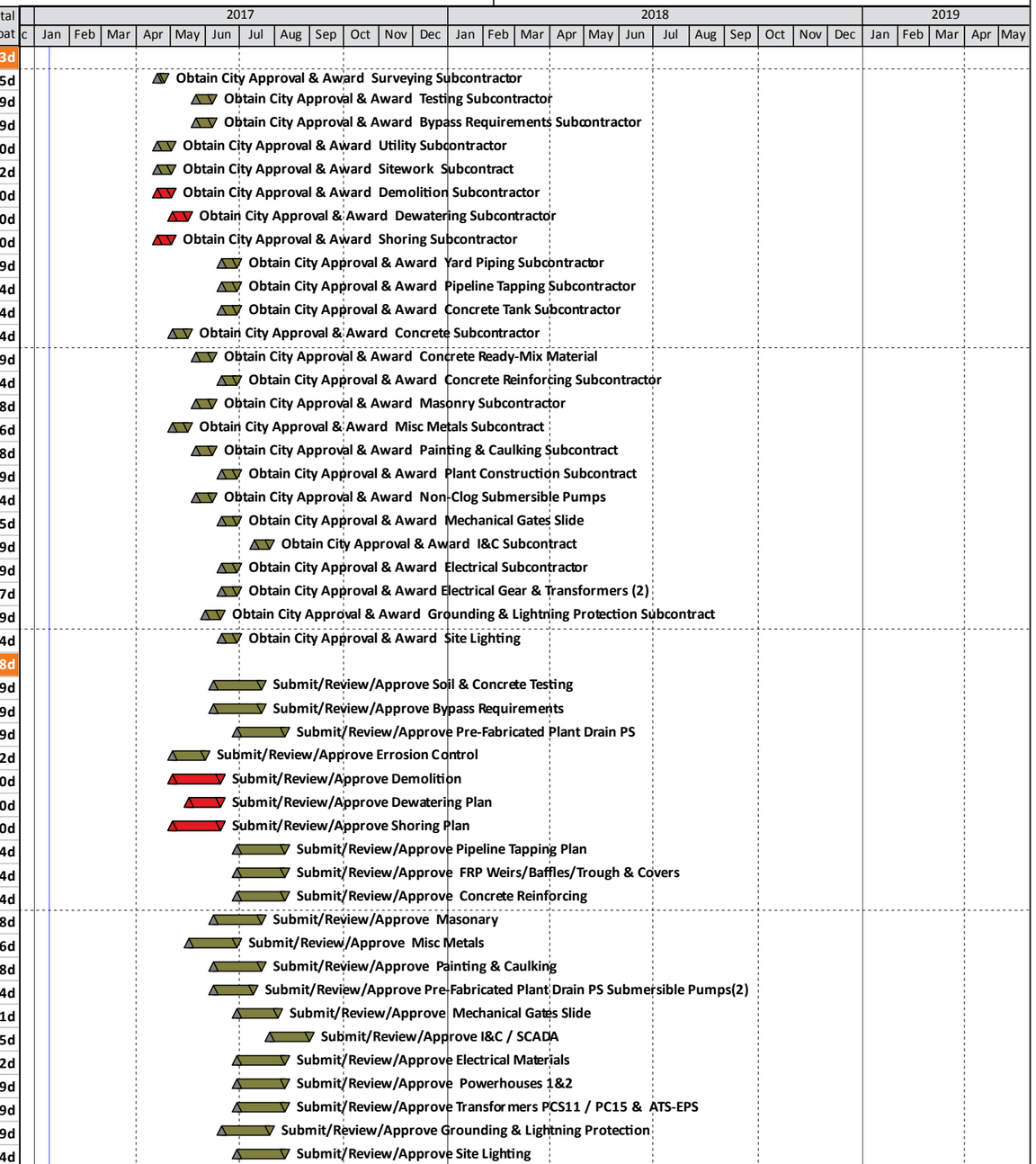
T.E.Maxson Wastewater Treatment Plant
PROCESS UPGRADES

DATE:15-Jan-17 TIME: 22:21

Activity ID	Activity Name	Dur	Start	Finish	Total Float
PKG 1 Obtain City Approval & Award		**70d**	**19-Apr-17**	**27-Jul-17**	**353d**
Proc1.AA-5602	Obtain City Approval & Award Surveying Subcontractor	5d	19-Apr-17	25-Apr-17	5d
Proc1.AA-5605	Obtain City Approval & Award Testing Subcontractor	10d	24-May-17	07-Jun-17	19d
Proc1.AA-5609	Obtain City Approval & Award Bypass Requirements Subcontractor	10d	24-May-17	07-Jun-17	29d
Proc1.AA-5611	Obtain City Approval & Award Utility Subcontractor	10d	19-Apr-17	02-May-17	10d
Proc1.AA-5613	Obtain City Approval & Award Sitework Subcontract	10d	19-Apr-17	02-May-17	2d
Proc1.AA-5615	Obtain City Approval & Award Demolition Subcontractor	10d	19-Apr-17	02-May-17	0d
Proc1.AA-5620	Obtain City Approval & Award Dewatering Subcontractor	10d	03-May-17	16-May-17	0d
Proc1.AA-5625	Obtain City Approval & Award Shoring Subcontractor	10d	19-Apr-17	02-May-17	0d
Proc1.AA-5630	Obtain City Approval & Award Yard Piping Subcontractor	10d	15-Jun-17	28-Jun-17	379d
Proc1.AA-5635	Obtain City Approval & Award Pipeline Tapping Subcontractor	10d	15-Jun-17	28-Jun-17	14d
Proc1.AA-5640	Obtain City Approval & Award Concrete Tank Subcontractor	10d	15-Jun-17	28-Jun-17	34d
Proc1.AA-5644	Obtain City Approval & Award Concrete Subcontractor	10d	03-May-17	16-May-17	64d
Proc1.AA-5646	Obtain City Approval & Award Concrete Ready-Mix Material	10d	24-May-17	07-Jun-17	49d
Proc1.AA-5648	Obtain City Approval & Award Concrete Reinforcing Subcontractor	10d	15-Jun-17	28-Jun-17	4d
Proc1.AA-5650	Obtain City Approval & Award Masonry Subcontractor	10d	24-May-17	07-Jun-17	48d
Proc1.AA-5655	Obtain City Approval & Award Misc Metals Subcontract	10d	03-May-17	16-May-17	296d
Proc1.AA-5660	Obtain City Approval & Award Painting & Caulking Subcontract	10d	24-May-17	07-Jun-17	218d
Proc1.AA-5670	Obtain City Approval & Award Plant Construction Subcontract	10d	15-Jun-17	28-Jun-17	249d
Proc1.AA-5675	Obtain City Approval & Award Non-Clog Submersible Pumps	10d	24-May-17	07-Jun-17	4d
Proc1.AA-5680	Obtain City Approval & Award Mechanical Gates Slide	10d	15-Jun-17	28-Jun-17	255d
Proc1.AA-5685	Obtain City Approval & Award I&C Subcontract	10d	14-Jul-17	27-Jul-17	249d
Proc1.AA-5690	Obtain City Approval & Award Electrical Subcontractor	10d	15-Jun-17	28-Jun-17	119d
Proc1.AA-5692	Obtain City Approval & Award Electrical Gear & Transformers (2)	10d	15-Jun-17	28-Jun-17	117d
Proc1.AA-5696	Obtain City Approval & Award Grounding & Lightning Protection Subcontract	10d	01-Jun-17	14-Jun-17	259d
Proc1.AA-5698	Obtain City Approval & Award Site Lighting	10d	15-Jun-17	28-Jun-17	334d
Submittals		**85d**	**03-May-17**	**31-Aug-17**	**318d**
Proc1.S-5705	Submit/Review/Approve Soil & Concrete Testing	30d	08-Jun-17	20-Jul-17	19d
Proc1.S-5709	Submit/Review/Approve Bypass Requirements	30d	08-Jun-17	20-Jul-17	29d
Proc1.S-5711	Submit/Review/Approve Pre-Fabricated Plant Drain PS	30d	29-Jun-17	10-Aug-17	269d
Proc1.S-5713	Submit/Review/Approve Errosion Control	20d	03-May-17	31-May-17	2d
Proc1.S-5715	Submit/Review/Approve Demolition	30d	03-May-17	14-Jun-17	0d
Proc1.S-5720	Submit/Review/Approve Dewatering Plan	20d	17-May-17	14-Jun-17	0d
Proc1.S-5725	Submit/Review/Approve Shoring Plan	30d	03-May-17	14-Jun-17	0d
Proc1.S-5735	Submit/Review/Approve Pipeline Tapping Plan	30d	29-Jun-17	10-Aug-17	14d
Proc1.S-5748	Submit/Review/Approve FRP Weirs/Baffles/Trough & Covers	30d	29-Jun-17	10-Aug-17	4d
Proc1.S-5749	Submit/Review/Approve Concrete Reinforcing	30d	29-Jun-17	10-Aug-17	4d
Proc1.S-5750	Submit/Review/Approve Masonary	30d	08-Jun-17	20-Jul-17	48d
Proc1.S-5755	Submit/Review/Approve Misc Metals	30d	17-May-17	28-Jun-17	296d
Proc1.S-5760	Submit/Review/Approve Painting & Caulking	30d	08-Jun-17	20-Jul-17	218d
Proc1.S-5775	Submit/Review/Approve Pre-Fabricated Plant Drain PS Submersible Pumps(2)	25d	08-Jun-17	13-Jul-17	4d
Proc1.S-5780	Submit/Review/Approve Mechanical Gates Slide	25d	29-Jun-17	03-Aug-17	251d
Proc1.S-5785	Submit/Review/Approve I&C / SCADA	25d	28-Jul-17	31-Aug-17	245d
Proc1.S-5790	Submit/Review/Approve Electrical Materials	30d	29-Jun-17	10-Aug-17	132d
Proc1.S-5792	Submit/Review/Approve Powerhouses 1&2	30d	29-Jun-17	10-Aug-17	129d
Proc1.S-5794	Submit/Review/Approve Transformers PCS11 / PC15 & ATS-EPS	30d	29-Jun-17	10-Aug-17	119d
Proc1.S-5796	Submit/Review/Approve Grounding & Lightning Protection	30d	15-Jun-17	27-Jul-17	349d
Proc1.S-5798	Submit/Review/Approve Site Lighting	30d	29-Jun-17	10-Aug-17	334d



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Activity ID	Activity Name	Dur	Start	Finish	Total Float
Fabrication & Delivery		150d	29-Jun-17	06-Feb-18	205d
Proc1.FD-5810	Fab/Deliver Misc Metals	60d	29-Jun-17	22-Sep-17	296d
Proc1.FD-5820	Fab/Deliver FRP Weirs/Baffles/Trough & Covers	80d	11-Aug-17	29-Oct-17	248d
Proc1.FD-5830	Fab/Deliver Electrical Materials	40d	11-Aug-17	06-Oct-17	132d
Proc1.FD-5840	Fab/Deliver Mechanical Gates Slide	100d	04-Aug-17	11-Nov-17	368d
Proc1.FD-5850	Fab/Deliver Transformer PC15 & PC11	100d	11-Aug-17	08-Jan-18	116d
Proc1.FD-5860	Fab/Deliver ATS-EPS	80d	11-Aug-17	07-Dec-17	139d
Proc1.FD-5870	Fab/Deliver Powerhouses 1&2	120d	11-Aug-17	06-Feb-18	129d
Proc1.FD-5880	Fab/Deliver Pre-Fabricated Plant Drain Pump Station	40d	11-Aug-17	06-Oct-17	269d
Proc1.FD-5890	Fab/Deliver Plant Drain Submersible Pumps (2)	60d	14-Jul-17	06-Oct-17	285d
CONSTRUCTION		449d	26-Apr-17	12-Feb-19	0d
Mobilization		40d	26-Apr-17	21-Jun-17	5d
CN1.Mblz-6000	Mobilization	30d	26-Apr-17	07-Jun-17	5d
CN1.Mblz-6002	Site Survey and Establish Benchmarks	10d	26-Apr-17	09-May-17	5d
CN1.Mblz-6005	Install Electrical Temporary Power	30d	03-May-17	14-Jun-17	10d
CN1.Mblz-6010	Install Temporary Facilities	30d	10-May-17	21-Jun-17	5d
CN1.Mblz-6020	Install Site Erosion Control Measures	8d	01-Jun-17	12-Jun-17	2d
Site Work		10d	13-Jun-17	26-Jun-17	2d
CN1.SW-6030	Clear and Grub Site	10d	13-Jun-17	26-Jun-17	2d
DISINFECTION		414d	15-Jun-17	12-Feb-19	0d
PAA Contact Basin Construction and PAA Feed Building w/ Electrical and I&C		414d	15-Jun-17	12-Feb-19	0d
80 PAA Contact Tank		414d	15-Jun-17	12-Feb-19	0d
Structure		318d	15-Jun-17	20-Sep-18	76d
CN1.80.S-6000	Install Dewatering	10d	15-Jun-17	28-Jun-17	0d
CN1.80.S-6010	Demo Existing Structure	5d	15-Jun-17	21-Jun-17	0d
CN1.80.S-6020	Sheeting - North	10d	15-Jun-17	28-Jun-17	0d
CN1.80.S-6022	Sheeting - West	10d	29-Jun-17	13-Jul-17	24d
CN1.80.S-6030	Excavate for Foundations	15d	28-Jun-17	19-Jul-17	0d
CN1.80.S-6040	Install PAA Underdrain System	20d	20-Jul-17	16-Aug-17	0d
CN1.80.S-6050	Form/Pour/Cure Foundation & PAA Tank Drains	130d	16-Aug-17	14-Feb-18	0d
CN1.80.S-6060	Form/Pour/Cure PAA Tank Walls	190d	28-Sep-17	21-Jun-18	0d
CN1.80.S-6070	Backfill /Compact Foundation	15d	14-Feb-18	07-Mar-18	76d
CN1.80.S-6080	Backfill /Compact Tank Walls	20d	05-Jul-18	02-Aug-18	81d
CN1.80.S-6090	Set Valve Vaults	5d	14-Jun-18	21-Jun-18	89d
CN1.80.S-6100	Form/Pour/Cure Elevated Slab Walkway	24d	28-Jun-18	02-Aug-18	77d
CN1.80.S-6110	Hydraulic/Standing Water Test Structure	30d	24-May-18	05-Jul-18	0d
CN1.80.S-6120	Yard Piping	10d	21-Jun-18	06-Jul-18	129d
CN1.80.S-6130	Misc. Metals - Hatches / Handrails / Grating	35d	02-Aug-18	20-Sep-18	81d
Mechanical		73d	21-Jun-18	04-Oct-18	46d
CN1.80.M-6200	Install Slide Gates in PAA	8d	21-Jun-18	04-Jul-18	112d
CN1.80.M-6205	Install Slide Gates in Effluent PS and Junction Boxes	15d	21-Jun-18	12-Jul-18	105d
CN1.80.M-6210	Install Slide Gate Hydro Test	5d	12-Jul-18	19-Jul-18	100d
CN1.80.M-6220	Install Mechanical Equipment / Peroxy Chem Piping (by Others)	60d	05-Jul-18	27-Sep-18	0d
CN1.80.M-6240	Install Mixers in PAA Contact Tank	5d	27-Sep-18	04-Oct-18	0d
Electrical		140d	19-Jul-18	12-Feb-19	0d
CN1.80.E-6310	Grounding	5d	19-Jul-18	26-Jul-18	100d
CN1.80.E-6320	PAA Tank Walkway Rough-In Electrical	15d	02-Aug-18	23-Aug-18	80d
CN1.80.E-6330	Rough-in Electrical @ Walls - PAA, Mixers & Gates	30d	04-Oct-18	15-Nov-18	0d

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Activity ID	Activity Name	Dur	Start	Finish	Total Float
CN1.80.E-6340	Install Lighting Poles	10d	15-Nov-18	03-Dec-18	13d
CN1.80.E-6350	Light Pole Installation	15d	23-Aug-18	14-Sep-18	80d
CN1.80.E-6360	Install Power / Control Conduits	20d	27-Sep-18	25-Oct-18	15d
CN1.80.E-6370	Set Junction Boxes & Finish Conduit	15d	15-Nov-18	06-Dec-18	0d
CN1.80.E-6380	Pull & Terminate Feeder & Branch Control Wires	10d	06-Dec-18	20-Dec-18	0d
CN1.80.E-6390	Electrical Connections & Terminations	10d	20-Dec-18	07-Jan-19	0d
CN1.80.E-6395	Complete Punchlist Items	20d	14-Jan-19	12-Feb-19	0d
Instrumentation		15d	20-Dec-18	14-Jan-19	0d
CN1.80.I-6400	Install I & C Devices	10d	20-Dec-18	07-Jan-19	0d
CN1.80.I-6410	Loop Test & Terminate I&C Devices	5d	07-Jan-19	14-Jan-19	0d
Plant Drain Pump Station		287d	20-Jul-17	11-Sep-18	102d
CN1.PDPS-7000	Install Excavation Protection and Excavate (from El 28 to 38)	5d	20-Jul-17	26-Jul-17	320d
CN1.PDPS-7010	Place Pre-fab PS Bottom Slab	3d	10-Oct-17	12-Oct-17	269d
CN1.PDPS-7020	Install Pre-Fab Wet Well Walls	10d	13-Oct-17	26-Oct-17	269d
CN1.PDPS-7030	Standing Water Test Structure	3d	27-Oct-17	31-Oct-17	269d
CN1.PDPS-7040	Install Submersible Pumps (2)	5d	01-Nov-17	07-Nov-17	269d
CN1.PDPS-7050	Install Supports and Discharge Piping	5d	08-Nov-17	15-Nov-17	271d
CN1.PDPS-7060	Backfill & Compact Wet Well Structure	10d	08-Nov-17	22-Nov-17	282d
CN1.PDPS-7070	Pour Slab on Grade (SOG)	5d	08-Nov-17	15-Nov-17	269d
CN1.PDPS-7080	Rough-in Electrical	18d	16-Nov-17	13-Dec-17	269d
CN1.PDPS-7090	Start-up & Test Plant Site LIft Station	1d	11-Sep-18	11-Sep-18	102d
CN1.PDPS-7100	Complete Punchlist Items	20d	14-Dec-17	12-Jan-18	269d
SCADA and Programming for the full system		40d	04-Dec-17	31-Jan-18	164d
CN1.Scada-7100	Scada and Programming	20d	04-Dec-17	02-Jan-18	164d
CN1.Scada-7110	Field Installation	20d	03-Jan-18	31-Jan-18	164d
IPA ELECTRICAL BUILDING AND SERVICE IMPROVEMENTS		296d	10-Aug-17	16-Oct-18	78d
IPA Electrical Building		214d	16-Nov-17	24-Sep-18	93d
CN1.IPA.E-8200	Install Building Grounding	5d	16-Nov-17	22-Nov-17	153d
CN1.IPA.E-8210	Prep Building Pad	5d	27-Nov-17	01-Dec-17	153d
CN1.IPA.E-8220	Install U/G Counduits for Building	15d	04-Dec-17	22-Dec-17	153d
CN1.IPA.E-8230	Building Foundation & SOG	5d	26-Dec-17	02-Jan-18	153d
CN1.IPA.E-8240	Set Powerhouse on Slab	5d	07-Feb-18	13-Feb-18	129d
CN1.IPA.E-8250	Elec & Mech Rough in	5d	14-Feb-18	21-Feb-18	129d
CN1.IPA.E-8260	Pull & terminate Feeder & Branch Wires	10d	22-Feb-18	07-Mar-18	129d
CN1.IPA.E-8270	Test New Equipment	15d	08-Mar-18	28-Mar-18	129d
CN1.IPA.E-8280	Energize & Electrical Connections & terminations	5d	18-Sep-18	24-Sep-18	14d
CN1.IPA.E-8290	Complete Punchlist Items	20d	29-Mar-18	25-Apr-18	198d
Main Plant Feed System		296d	10-Aug-17	16-Oct-18	78d
CN1.IPA.FS-8300	Power Co. Relocate Primary Power Ploes for Project to Connect	20d	10-Aug-17	08-Sep-17	132d
CN1.IPA.FS-8305	Install Ductbanks from Metering Pad to IPA Bldg	26d	10-Oct-17	15-Nov-17	132d
CN1.IPA.FS-8310	Pull Wire from Metering Pad to IPA Electrical Building	8d	14-Feb-18	26-Feb-18	131d
CN1.IPA.FS-8320	Install Ductwork from IPA Electrical Building to exisiting MV Transformers	10d	25-Apr-18	08-May-18	80d
CN1.IPA.FS-8330	Install Ductbank from Existing SW-1&2 to SW-9&10	10d	09-May-18	22-May-18	85d
CN1.IPA.FS-8340	Install Ductbank from IPA to Existing Switches	15d	09-May-18	30-May-18	80d
CN1.IPA.FS-8350	Pull WIre frm IPA Electrical Building to MV Transformers	5d	23-May-18	30-May-18	85d
CN1.IPA.FS-8360	Pull Wire from SW-1&2 TO sw-9&10	5d	23-May-18	30-May-18	85d
CN1.IPA.FS-8370	Pull WIre from IPA Electrical Building to Exisitng Switches	5d	31-May-18	06-Jun-18	80d
CN1.IPA.FS-8380	Test and Terminate Wires	5d	11-Sep-18	17-Sep-18	14d

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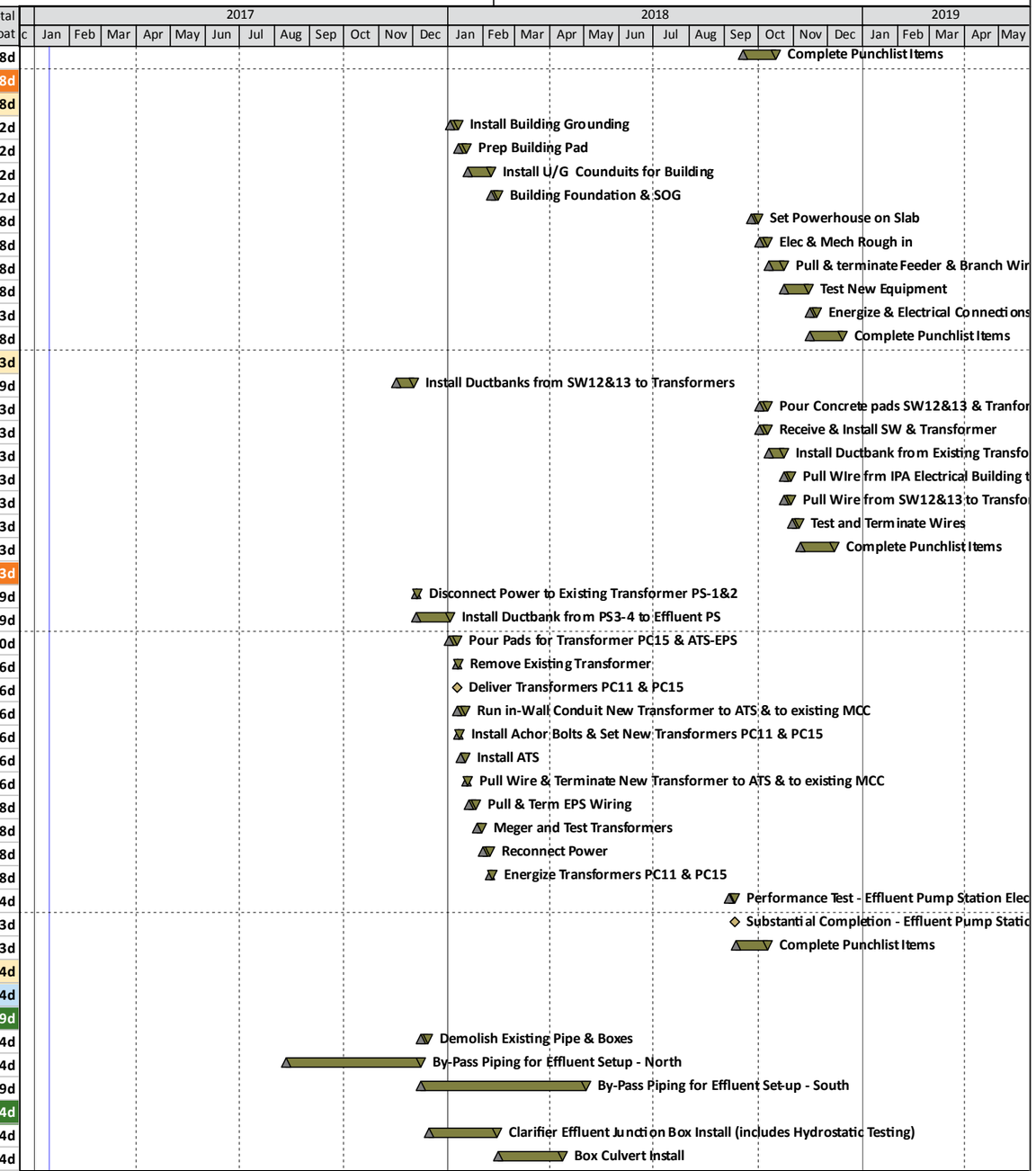
Activity ID	Activity Name	Dur	Start	Finish	Total Float
CN1.IPA.FS-8390	Complete Punchlist Items	20d	18-Sep-18	16-Oct-18	78d
PAA IPA ELECTRICAL BUILDING		269d	16-Nov-17	14-Dec-18	38d
PAA Electrical Building		239d	03-Jan-18	14-Dec-18	38d
CN1.PPA.E-8400	Install Building Grounding	5d	03-Jan-18	09-Jan-18	192d
CN1.PPA.E-8410	Prep Building Pad	5d	10-Jan-18	17-Jan-18	192d
CN1.PPA.E-8420	Install U/G Counduits for Building	15d	18-Jan-18	07-Feb-18	192d
CN1.PPA.E-8430	Building Foundation & SOG	5d	08-Feb-18	14-Feb-18	192d
CN1.PPA.E-8440	Set Powerhouse on Slab	5d	25-Sep-18	01-Oct-18	38d
CN1.PPA.E-8450	Elec & Mech Rough in	5d	02-Oct-18	09-Oct-18	38d
CN1.PPA.E-8460	Pull & terminate Feeder & Branch Wires	10d	10-Oct-18	23-Oct-18	38d
CN1.PPA.E-8470	Test New Equipment	15d	24-Oct-18	14-Nov-18	38d
CN1.PPA.E-8480	Energize & Electrical Connections & terminations	5d	15-Nov-18	21-Nov-18	43d
CN1.PPA.E-8490	Complete Punchlist Items	20d	15-Nov-18	14-Dec-18	38d
Main Plant Feed System		264d	16-Nov-17	07-Dec-18	43d
CN1.PPA.FS-8500	Install Ductbanks from SW12&13 to Transformers	10d	16-Nov-17	01-Dec-17	139d
CN1.PPA.FS-8510	Pour Concrete pads SW12&13 & Tranformer	5d	02-Oct-18	09-Oct-18	43d
CN1.PPA.FS-8520	Receive & Install SW & Transformer	5d	02-Oct-18	09-Oct-18	43d
CN1.PPA.FS-8530	Install Ductbank from Existing Transformer to IPA Bldg	10d	10-Oct-18	23-Oct-18	43d
CN1.PPA.FS-8540	Pull WIre frm IPA Electrical Building to Transformers	5d	24-Oct-18	30-Oct-18	43d
CN1.PPA.FS-8550	Pull Wire from SW12&13 to Transformers	5d	24-Oct-18	30-Oct-18	43d
CN1.PPA.FS-8560	Test and Terminate Wires	5d	31-Oct-18	06-Nov-18	43d
CN1.PPA.FS-8570	Complete Punchlist Items	20d	07-Nov-18	07-Dec-18	43d
Effluent Pump Station Electrical Improvements & Redundant Feeder		290d	11-Aug-17	09-Oct-18	83d
CN1.EPS.E-9000	Disconnect Power to Existing Transformer PS-1&2	1d	04-Dec-17	04-Dec-17	139d
CN1.EPS.E-9010	Install Ductbank from PS3-4 to Effluent PS	20d	04-Dec-17	02-Jan-18	139d
CN1.EPS.E-9020	Pour Pads for Transformer PC15 & ATS-EPS	5d	02-Jan-18	09-Jan-18	140d
CN1.EPS.E-9030	Remove Existing Transformer	1d	09-Jan-18	09-Jan-18	116d
CN1.EPS.E-9040	Deliver Transformers PC11 & PC15	0d	09-Jan-18		116d
CN1.EPS.E-9050	Run in-Wall Conduit New Transformer to ATS & to existing MCC	5d	09-Jan-18	16-Jan-18	116d
CN1.EPS.E-9060	Install Achor Bolts & Set New Transformers PC11 & PC15	2d	10-Jan-18	11-Jan-18	116d
CN1.EPS.E-9070	Install ATS	2d	12-Jan-18	16-Jan-18	116d
CN1.EPS.E-9080	Pull Wire & Terminate New Transformer to ATS & to existing MCC	2d	17-Jan-18	18-Jan-18	116d
CN1.EPS.E-9090	Pull & Term EPS Wiring	5d	19-Jan-18	25-Jan-18	158d
CN1.EPS.E-9100	Meger and Test Transformers	3d	26-Jan-18	30-Jan-18	158d
CN1.EPS.E-9110	Reconnect Power	5d	31-Jan-18	06-Feb-18	158d
CN1.EPS.E-9120	Energize Transformers PC11 & PC15	2d	07-Feb-18	08-Feb-18	158d
CN1.EPS.E-9130	Performance Test - Effluent Pump Station Electrical Improvements	4d	05-Sep-18	10-Sep-18	14d
CN1.EPS.E-9140	Substantial Completion - Effluent Pump Station Electrical Improvements	0d		10-Sep-18	83d
CN1.EPS.E-9150	Complete Punchlist Items	20d	11-Sep-18	09-Oct-18	83d
Effluent Piping and JBs Constructed, Bypass Pumping, and Site Piping		266d	11-Aug-17	04-Sep-18	14d
05 YARD PIPING		266d	11-Aug-17	04-Sep-18	14d
By-Pass Pumping		180d	11-Aug-17	02-May-18	19d
CN1.YP-9200	Demolish Existing Pipe & Boxes	5d	08-Dec-17	14-Dec-17	14d
CN1.YP-9210	By-Pass Piping for Effluent Setup - North	80d	11-Aug-17	07-Dec-17	14d
CN1.YP-9212	By-Pass Piping for Effluent Set-up - South	100d	08-Dec-17	02-May-18	19d
Culverts & Manufactured Construction		160d	15-Dec-17	03-Aug-18	14d
CN1.YP-9220	Clarifier Effluent Junction Box Install (includes Hydrostatic Testing)	40d	15-Dec-17	13-Feb-18	14d
CN1.YP-9222	Box Culvert Install	40d	14-Feb-18	11-Apr-18	14d



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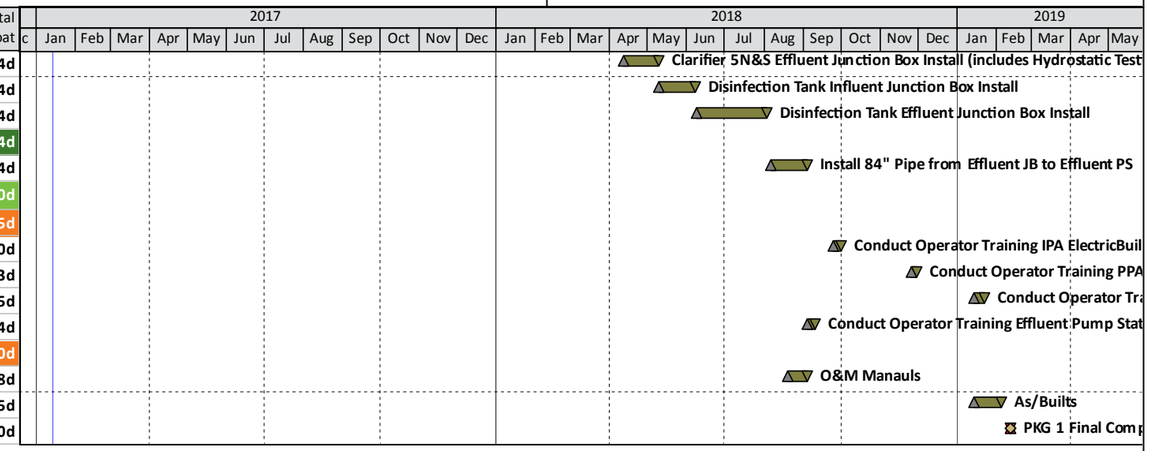
Activity ID	Activity Name	Dur	Start	Finish	Total Float
CN1.YP-9240	Clarifier 5N&S Effluent Junction Box Install (includes Hydrostatic Testing)	20d	12-Apr-18	09-May-18	14d
CN1.YP-9242	Disinfection Tank Influent Junction Box Install	20d	10-May-18	07-Jun-18	14d
CN1.YP-9250	Disinfection Tank Effluent Junction Box Install	40d	08-Jun-18	03-Aug-18	14d
Prestressed Concrete Cylinder Pipe		21d	06-Aug-18	04-Sep-18	14d
CN1.YP-9260	Install 84" Pipe from Effluent JB to Effluent PS	21d	06-Aug-18	04-Sep-18	14d
CLOSEOUT		119d	20-Aug-18	12-Feb-19	0d
Testing		96d	04-Sep-18	22-Jan-19	15d
C01-T-9820	Conduct Operator Training IPA ElectricBuilding	5d	25-Sep-18	01-Oct-18	80d
C01-T-9830	Conduct Operator Training PPA ElectricBuilding	5d	26-Nov-18	30-Nov-18	43d
CO1-T-9810	Conduct Operator Training Disinfection	5d	14-Jan-19	22-Jan-19	15d
CO1.T-9800	Conduct Operator Training Effluent Pump Station	5d	04-Sep-18	10-Sep-18	14d
Closeout		119d	20-Aug-18	12-Feb-19	0d
CO1-9900	O&M Manauls	10d	20-Aug-18	04-Sep-18	108d
CO1-9910	As/Builts	15d	14-Jan-19	05-Feb-19	5d
CO1-9920	PKG 1 Final Completion	0d		12-Feb-19*	0d



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Section 6

Opinion of Probable Construction Cost (OPCC)

This section presents the opinion of probable construction cost (OPCC) for Package 1 at the preliminary engineering report (PER) stage of the design process. As presented in earlier sections of this PER, the scope for Package 1 include the following items:

1. Sitework including excavation of the PAA Contact Tank and the four Effluent Junction Boxes;
2. Yard Piping - PAA Contact Tank Piping, Effluent PS Piping, and Effluent Bypass Piping (including bypass pumping of the entire facility flow);
3. PAA Contact Tank;
4. Drain Pump Station;
5. Effluent Water Pump Station
6. Effluent Hydraulics Improvements (Four Junction Boxes, three with Slide Gates);
7. SCADA Programming for the effluent flow measurement;
8. Electrical - Site Lighting, Feeder, Power, Starters, Equipment, Testing;
9. Total Overall Base Bid Project CM GC's (not including design or CM GC Pre-Construction Services).

The OPCC for Package 1 is based on the 60-Percent Design Package submitted to the City of Memphis (City) in December 2016. In addition, the OPCC includes refinement of the package as the design has progressed to the 60-percent level as shown in **Table 6-1**.

Table 6-1 Package 1 Opinion of Probable Construction Cost

Package 1 Scope Item	Construction w/ Add. Services (10%)[1]
Effluent Pump Station Improvements (270 & 275)	$2,300,000
Disinfection System and Yard Piping (60, 82 & 90)	$21,700,000
Outfall Channel Repairs – CoM to self-perform	$0
Effluent Hydraulic Improvements and Site Work (50 & 110)	$9,200,000
Main Electrical Service (220, 900, 905 & 910)	$5,700,000
Additional Design Services and Construction Services	$1,500,000
TOTAL	**$41,600,000**

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FINAL PRELIMINARY ENGINEERING REPORT

T.E. Maxson WWTF Process Upgrades

Headworks Improvements

Prepared for:

Memphis, Tennessee

[redacted]

March 2017

CDM Smith Project No.:
36694-111641

CDM Smith

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Section 1

Introduction

The City of Memphis (City) retained CDM Smith Inc. to design and construct disinfection, biological treatment and hydraulic capacity improvements at the City's T.E. Maxson Wastewater Treatment Facility (WWTF) via a construction management at risk (CMAR) project delivery method. These improvements include:

- Replacement of the Existing Headworks Manual Coarse Screens;
- Upgrades to the Effluent Pump Station Electrical Improvements;
- Biotower Upgrades and RAS Re-aeration Basin;
- Conversion from coarse bubble to fine bubble diffusers in the Aeration Basins;
- Addition of peracetic acid (PAA) disinfection system including Disinfection Tank;
- Demolition of the existing Clarifier 5-N and 5-S and construction of two new Clarifiers;
- Miscellaneous hydraulic improvements; and,
- Improvements to the odor control system.

These improvements will be divided into multiple design packages throughout the project duration. This Preliminary Engineering Report (PER) describes the replacement of the existing manual coarse screens located in the Headworks Building with mechanical screens. This report includes:

<u>Headworks Improvements:</u>

- Basis of Design and Equipment Data Sheets
- Control Narrative for the Coarse Screen Replacement
- Construction Sequencing and Constraints for the Headworks Improvements
- Project Schedule
- Opinion of Probable Construction Cost

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Section 2

Coarse Screen Replacement

The existing headworks building was constructed in the mid-1970's and currently utilizes two influent channels with two manually-cleaned coarse screens, in series, in each channel. The existing coarse screens utilize embedded guiderails and an overhead wire rope winch that allows them to be removed from the channel for manual cleaning. Screenings are placed on one of two belt conveyors and conveyed to the screenings dumpsters located outside of the building. The City staff estimates the screens to have a spacing between 1-1/2 and 2-inches.

Although the coarse screens were replaced and the channels repaired around 1999, further concrete degradation has occurred in the channels, the manual operation of the screens presents a safety concern for the operators and the City has reported that the screens are not capturing many screenings. The Conceptual Design Report (CDR) recommended that the existing screenings equipment be replaced with new climber screens and dedicated washing presses installed for each channel.

This section further details the design basis for the new screening equipment, includes a control narrative for the screening process, and discusses construction sequencing and constraints. In addition, equipment data sheets (EDS) are included in **Appendix A**. Drawings and specifications at a 90-percent design level were provided to the City for review in October 2016.

2.1 Design Basis

The basis of design for the new mechanical screens is listed in **Table 2-1.**

Table 2-1 Mechanical Screen Basis of Design

Parameter	Units	Value	Notes
Number of Channels	Each	2	
Number of Screens per Channel	Each	1	
Peak Hour Flow (Total/Per Channel)	MGD	170/85	
Design Average Flow (Total/Per Channel)	MGD	90/45	
Minimum Flow (Total/Per Channel)	MGD	50/25	
Channel Width	Feet	6.5	
Channel Height	Feet	10	To underside of slab
Channel Invert Elevation		181.25	Based upon As-Built Drawings
Operating Floor Elevation		229.0	Based upon As-Build Drawings
Minimum Rake Engagement Frequency	Minutes	5	
Angle of Inclination (from horizontal)	Degrees	85	
Bar Spacing	Inches	1.0	
Bar Thickness	Inches	3/8	
Anticipated Screenings Quantity	CY/day	17	Wet Weather
	CY/day	8	Dry Weather

The hydraulic evaluation to determine the screen spacing was performed in the CDR. These results are presented and summarized here.

2.1.1 Hydraulic Summary

During high flow conditions the existing coarse screen system floods as a result of blinding across the manually-cleaned screens and high wet well water surface elevations. While new mechanically-cleaned coarse screens will reduce blinding and improve operator safety, they will not eliminate flooding in the coarse screen area of the headworks. As a result, the bar spacing was selected to achieve the minimum bar spacing without making the current hydraulic conditions worse.

Headloss through a screen is a function of the available flow area (calculated by determining the screen blinding rate, bar spacing, and downstream water surface) and the flow through the screen. The blinding rate is a function of the frequency with which the screen is cleaned, e.g. climber screens typically have a blinding rate of 40 to 60-percent. The bar spacing is variable depending upon the desired screening capture and the available headloss, while the flow rate is set at a given facility based on the design plant flows. The primary variables that can be manipulated are the bar spacing and the downstream water surface elevation. The City of Memphis provided hourly instantaneous influent pump station discharge flows and water levels upstream and downstream of the existing coarse screens from May 2015 through November 2015. That data is summarized in **Table 2-2**.

Table 2-2 Hourly Influent Pump Station Flow and Water Depth Data

Parameter	Average	Percentiles[1]		
		50th	90th	95th
Influent Pump Station Discharge Flow, MGD	66.8	62.1	84.7	102.9
Water Depth Upstream of Screens, inches	106.3	105.9	133.7	143.1
Water Depth Downstream of Screens, inches	75.2	75.7	105.4	115.6

Note: 1. Based on hourly data from May 2015 through November 2015

The downstream water surface is the same as the influent pump station wet well. Therefore, the plant staff are able to control the downstream water surface through the operation of the Influent Pump Station. Based on discussions with Maxson WWTF staff, the downstream water surface elevation data used to calculate screen headloss was the 50th percentile and checked against the 90th percentile to confirm that the upstream water depth would not exceed 120 inches at peak flow. Bar spacing of 1-inch, 1-1/4-inch and 1-1/2-inch were evaluated for these calculations. Other assumptions used for the headloss calculations included:

- Blinding rate of 50-percent for climber screens
- Screen frame protrudes 6-inches from each channel wall
- Bar thickness is 3/8-inch
- Maximum upstream water depth is 120 inches
- 50th percentile downstream water depth is 76 inches
- 90th percentile downstream water depth is 105 inches

- Peak Hour Flow is 170 MGD
- Design Average Flow is 90 MGD
- Two channels are in service

The results of the headloss calculations are summarized in **Table 2-3**.

Table 2-3 Climber Screen Headloss Calculation Results

Parameter	Downstream Depth = 50th Percentile		Downstream Depth = 90th Percentile	
	Peak Flow	Average Flow	Peak Flow	Average Flow
Total Flow, MGD	170	90	170	90
Number of Operational Screens	2	2	2	2
Flow per Screen, MGD	85	45	85	45
Bar Spacing, inches	1	1	1	1
Channel Velocity, feet per second	3.20	1.69	2.31	1.22
Velocity through Bars, feet per second	10.39	5.50	7.52	3.98
Width of Channel not blocked by bars or screen frame[1], feet	4.00	4.00	4.00	4.00
Assumed Downstream Water Level, inches	76	76	105	105
Channel Freeboard, feet	1.50	3.06	0.11	0.93
Headloss, feet	2.17	0.61	1.14	0.32
Upstream Water Level, inches	102	83	119	109
Blinding Factor	50%	50%	50%	50%

Notes: 1. Assumes frame takes up 1 foot of channel width

These results indicate that the climber screen can maintain an upstream water depth less than 120 inches at peak flow and with the 90th percentile downstream water depth at a 1-inch bar spacing. For this screen, the manufacturer indicated peak screen capture at velocities between 1.5 and 4 feet per second, where 1.5 feet per second corresponds to the minimum velocity to prevent deposition of heavy debris immediately in front of the screen and 4 feet per second corresponds to reduced capture per WEF Manual of Practice No. 8. Per the table above, this condition is met during average flows, particularly when the downstream water level is in the higher percentile. But, the velocity through the climber screen at peak flow conditions is anticipated to be up to 10.39 feet per second at the 50th percentile downstream water level. These higher velocities can lead to a reduced screenings capture efficiency; however, negative impacts to downstream processes are not anticipated for this application. Higher velocities will be observed infrequently – only during peak hour conditions, and the reduced capture noted by the manufacturer does not tend to impact the large debris that would negatively impact the influent pump station. Additionally, process areas downstream of the influent lift station would still be protected by the fine screens, which are expected to capture any smaller debris that would pass the coarse screens.

2.1.2 Screenings Equipment Information

Process mechanical layouts and specifications for the mechanical screens and the dedicated washer compactors were included in the 90-percent design documents provided to the City in October 2016. Because the City's other screen installations have utilized Vulcan Industries screens, they are utilized as the basis of design. Equipment highlights are summarized below:

- Material of Construction: 316 stainless steel (SS) will be utilized over 304 SS because of its superior corrosion properties, especially with chlorides.
- Screens will come in 6 different sections plus the mechanism (Four, 12-ft long weighing 4,000 lbs. Bar rack section, 6,000 lbs; Top section, 500 lbs; Mechanism, 1,500 lbs).
- Each washing press will be placed on a 316 SS dolly to allow it to be moved so maintenance can be performed on the screw.
- Each washing press will include a wash water manifold with five (5) solenoid valves with dedicated PVC ball valves. Four (4) of the valves are utilized for washing the material in the machine. The fifth valve is for the screen discharge chute flush water. The discharge chute is provided by the manufacturer and will come with two spray nozzles for moving screenings off the chute.
- 316 SS safety cages will be located at main operating level of the headworks building, and handrail will be provided at the other two operating levels.
- Electrical & Control Components provided by Vulcan:
  - Screens will utilize 5 HP (7.6 FLA @ 480 V, 3-Phase, 60 Hz), two speed, NEMA 6P rated motor
  - Washing press will utilize 7.5 (11.0 FLA @ 480 V, 3-Phase, 60 Hz), NEMA 7 motor
  - One NEMA 4X control panel for each screen & W/C combination and featuring Vulcan's standard control system, which will be PLC based
  - Control panels will include touch screen for operator interface
  - Two NEMA 7 level elements and transmitters (utilized by both screens)
  - One NEMA 7 float switch with transmitter (utilized by both screens)
  - Four NEMA 7 disconnects (one for each piece of equipment)
  - Two NEMA 7 screen local control stations (one for each screen)
    - *Push-to-Stop/Pull-to Run emergency stop maintained push button with lockout*
    - *HAND/OFF/AUTO selector switch*
    - *FORWARD/OFF/REVERSE selector switch. Switch shall spring return from REVERSE to OFF.*
  - Two NEMA 7 W/C local control stations (one for each W/C)

- *Push-to-Stop/Pull-to Run mushroom type emergency stop maintained push button with lockout.*
- *HAND/OFF/AUTO selector switch.*
- *FORWARD/OFF/REVERSE selector switch. Switch shall spring return from REVERSE to OFF.*
- *Wash Initiate button*

- Each washing press will be equipped with an emergency pull cord.
- Components will also include heat tracing

2.1.3 Engineering Disciplines

In addition to the screenings equipment, other improvements are required to accommodate the removal of the existing screens and the installation of the new climber screens. These other required improvements are summarized in the subsections below.

2.1.3.1 Miscellaneous Process Improvements

New stop logs at the upstream and downstream ends of the screening channels will need to be provided. Stop logs will be made of FRP, and the stop log guides will be made of 316 SS and be embedded into the channel walls. A lifting point will be provided to install and remove the stop logs from the channel, and stop log racks will allow for the logs to be stored when not in use.

The screenings washing presses will discharge into dedicated 4 cubic yard dumpsters located on the north side of the headworks building.

2.1.3.2 Architectural

The headworks building is classified as a low-hazard factory industrial, group F-2 occupancy. The existing handrails around the slab openings will require complete replacement based on the final sizes of new equipment and the condition of the existing handrails and their supports. The existing wall openings for the conveyor belts on the north wall of the headworks building will be infilled with CMU to match the existing building construction. New openings will be created in the north wall to accommodate the new discharge chutes for the washing press units to the dumpsters outside the building. A new metal canopy will be constructed on the north side of the headworks building over the dumpster units.

2.1.3.3 Structural

The drawings illustrate the demolition required to install the new screens and washer compactors. The extent of the concrete rehabilitation will not be known until the condition assessment is performed, however for cost estimating purposes it is assumed that each channel wall will have a maximum depth of concrete removed of 10-inches by 19-feet along the length of channel wall, and 10-feet high. New reinforcing steel will be installed and calcium aluminate cement will be utilized as it has corrosion resistant properties. New channels stop logs will be embedded in the channel walls in both channels upstream and downstream of the new screens. Modifications to the intermediate slabs will be required based upon the new screenings equipment layout. Modifications will include removing portions of the existing slabs and installing new concrete slabs.

2.1.3.4 Civil

No civil work will be required on this portion of the project, aside from running a new 2-inch city water line to the headworks building for use with the screening equipment.

2.1.3.5 Electrical

The one line diagram for the new equipment is shown in Appendix A. Heat trace and insulation will be installed on the sections of the washing press discharge pipes that protrude out of the headworks building. The heat trace and insulation shall be terminated 6-inches from the end of the discharge pipe. The insulation shall have aluminum shielding to protect it.

2.1.3.6 Instrumentation & Controls

The two new control panels will be connected to the existing SCADA system via Ethernet to the Administration Building. This will allow the screening system to be monitored via SCADA. A new combustible gas detector will be installed, along with a strobe and horn, in order to comply with NFPA 820.

2.1.3.7 Plumbing

The new washing presses require water to assist in the washing of the screenings. In addition, flush water will be required on the chute that conveys screenings from the screen to the washing press, as the space within the existing headworks building do not allow for the desired chute geometry. Each discharge chute will include two spray nozzles, one on each side of the chute, along with a solenoid and a ball valve for each discharge chute. The solenoid and ball valves will be located on the washing press valve manifold. Therefore, a new potable water line will be run from the Influent Pump Station into the headworks building. The line will need to include a code compliant backflow preventer or tie into the potable water line downstream of the preventer in the Influent Pump Station.

2.1.3.8 HVAC/Odor Control

The existing HVAC system will not be modified as part of this work. However, a new headworks odor control system will be included in GMP 2. New fiberglass reinforced plastic (FRP) duct work for the odor control system will be required at the influent side of the headworks to extend the exhaust duct down to just above the high water line.

2.2 Control Narrative

The control narrative for the operation of the screens and washing presses are described herein.

2.2.1 Screen Control Narrative

The climber screen will be able to operate in manual or automatic mode, and those modes of operation are described below.

2.2.1.1 Manual Screen Operation

When the operator uses the HAND-OFF-AUTO selector switch at the local control station and selects the HAND position, the screen will operate continuously. The operator can utilize the FORWARD-OFF-REVERSE selector switch to dictate the direction the screen will operate.

Interlocks are not active when the screen is operated in manual mode.

2.2.1.2 Automatic Screen Operation

When the operator uses the HAND-OFF-AUTO selector switch at the local control station and selects the AUTO position, the screen will automatically start based upon the following:

- A software based elapse timer (TMR1) is also included, and will be operator adjustable at the PLC. The screen will automatically initiate cleaning cycle(s) when the elapse timer has timed out. This functionality helps ensure the screens are cleaned a minimum number of times each day. The cycle frequency (CF) and the duration times (TMR2) associated with the timer shall be set by the operator through set points in the Operator Interface Terminal (OIT).
- The normal timer start will be overridden by a start commend generated by the PLC based upon the water surface level sensors and the operator adjustable water surface level differential set point (DIFF1). When a water surface differential greater than the surface level differential set point DIFF1 is observed, the screen will automatically initiate a cleaning cycle. The screen will continue to run until the water surface differential achieves second operator adjustable set point (DIFF2), which indicates the screen is clean.
- The normal timer start will be overridden by a high level alarm generated from the high level (HWL) float switch provided. The switch will be located at a common point immediately upstream of the channels. The screen will run continually when the high level switch is activated, and an alarm will be initiated. The screen will continue to operate until the water level is reduced below the high level float switch set point.
- Given there is one set of level elements, both screens will operate simultaneously when they are both placed in AUTO.
- A cycle counter on the screens keeps track of how many cleaning cycles each screen performs.
- Initial set point values are included in the table below.

Parameter	Set Point
TMR1	60 Minutes
TMR2	2 Minutes
CF	3
DIFF1	2’-0”
DIFF2	6”
HWL	EL 189.25

2.2.2 Washing Press Control Narrative

The washing press will be able to operate in manual or automatic mode, and those modes of operation are described below.

2.2.2.1 Manual Washing Press Operation

When the operator uses the HAND-OFF-AUTO selector switch at the local control station and selects the HAND position, the washing press will operate continuously. The operator can utilize the FORWARD-OFF-REVERSE selector switch to dictate the direction the screw will operate. A spring return is provided for the REVERSE position.

Interlocks are not active when the washing press is operated in manual mode.

With the HAND-OFF-AUTO selector switch in the HAND position, the operator can begin a cleaning sequence when using the INITIATE pushbutton.

2.2.2.2 Automatic Washing Press Operation

When the operator uses the HAND-OFF-AUTO selector switch at the local control station and selects the AUTO position, the washing press will automatically start based upon the following:

- The operation of the washing press is controlled by the number of cycles perform by the dedicated screen. An adjustable set point allows for the number of cycles required before initiating the operation of the washing press to be selected by the operator. The PLC keeps track of the number of cycles via the screen cycle counter.
- The solenoid valve for the screen discharge chute flush water is automatically opened and closed based upon an operator adjustable set point. The length of time the solenoid valve is open is also operator adjustable. This allows the operator to control how often the flush water is utilized, and for how long.

2.3 Construction Sequencing and Constraints

The major constraint associated with the coarse screen replacement is whether the work will be performed while the headworks building is in operation with one channel being off line at a time, or if the entire headworks/influent pump station structure will be by-passed. Given the relative frequency that the lower level of the headworks building is flooded during high flow events when both channels are in service, performing the work with only one channel in service poses safety concerns and can result in delays when flooding events do occur. Therefore, it is recommended that bypass pumping be installed from the Influent Bypass Structure to the influent chambers at the Aerated Grit Tanks.

In an effort to minimize the costs associated with by-pass pumping, as much work as possible will be performed ahead of time. A preliminary list of work items are included herein, but more detailed schedule/plan will be developed as this design work moves forward. This work would be focused at the operating floor level in the headworks building, or outside of the headworks building. Because the interior of the headworks building will be classified as a Class 1 Division 2 environment until the bypass pumping begins, only non-spark generating activities can be performed inside the headwork building. The movable portions of the coarse screens, and the conveyors could be removed. The existing openings on the north wall could be filled in and the new openings made. The new potable water line can be run to the building. The two master control panels and fabricated equipment shelter can be installed outside of the headworks building, and new electrical and controls wiring can be installed up to the headworks building. Once the bypass pumping system is operational, the remaining demolition can begin.

Section 3

Schedule and Opinion of Probable Construction Cost (OPCC)

3.1 Schedule

The schedule for the Headworks Improvements will be dependent on the City's review of the design documents and the approval for funding of the work by the Clean Water State Revolving Fund. Once funding for this work has been approved, Issued for Construction documents will be submitted to TDEC for approval within 2 months of that date. The work will be sent to bid upon approval from TDEC with an anticipated construction duration of 14 months.

Based upon the work included in these improvements, we estimate a total of 7 bid packages will be developed, including equipment and subcontractors. Estimated bid packages are as follows:

- Electrical Gear
- Mechanical Screens and Washing Presses
- Bypass Pumping
- Canopy Subcontractor
- Concrete Subcontractor
- Electrical Subcontractor
- Mechanical Subcontractor

These bid packages are still in discussion with the City, in an attempt to maximize opportunities for Minority- and Women-Owned Businesses. Procurement of the bid packages will be done in accordance with the City's procurement requirements and in compliance with the requirements of the Clean Water State Revolving Fund.

Critical path for the Headworks Improvements schedule runs through review and approval times for the activities that precede bid package procurement, the bypass pumping system implementation as well as the lead times for the electrical gear and the screening equipment. It is critical that we maintain the equipment review and approval activity durations in order to get started on procuring the long lead time equipment. For the purpose of this schedule we have included the lead times provided by the vendors at this preliminary stage. Once the equipment has been selected. we will work with the selected vendors to improve on fabrication and delivery times.

3.2 OPCC

This section presents the opinion of probable construction cost (OPCC) for the Headworks Improvements at the preliminary engineering report (PER) stage of the design process. As presented in earlier sections of this PER, the scope for the Headworks Improvements includes the following items:

- Replacement of the existing Manual Coarse Screens w/Mechanical Coarse Screens and the associated appurtenances (including bypass pumping of the entire plant flow around the headworks and influent pump station).
- Total Overall Base Package Project CM GC's (not including design or CM GC Pre-Construction Services).

The OPCC for the Headworks Improvements is based on the 90-percent Design Package submitted to the City of Memphis (City) in October 2016. In addition, the OPCC includes refinement of the package as the design has progressed to the 90-percent level. The OPCC is shown in **Table 3-1**.

Table 3-1 Headworks Improvements OPCC

Headworks Improvements Scope Item	Construction Cost w/ Add Services (12%)[1]
Headworks Improvements (070, 250 & 800)	$10,300,000

Notes:

1. 12% multiplier is estimate based on 2% construction services and 10% general conditions for CMAR contract

CDM Smith EQUIPMENT SELECTION AND DATA SHEET — Draft – Not for Construction

GENERAL

JOB NAME	P&ID REVIEW	DESIGN	CHECK	REVISIONS	
MEMPHIS MAXSON WWTF PROCESS UPGRADES HEADWORKS IMPROVEMENTS	BY:	BY: TYSON HANN	BY: BH	1	4
JOB NUMBER	DATE:	DATE: 2/29/2016	DATE: 3/2/16	2	5
36694-111641				3	6

EQUIPMENT NAME	LOCATION	EQUIPMENT NUMBER(S)
Mechanical Bar Screens	Headworks Building	Coarse Screen 1 Coarse Screen 2
		SPECIFICATION NUMBER(S)
		11330

MECHANICAL

WEIGHT (EMPTY/OPERATING)	NO. OF UNITS	SPECIAL REQUIREMENTS
	INIT: 2 / ULT: 2	• Screen Angle – 85 degrees • Channel Depth -47'-9" • Max. Water Depth – 10'-0" • Max. Head Differential at Average condition with clean screen – 1-1/4" • Max. Building Height – 17'-4"
SIZE	**STATUS**	
6'-6" CHANNEL WIDTH 1" BAR SPACING		
CAPACITY	**SERVICE**	
85 MGD PER SCREEN	Raw Sewage Screening	
RAKE SPEED	**MATERIALS OF CONSTRUCTION**	**ACCESSORIES**
MIN - 25 FT/MIN	• 316L SS	• Two spray nozzles on the discharge chute • Enclosed discharge chute with access panel to spray nozzles.
TDH FOR PUMPS		
NA		
CLASS OR RATING		
NEMA 6P/7		

ELECTRICAL

HP	MOTOR TYPE	ACCESSORIES
5 HP	Submersible TENV Drive Motor	• High level float switch • Two level elements and one transmitter for WSE in the channel • Drive and brake motor have heaters and overtemperature switches • Overrotate limit switch, N.O. • Two end of travel limit switches, one N.O. and one N.C. • Two NEMA 7 rated disconnect switches
VOLTAGE	**MOTOR SPEED**	
480V – 7.6 FLA	1800 rpm	
ENCLOSURE	**STARTS/DAY**	
NEMA 6P/7	Up to 48	
PHASE	**RUNNING TIME**	
3/60 Hz	Continuous	
EMERGENCY POWER	☐ YES ☒ NO	

INSTURMENTATION

INST. CONTROL REQ'D			NORMAL CONTROL	ABNORMAL CONTROL CONDITIONS		FIELD INTERFACE
☒ YES	☐ NO		• Two NEMA 4X Main Control Panels, located outside building housing PLC and OIT • Two NEMA 7 LCP local control next to equipment • MCP will control both the screen and dedicated washing press. • Controls will typically be in AUTO, with SCADA monitoring status and alarms.	ALARM	SHUT DOWN	LOCAL CONTROL
				HIGH LEVEL	NO	YES –OIT @ MCP
TYPE				OVERROTATE	YES	
☐ MANUAL	☒ AUTO	☐ DACS		OVER TEMP	YES	
INST. PKG BY MFR						
☒ YES	☐ NO					
CONTROL REQUEST						
☒ YES	☐ NO					

ENVIRONMENTAL CONDITIONS

	YES	NO	REMARKS		YES	NO	REMARKS
INSIDE BUILDING	☒	☐	*CLASS 1, DIVISION 2*	CORROSIVE AREA	☒	☐	
DAMP AREA	☒	☐		DUSTY AREA	☐	☒	
SUBJECT TO FREEZING	☒	☐		EXPLOSIVE AREA	☒	☐	
SUBJECT TO DIRECT SUN	☐	☒		SUBJECT TO FLOODING	☒	☐	Motor and Level Elements
TEMP LIMITS ON EQUIP	☒	☐		OTHER	☐	☒	

EQUIPMENT SELECTION

SELECTED MANUFACTURER	MODEL	COST
Vulcan FT-78 Mensch Severe-Duty Bar Screen	316L SS	$840,000
ALTERNATIVE MANUFACTURER (NONE)		

CDM Smith EQUIPMENT SELECTION AND DATA SHEET

Draft – Not for Construction

GENERAL

JOB NAME	P&ID REVIEW	DESIGN	CHECK	REVISIONS	
MEMPHIS MAXSON WWTF PROCESS UPGRADES HEADWORKS IMPROVEMENTS	BY:	BY: TYSON HANN	BY: BH	1	4
JOB NUMBER	DATE:	DATE: 2/29/2016	DATE: 3/2/16	2	5
36694-111641				3	6

EQUIPMENT NAME	LOCATION	EQUIPMENT NUMBER(S)
Screenings Washing Press	Headworks Building	Washing Press 1 Washing Press 2
		SPECIFICATION NUMBER(S)
		11332

MECHANICAL

WEIGHT (EMPTY/OPERATING)	NO. OF UNITS	SPECIAL REQUIREMENTS
	INIT: 2 / ULT: 2	• Potable water connection • Potable water flow between 19 & 25 gpm and a pressure between 35 and 60 psi
SIZE	**STATUS**	
EWP 300/1000		
CAPACITY	**SERVICE**	
53 CF/HR (BATCH) & 140 CF/HR (CONTINUOUS)	Raw Sewage Screening	
RAKE SPEED	**MATERIALS OF CONSTRUCTION**	**ACCESSORIES**
NA	• 316L SS	• Dolly/Caster Mounted for maintenance • Discharge piping with 6" x 6" access ports • Enclosed discharge chute with spray nozzle access panel.
TDH FOR PUMPS		
NA		
CLASS OR RATING		
NEMA 7		

ELECTRICAL

HP	MOTOR TYPE	ACCESSORIES
7.5 HP	TENV Drive Motor	• Drive motor has heaters and overtorque switches • Five SS, NEMA 7 solenoid valves • Two NEMA 7 rated disconnect switches • NEMA 7 Emergency stop pull cord & switch
VOLTAGE	**MOTOR SPEED**	
480V – 11.0 FLA	1800 rpm	
ENCLOSURE	**STARTS/DAY**	
NEMA 7	Up to 48	
PHASE	**RUNNING TIME**	
3/60 Hz	Continuous	
EMERGENCY POWER	☐ YES ☒ NO	

INSTURMENTATION

INST. CONTROL REQ'D			NORMAL CONTROL	ABNORMAL CONTROL CONDITIONS		FIELD INTERFACE
☒ YES	☐ NO		• Two NEMA 4X Main Control Panels, located outside building housing PLC and OIT • Two NEMA 7 LCP local control next to equipment • MCP will control both the screen and dedicated washing press. • Controls will typically be in AUTO, with SCADA monitoring status and alarms.	ALARM	SHUT DOWN	LOCAL CONTROL
TYPE				OVER TEMP	YES	YES – OIT @ MCP
☐ MANUAL	☒ AUTO	☐ DACS		OVER TORQUE	YES	
INST. PKG BY MFR						
☒ YES	☐ NO					
CONTROL REQUEST						
☒ YES	☐ NO					

ENVIRONMENTAL CONDITIONS

	YES	NO	REMARKS		YES	NO	REMARKS
INSIDE BUILDING	☒	☐	*CLASS 1, DIVISION 2*	CORROSIVE AREA	☒	☐	
DAMP AREA	☒	☐		DUSTY AREA	☐	☒	
SUBJECT TO FREEZING	☒	☐		EXPLOSIVE AREA	☒	☐	
SUBJECT TO DIRECT SUN	☐	☒		SUBJECT TO FLOODING	☐	☒	
TEMP LIMITS ON EQUIP	☒	☐		OTHER	☐	☒	

EQUIPMENT SELECTION

SELECTED MANUFACTURER	MODEL	COST
Vulcan	EWP 300/1000 Washing Press	$170,000
ALTERNATIVE MANUFACTURER (NONE)		

PRELIMINARY ENGINEERING REPORT

T.E. Maxson WWTF Process Upgrades

Package 2A

[redacted]

City of Memphis

July 2017

CDM Smith

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Section 1

Introduction

1.1 Overview

The City of Memphis (City) retained CDM Smith Inc. to design and construct disinfection, biological treatment and hydraulic capacity improvements at the City's T.E. Maxson Wastewater Treatment Facility (WWTF) via a construction management at risk (CMAR) project delivery method. These improvements include:

- Replacement of the Existing Headworks Manual Coarse Screens;
- Upgrades to the Effluent Pump Station Electrical Improvements;
- Biotower Upgrades and RAS Re-Aeration Basin;
- Conversion from coarse-bubble to fine bubble diffusers in the Aeration Basins;
- Addition of peracetic acid (PAA) disinfection system including contact tanks;
- Demolition of the existing Final Clarifier 5-N and 5-S and construction of two new Final Clarifiers;
- Miscellaneous hydraulic improvements; and,
- Improvements to the odor control system.

These improvements will be divided into multiple design packages throughout the project duration. Package 2A, as described in this Preliminary Engineering Report (PER), includes the demolition of the coarse-bubble diffused aeration system in the Aeration Basins and conversion to fine-bubble diffused aeration; demolition of existing Final Clarifiers 5-N and 5-S and construction of Final Clarifiers 5-N and 5-S with dedicated scum pumping for each new clarifier; a dedicated return activated sludge pump station for Final Clarifiers 5-N and 5-S; odor control systems for the influent junction box, coarse screens, grit removal system, fine screens, primary clarifiers and the Intermediate Pump Station Wet Wells; and hydraulic improvements to the discharge box of the Intermediate Pump Station.

In addition, this report revises the primary effluent process design parameters from the January 2016 Conceptual Design Report. The basis of the process design is utilizing Primary Clarifiers 1, 2 and 3 as primary clarifiers and using existing Primary Clarifier 4 as a thickener. The revised primary effluent design criteria affects the discharge criteria of the trickling filters as well as the design criteria for the proposed solids contact process consisting of the existing 16.8 million gallons (MG) of aeration basin volume combined with the proposed 3.5 MG RAS Reaeration Basin.

The City has also requested that the secondary treatment process be evaluated using the existing wood media in the trickling filters (operating in roughing mode), a combined plastic media/wood media option (operating in roughing mode) where four of the existing trickling filters would be retrofitted with 23 feet of plastic media and the remaining two trickling filters use the existing wood media, and an option where all six trickling filters are upgraded with 23 feet of plastic media

(operating in roughing mode) . This report discusses the design parameters for these process alternatives as well.

Package 2A does not include the RAS Reaeration Basin structure (currently proposed for design in Package 2B). This report does include the process design and process air requirements for the RAS Reaeration Basin for the scenarios listed above.

The format for the report includes:

- Revised Primary Effluent Process Design Parameters
- Basis of Design
- Construction Sequencing and Constraints
- Project Schedule
- Major Equipment Specifications
- 30-Percent Drawings for the demolition of the existing coarse-bubble diffusers, demolition of Final Clarifiers 5-N and 5-S, modifications to Final Clarifiers 5-N and 5-S, new scum and RAS pumping, the hydraulic improvements to the Intermediate Pump Station, and the odor control upgrades.

1.2 Revised Primary Effluent Design Parameters

The January 9, 2017 memorandum from CDM Smith to the City recommended that the City recommence using Primary Clarifier No. 4 as a primary sludge thickener. The basis of this recommendation was to maintain CFR 503 regulations for retention time in the anaerobic lagoons during winter conditions. The City has also requested that the secondary treatment process be evaluated using the existing wood media in the trickling filters or a combined plastic media/wood media option where four of the existing trickling filters would be retrofitted with 23 feet of plastic media and the remaining two trickling filters use the existing wood media. The purpose of Section 1.2 is to:

- Provide revised primary effluent design criteria using three primary clarifiers in service;
- Determine the removal efficiency of soluble BOD_5 and establish the mass loadings leaving the trickling filters for both media options mentioned above; and,
- Reevaluate the secondary treatment process including impacts on the secondary clarifier performance and the aeration system design.

1.2.1 Primary Effluent Design Criteria

1.2.1.1 Original Basis of Design – Four Primary Clarifiers in Service

The January 2016 conceptual design report (CDR) developed the basis of design for mass loadings in the raw influent and primary effluent (PE). This analysis included statistical evaluation of the flows and mass loadings along with performance evaluation for the primary clarifiers in order to establish removal efficiencies for biochemical oxygen demand (BOD_5) and total suspended solids (TSS). This analysis included evaluation of data with four primary clarifiers in service to establish the basis of design.

The predicted primary effluent BOD_5 mass load in the 2016 CDR was established using an average of three regression analyses of the data. These analyses included:

- Correlation 1 - Daily influent BOD_5 mass load versus daily primary effluent BOD_5 mass load;
- Correlation 2 - Daily influent BOD_5 mass load versus daily primary effluent BOD_5 mass load forcing the y-intercept to be zero; and,
- Correlation 3 - Monthly average influent BOD_5 mass load versus monthly average primary effluent BOD_5 mass load.

Table 1-1 summarizes the results of each regression analysis, the predicted primary clarifier removal rate for each regression analysis and the average of the three analyses. As noted previously, the average of the three regression analyses used as the basis of design for the primary effluent at a plant capacity of 90 million gallons per day (MGD) with four primary clarifiers in service.

Table 1-1 Predicted Primary Effluent BOD_5 at 90 MGD (from 2016 CDR) – 4 Clarifiers in Service

Parameter	Correlation	Unit	BOD_5 Mass Loading at Design Capacity		
			AD	ADMM	MD
Raw Influent	N/A	lb/day	543,000	686,000	776,000
Primary Effluent	1	lb/day	415,000	495,000	545,000
Removal Efficiency	1	%	24	28	30
Primary Effluent	2	lb/day	435,000	550,000	622,000
Removal Efficiency	2	%	20	20	20
Primary Effluent	3	lb/day	457,000	571,000	643,000
Removal Efficiency	3	%	16	17	17
Average (Design Value)	Avg 1, 2, &3	lb/day	**436,000**	**539,000**	**603,000**
Removal Efficiency	N/A	%	**20**	**21**	**22**

The predicted primary effluent TSS mass load in the 2016 CDR was established using regression analysis which predicted primary effluent mass load as a function of raw influent mass load. **Table 1-2** summarizes the primary effluent TSS at 90 MGD utilizing four primary clarifiers.

Table 1-2 Predicted Primary Effluent TSS at 90 MGD (from 2016 CDR) – 4 Clarifiers in Service

Parameter	Unit	TSS Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	418,000	522,000	664,000
Primary Effluent	lb/day	208,000	234,000	271,000
Removal Efficiency	%	50	55	59

1.2.1.2 Revised Basis of Design – Three Primary Clarifiers in Service

The 2009 to 2014 Maxson data set was reevaluated to include only primary effluent data with three primary clarifiers in service. This data set, however, did not use Clarifier No. 4 as a thickener and was not used. Additional data in 2016 and 2017 was provided by the City while Clarifier No. 4 was being operated as a thickener. This data set was evaluated to determine the predicted change in the primary effluent BOD_5 and TSS when changing from four clarifiers to three clarifiers in service.

Analyses similar to those done in the 2016 CDR were performed but did not yield results that provide correlations to develop the primary effluent design criteria. Therefore, new correlations were developed which utilized surface overflow rate to the primary clarifiers, influent TSS concentration, influent temperature, and sludge blanket depth in Clarifiers 1, 2 and 3 and, in the thickener (Clarifier No. 4) to predict removal efficiency. The TSS removal efficiency in the primary clarifiers is summarized below:

$$TSS\ removal\ (\%) = a(SOR)^{w} \times (Temp)^{x} \times (TSS)^{y} \times (D_{b1-3})^{z} \times (D_{b4})^{a'}$$

where:

- SOR = clarifier surface overflow rate (gpd/sf)
- Temp = influent temp (Deg C)
- TSS = influent TSS (mg/L)
- Db1-3 = blanket depth in Clarifiers No. 1-3 (ft)
- Db4= blanket depth in thickener (Clarifier No. 4) (ft)

Solver analysis was used to select coefficients a, w, x, y, z, and a' to minimize the sum of squares between the predicted and actual TSS removal efficiencies. Results of the sum of squares yielded the following equation:

$$TSS\ removal\ (\%) = \frac{T^{1.02} \times TSS^{0.79}}{(2.5)SOR^{1.13} \times {D_{b1-3}}^{0.26} \times {D_{b4}}^{0.26}}$$

Figure 1-1 shows the predicted versus reported TSS removal efficiencies for the data set. **Figure 1-2** shows the predicted and reported TSS removals versus clarifier surface overflow rate.

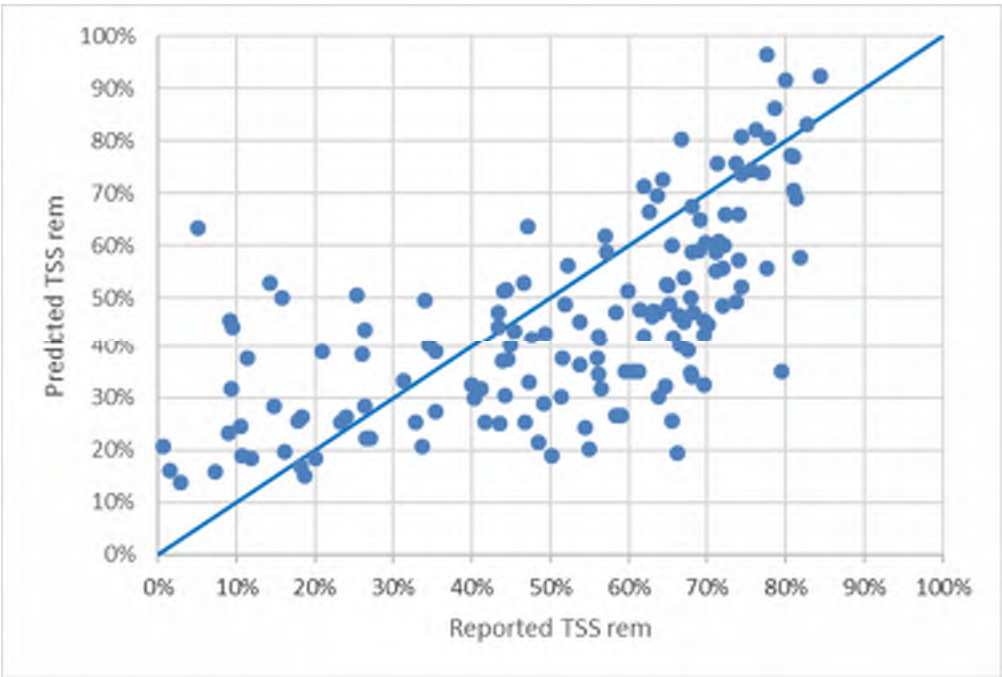

Figure 1-1 Predicted Versus Reported Primary Clarifier TSS Removal for 2016-2017 Data

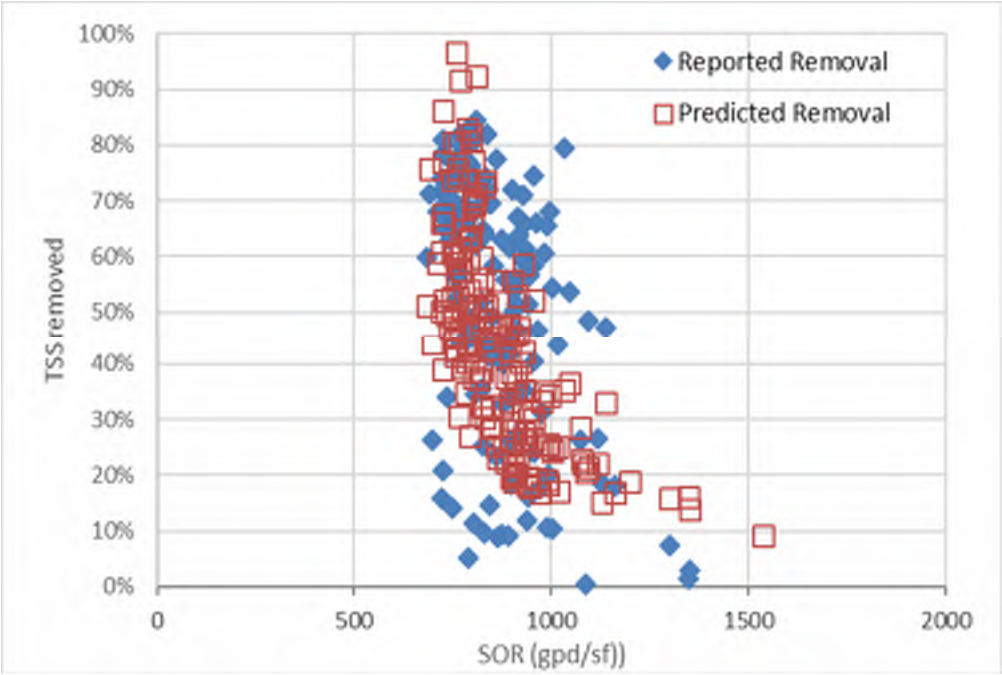

Figure 1-2 Predicted Versus Reported Primary Clarifier TSS Removal for 2016-2017 Data as a Function of Surface Overflow Rate

The algorithm is applied to the design conditions at 90 MGD. **Table 1-3** summarizes the results. As expected, the efficiency of TSS removal of the primary clarifiers has decreased. The 2016 CDR predicted an average of 50- to 59- percent removal with four clarifiers in service.

Table 1-3 Predicted Primary Effluent TSS at 90 MGD – 3 Clarifiers in Service

Parameter	Unit	TSS Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	418,000	522,000	664,000
Flow	MGD	90	90	90
TSS	mg/L	557	695	885
SOR	gpd/sf	1,179	1,179	1,179
Blanket Depth, Clarifiers Nos 1-3	ft	1.0	1.0	1.0
Blanket Depth, Thickener (Clarifier No. 4)	ft	4.0	4.0	4.0
Primary Effluent	lb/day	269,000	301,000	324,000
Removal Efficiency	%	36	42	51

The analysis assumes a constant flow at 90 MGD at all design loading conditions as data indicates that at flows greater than 90 MGD that the mass loads are less than the average load for the plant which indicates that peak flows and loads are not simultaneous. The analysis also assumes an average temperature of 24 degrees Celsius, sludge blanket depth of 1 foot Clarifiers Nos. 1, 2 and 3 and a blanket depth of 4 feet in thickener (Clarifier No. 4). The sludge blanket depth in Clarifiers Nos. 1, 2 and 3 used is less than the average of the 2016-2017 data set, however, the primary sludge pumps

should be upgraded by the time the facility reaches 90 MGD and there should not be limitations on removing sludge from the primaries and into the thickener (Clarifier No. 4).

The primary effluent BOD_5 correlation developed in the 2016 CDR was also reevaluated due to the change in the number of primary clarifiers. This was due to several factors including the reduction of clarifier surface area and the appearance of a lower soluble BOD_5 fraction in the primary effluent. The soluble BOD_5 content averaged 80-percent from the 2009-2014 data set while it averaged 78-percent in the 2015-2016 data set.

There appears to still be a trend that relates influent BOD_5 load to primary effluent BOD_5. **Figure 1-3** shows the plot of influent BOD_5 versus primary effluent BOD_5 for the 2016-2017 data set. The coefficient of determination, R^2, is 0.21 in this data set which shows a trend. This trend is not as strong as the trend developed in the 2016 CDR which showed a coefficient of determination of 0.49. To address this, a stronger correlation was developed that uses both influent BOD_5 load as well as predicted primary clarifier TSS removal efficiency to determine primary effluent BOD_5 load.

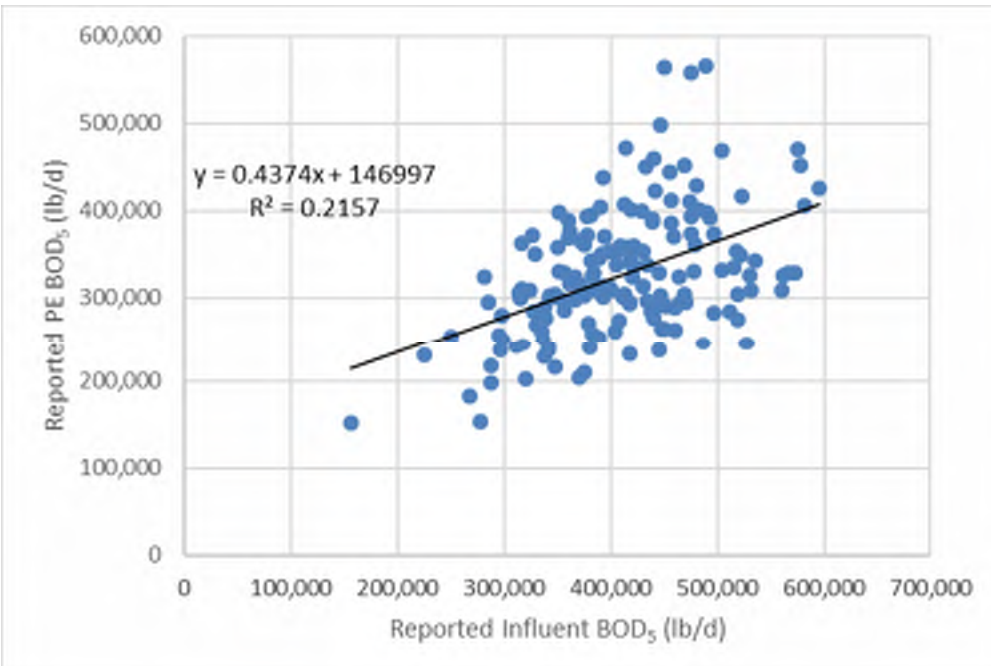

Figure 1-3 Reported Influent and Primary Effluent BOD_5 Loadings From 2016-2017 Data Set

The primary effluent BOD_5 correlation uses the TSS removal correlation developed previously along with the influent BOD_5 load and uses two additional coefficients, b and c, in the algorithm. The primary effluent BOD_5 load algorithm is summarized below:

$$PE\ BOD_5 = [a(SOR)^w \times (Temp)^x \times (TSS)^y \times (D_{b1-3})^z \times (D_{b4})^{a'}]^b \times BOD_{5,i}{}^c$$

where:

- PE BOD_5 = predicted primary effluent BOD_5 (lb/d)
- SOR = clarifier surface overflow rate (gpd/sf)

- Temp = influent temp (Deg C)
- TSS = influent TSS (mg/L)
- Db1-3 = blanket depth in Clarifiers No. 1-3 (ft)
- Db4= blanket depth in thickener (Clarifier No. 4) (ft)
- BOD_5,i = reported influent BOD_5 (lb/d)

or, simplified:

$$PE\ BOD_5 = [Predicted\ TSS\ removal\ efficiency]^b \times BOD_{5,i}{}^c$$

Solver analysis was used to select coefficients b and c along with the generated predictions of TSS removal efficiencies to generate predicted primary effluent BOD_5 loads by minimizing the sum of squares between the predicted and actual primary effluent BOD_5 loads. Results of the sum of squares yielded the following equation:

$$PE\ BOD_5 = \frac{BOD_{5,i}{}^{0.97}}{(Predicted\ TSS\ removal\ \%)^{0.07}}$$

Figure 1-4 shows the predicted versus reported primary effluent BOD_5 mass loads for the data set.

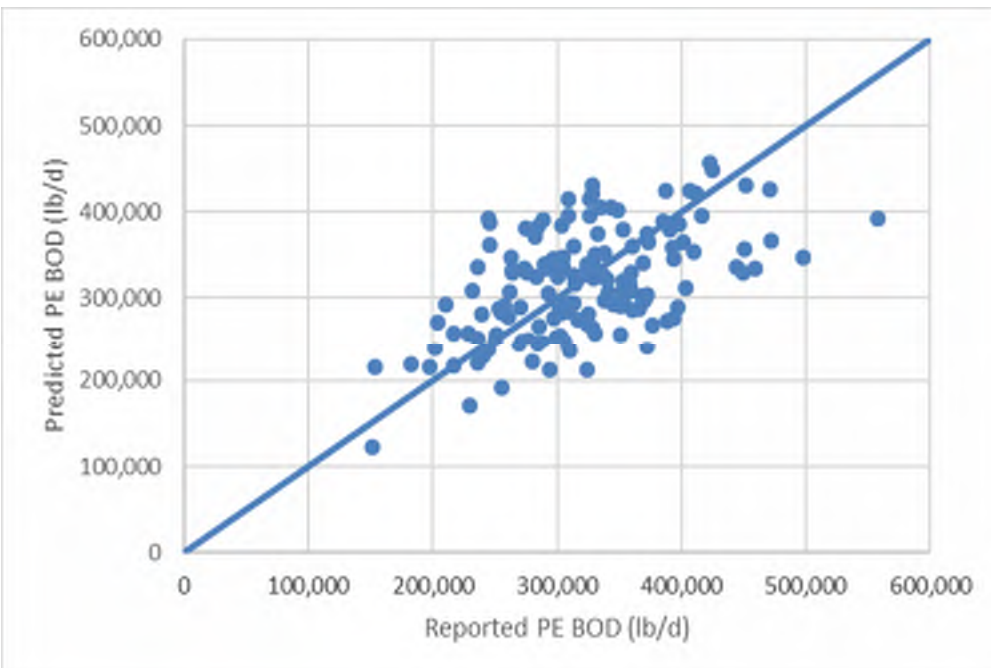

Figure 1-4 Predicted Versus Reported Primary Effluent BOD_5 Load for 2016-2017 Data

The algorithm is applied to the design conditions at 90 MGD. **Table 1-4** summarizes the results. The removal efficiencies for BOD_5 are predicted to increase 2- to 3-percent from the 2016 CDR. The soluble BOD fraction of the primary effluent BOD_5 decreased 2% from the 2009-2014 data set to the 2016-2017 data set. This does appear to be counterintuitive, but could be explained by decreased fermentation in the primary clarifiers or an increased particulate fraction of BOD_5 in the raw influent due to closure of Cargill and the high soluble BOD_5 fraction of their waste stream.

Table 1-4 Predicted Primary Effluent BOD_5 at 90 MGD – 3 Clarifiers in Service

Parameter	Unit	BOD_5 Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	543,000	686,000	776,000
Predicted TSS Removal Efficiency	%	23	42	51
Predicted Primary Effluent BOD_5	lb/day	418,000	519,000	576,000
BOD_5 Percent Removal	%	23	25	26

Table 1-5 summarizes the primary effluent mass loadings for the secondary treatment process assuming three primary clarifiers are in service.

Table 1-5 Primary Effluent Mass Loadings at 90 MGD – 3 Clarifiers in Service

Parameter	Unit	Design Condition		
		AD	ADMM	MD
Primary Effluent BOD_5	lb/day	418,000	519,000	576,000
Primary Effluent TSS	lb/day	269,000	301,000	324,000

Section 2

Revised Solids Contact Process Design Parameters and Aeration Basin Fine-Bubble Diffuser Conversion

There are seven two-pass aeration basins installed at the Maxson WWTF. Basins 1 through 10 on the north and south side have a overall footprint of 500 feet by 24 feet. Basins 11 through 14 on the north and south side have an overall footprint of 450 feet by 24 feet. The basins have a design sidewater depth of 13.75 feet yielding an overall treatment volume of 16.8 million gallons (MG). The aeration basins presently are installed with coarse-bubble diffused aeration. Air is provided by six 1,500 horsepower single-stage blowers. A 3.5 million gallon return activated sludge reaeration basin will be provided in future Package 2B as part of the trickling filter/solids contact design.

There are eight final clarifiers currently installed each with a diameter of 135 feet. Due to the revisions to the process design of the solids contact process, the sizing and process design of the final clarifiers is presented in this section as it is coupled with the process design of the aeration basins. Discussion on demolition of the existing final clarifiers can be found in Section 3. Discussion on the process/mechanical, structural, electrical and instrumentation components of the new final clarifiers, return activated sludge (RAS) and scum pumps can be found in Section 4.

2.1 Design Basis

Evaluation of the anticipated performance of the trickling filters (previously identified as Biotower) is required in order to determine oxygen requirements and air flows for the proposed diffused aeration system, design mixed liquor suspended solids concentrations and evaluation of expected performance of the final clarifiers. This section will:

- Determine the removal efficiency of soluble biochemical oxygen demand (BOD_5) and establish the mass loadings leaving the trickling filters for a wood media only, a hybrid plastic/wood media system and entire system replaced with plastic media;
- Reevaluate the secondary treatment process including impacts on the final clarifier performance and the aeration system design;
- Discuss any related structural, electrical, or automation related design considerations specifically related to the fine-bubble diffuser upgrades; and
- Discuss construction constraints related to the fine-bubble diffuser conversion.

2.1.1 Process/Mechanical

The primary effluent design criteria established in Section 1 is used to evaluate the performance of the trickling filters under three scenarios. The first scenario assumes that the existing wood media remains in place and six units are in service. The second scenario assumes that the wood media is replaced with 23 feet of plastic media in four of the six units. The remaining two units would keep wood media in place. The third scenario replaces the wood media with 23 feet of plastic media in all six trickling filters.

Soluble BOD_5 data was provided from September 2016 through February 2017 while the facility was operating with three primary clarifiers in service with the fourth unit serving as a thickener. The average soluble BOD_5 in the primary effluent over this time period was 78-percent which is similar to the soluble BOD_5 average in four primary clarifier operation (81-percent). There were days in which the soluble BOD_5 did increase and it is anticipated that fermentation was occurring in the sludge blanket. Upgrades to the primary sludge pumps and the ability to pump the blanket down faster should result in decreased soluble BOD_5 in the primary effluent. Based on those future improvements, utilizing 78-percent soluble BOD_5 fraction in the primary effluent should be conservative.

2.1.1.1 Expected Performance with Existing Wood Media

The January 9, 2017 memorandum titled "T.E. Maxson WWTF Draft Capacity Analysis Utilizing Wood Media in Trickling Filters", included in Appendix F, provided data analysis regarding the performance of the existing wood media which correlated soluble BOD_5 removal to the soluble BOD_5 loading to the trickling filters for both winter and summer conditions. **Figure 2-1** shows the soluble BOD_5 media loading rate versus soluble BOD_5 removed during summer conditions for days with water temperatures between 29 and 32 degrees Celsius. **Figure 2-2** shows the soluble BOD_5 media loading rate versus soluble BOD_5 removed during winter conditions for days with water temperatures between 17 and 20 degrees Celsius.

The regression analysis appears to show correlations for both the summer and winter conditions. The correlation suggests that the trickling filters remove more soluble BOD_5 as the load increases to the media within the loading range experienced at the plant. The regression analyses from Figure 1-3 and Figure 1-4 were used along with the PE soluble BOD_5 to predict the soluble BOD_5 leaving the trickling filters during summer and winter conditions at 90 MGD. **Tables 2-1** and **2-2** summarize soluble BOD_5 removal predicted in the trickling filters during summer and winter conditions, respectively, at their predicted media loading rate.

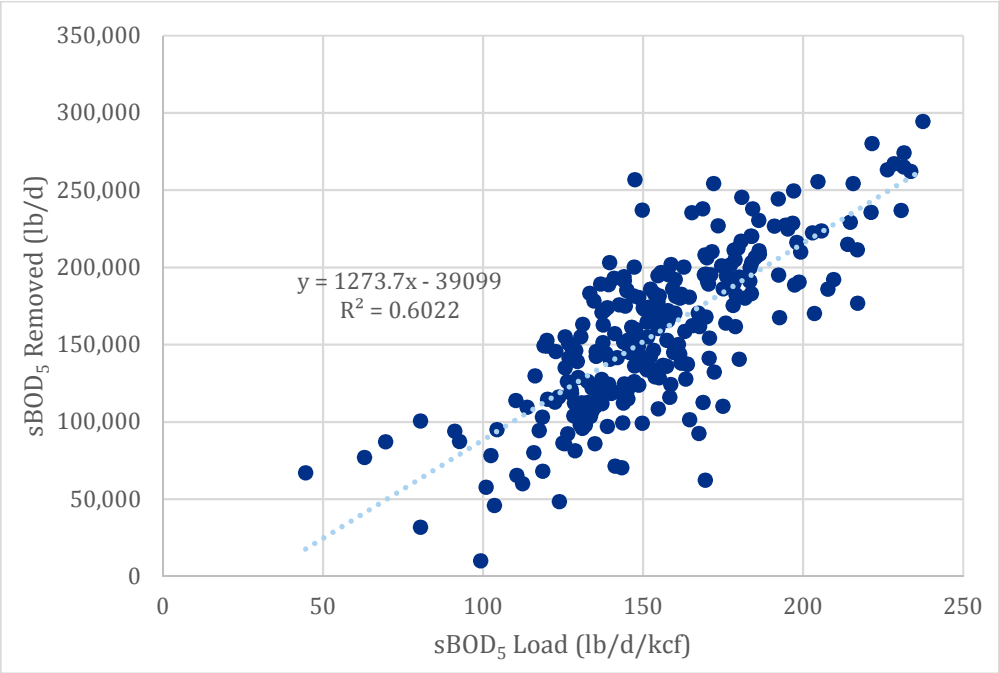

Figure 2-1 Wood Media Soluble BOD_5 Loading Rate Versus Removal During Summer Months

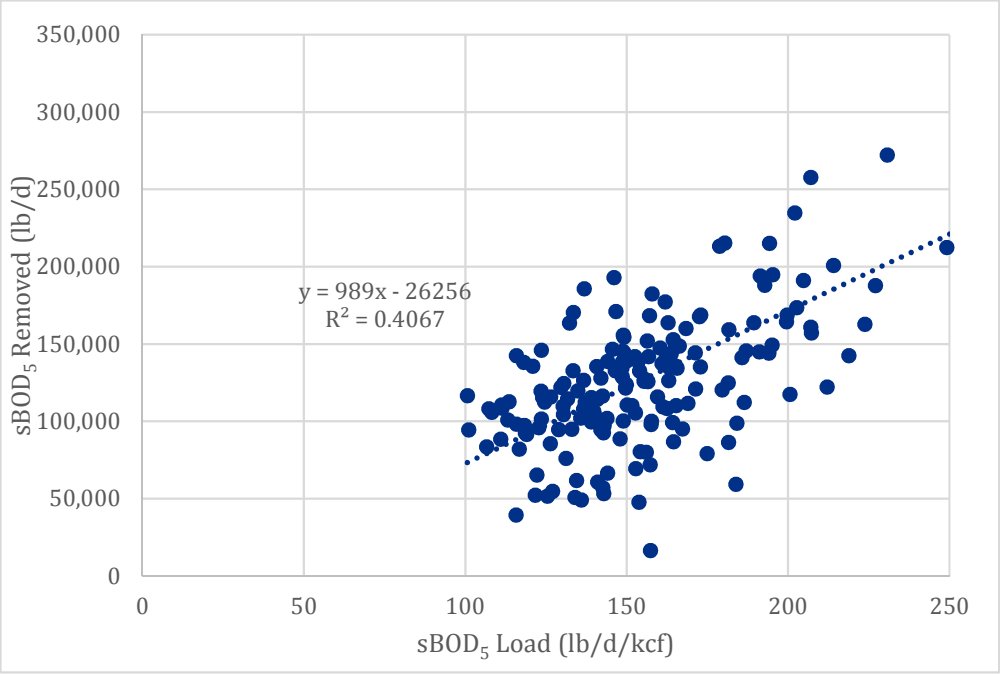

Figure 2-2 Wood Media Soluble BOD_5 Loading Rate Versus Removal During Winter Months

Table 2-1 Summary of Predicted Wood Media Trickling Filter Performance During Summer Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$	lb/day	326,000	405,000	449,000
TF $sBOD_5$ Loading[1]	lb/d/kcf	181	224	249
TF $sBOD_5$ Removed	lb/day	191,000	247,000	278,000
$sBOD_5$ Removed	%	59	61	62

[1] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

Table 2-2 Summary of Predicted Wood Media Trickling Filter Performance During Winter Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$	lb/day	326,000	405,000	449,000
TF $sBOD_5$ Loading[1]	lb/d/kcf	181	224	249
TF $sBOD_5$ Removed	lb/day	152,000	196,000	220,000
$sBOD_5$ Removed	%	47	48	49

[1] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

2.1.1.2 Expected Performance with Plastic Media/Wood Media (Hybrid Media) System

The Logan Trifil model was used in conjunction with the regression analyses presented in Figures 2-1 and 2-2 to predict soluble BOD_5 removal in the trickling filter process consisting of two units utilizing existing wood media and four units of mixed plastic media. The plastic media includes 3 feet of crossflow and 20 feet of vertical flow media (which will be referred to as the hybrid media system in this report). The analyses assume an equal flow split to all six trickling filters from the feed pump station operating with six pumps or roughly 198 million gallons per day (MGD) of forward flow (including trickling filter recycle) yielding two-thirds of the overall flow and load to the plastic media trickling filters. **Tables 2-3** and **2-4** summarize the trickling filter performance during summer and winter conditions at 90 MGD, respectively.

Table 2-3 Summary of Predicted Hybrid Media Trickling Filter Performance During Summer Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$, Total	lb/day	326,000	404,000	449,000
PE $sBOD_5$ Load to Wood Media Filters[1]	lb/day	108,700	134,800	149,800
TF $sBOD_5$ Loading[2] to Wood Media Filters	lb/d/kcf	181	224	249
TF $sBOD_5$ Removed in Wood Media Filters	lb/day	64,000	82,000	93,000
PE $sBOD_5$ Load to Plastic Media Filters[3]	lb/day	217,300	269,200	299,200
TF $sBOD_5$ Loading[2] to Plastic Media Filters	lb/d/kcf	165	205	227
TF $sBOD_5$ Removed in Plastic Media Filters	lb/day	163,000	204,000	230,000
$sBOD_5$ Removed, Total	lb/day	227,000	286,000	323,000
$sBOD_5$ Removed, Total	%	70	71	72

[1] Wood media filters loaded with one-third of forward flow.

[2] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

[3] Plastic media filters loaded with two-third of forward flow.

Table 2-4 Summary of Predicted Hybrid Media Trickling Filter Performance During Winter Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$, Total	lb/day	326,000	404,000	449,000
PE $sBOD_5$ Load to Wood Media Filters[1]	lb/day	108,700	134,800	149,800
TF $sBOD_5$ Loading[2] to Wood Media Filters	lb/d/kcf	181	224	249
TF $sBOD_5$ Removed in Wood Media Filters	lb/day	51,000	65,000	73,000
PE $sBOD_5$ Load to Plastic Media Filters[3]	lb/day	217,300	269,200	299,200
TF $sBOD_5$ Loading[2] to Plastic Media Filters	lb/d/kcf	165	205	227
TF $sBOD_5$ Removed in Plastic Media Filters	lb/day	146,000	182,000	202,000
$sBOD_5$ Removed, Total	lb/day	197,000	247,000	275,000
$sBOD_5$ Removed, Total	%	61	61	61

[1] Wood media filters loaded with one-third of forward flow.

[2] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

[3] Plastic media filters loaded with two-third of forward flow.

2.1.1.3 Expected Performance with Plastic Media System

The Logan Trifil model was used again to predict soluble BOD_5 removal in the trickling filter process consisting of six units of mixed plastic media. The plastic media includes 3 feet of crossflow and 20 feet of vertical flow media. The analyses assume an equal flow split to all six trickling filters from the feed pump station operating with six pumps or roughly 198 million gallons per day (MGD) of forward flow (including trickling filter recycle. **Tables 2-5** and **2-6** summarize the trickling filter performance during summer and winter conditions at 90 MGD, respectively.

Table 2-5 Summary of Predicted Plastic Media Trickling Filter Performance During Summer Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$	lb/day	326,000	404,000	449,000
TF $sBOD_5$ Loading[1]	lb/d/kcf	165	205	227
TF $sBOD_5$ Removed	lb/day	246,000	305,000	346,000
$sBOD_5$ Removed	%	75	75	77

[1] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

Table 2-6 Summary of Predicted Plastic Media Trickling Filter Performance During Winter Conditions at 90 MGD

Parameter	Unit	Design Condition		
		AD	ADMM	MD
PE $sBOD_5$	lb/day	326,000	404,000	449,000
TF $sBOD_5$ Loading[1]	lb/d/kcf	165	205	227
TF $sBOD_5$ Removed	lb/day	219,000	272,000	304,000
$sBOD_5$ Removed	%	67	67	68

[1] Loading based solely on soluble BOD_5 in primary effluent and does not account for recycle flow.

2.1.2 Diffused Aeration System Sizing

The BioWin simulation program was used in conjunction with the results of the trickling filter analysis to estimate oxygen demand and operating mixed liquor suspended solids (MLSS) concentration in the solids contact process. The raw influent used in the model is COD based and utilized the PE removal efficiencies provided earlier in this memorandum at ADMM and MD conditions to predict the PE values.

Adjustments were made to model parameters for the trickling filters in order to match the results of soluble BOD_5 removal predicted by the regression analysis in Tables 2-3 and 2-4 as well as to preclude nitrification from occurring in the tricking filter. Literature suggests that nitrification will not occur in the trickling filters as long as there is substantial amounts of $sBOD_5$ remaining. This is due to competition between the autotrophs and heterotrophs for dissolved oxygen. These changes in the BioWin model included revisions to default input parameters for the media specific area and the local temperature in the trickling filters.

The process model was configured with diffused air configured in four zones in series in the Contact Basins to account for variations in oxygen requirements in downstream portion of each aeration basin. Likewise, the RAS Reaeration Basin was configured with diffused air configured in two zones in series with each zone having two grids.

The modeling was used to estimate actual oxygen requirements (AOR) at the projected 90 MGD design conditions as well as at current average day and minimum day loads for winter conditions only to determine the range in conditions that the new fine-bubble diffused air system and the existing blowers should operate. **Tables 2-7**, **2-8,** and **2-9** summarize the estimated AORs from the modeling at summer and winter conditions, respectively. These tables indicate the following:

- Summer conditions will require more oxygen than in winter conditions in the solids contact process; and,
- Conversion to plastic media will decrease oxygen requirements in the solids contact process.

In order to accommodate either trickling filter media option, the design oxygen requirements for the aeration system shall be based on the maximum airflow during summer conditions utilizing the existing wood media trickling filters and the minimum air flow during winter conditions utilizing the upgrade of all six trickling filters to plastic media. Based on the results of the modeling, an air flow split of 31-, 23-, 23-, and 23-percent was used for the four zones in series in the Contact Basins while a 50-percent split was used for two zone configuration (25-percent split for each grid) for the RAS Reaeration Basins. **Table 2-10** summarizes the minimum and maximum AORs for each zone (as a total) and per process train utilizing the existing 7-two pass Contact Basins and three new one-pass RAS Reaeration Basins process trains. The hybrid media option is not included in Table 2-8 since the air demand falls between the all wood media alternative and the all plastic media alternative.

The April 22, 2016 technical memorandum "Process Air System Evaluation Feasibility Study for the T.E. Maxson WWTF", included in Appendix E, discussed various diffuser technologies including fine and ultra-fine diffusers. The memorandum included recommendations to proceed with 9-inch disc fine-bubble membranes as part of the upgrades for the following reasons:

- The EDI and Sanitaire Silver Series 9-inch membrane diffusers have been much more widely used diffusers than the ultra-fine diffusers;
- There is not information at this time to suggest that the EPDM material that is standard for the 9-inch fine-bubble membrane diffusers would be expected to foul at a significantly higher rate. EPDM had not been tested at the Maxson WWTF at the time of this TM;
- The EDI and Sanitaire Silver Series options provide much higher AT/AD which allows easier access and maintenance;
- The Aerostrip and Sanitaire Gold ultra-fine systems require bumping and would require a more sophisticated control system with a multitude of modulating valves to control bumping cycles to diffuser grids; and
- The Sanitaire fine-bubble diffusers units also come at a $4,000,000 cheaper capital than an optimized ultra-fine diffuser system for a similar return on 20-year lifecycle costs.

Table 2-7 AOR During Summer Conditions at Design Loadings

Parameter	Unit	90 MGD AD			90 MGD ADMM			90 MGD MD		
		Wood Media	Hybrid Media	Plastic Media	Wood Media	Hybrid Media	Plastic Media	Wood Media	Hybrid Media	Plastic Media
Solids Retention Time	days	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
AOR, Contact	lb O_2/day	149,000	138,000	135,000	175,000	165,000	161,000	210,000	199,000	193,000
AOR, RAS Reaeration	lb O_2/day	67,000	66,000	65,000	80,000	78,000	77,000	89,000	87,000	85,000
Total AOR	lb O_2/day	216,000	204,000	200,000	255,000	243,000	238,000	299,000	286,000	278,000

Table 2-8 AOR During Winter Conditions at Current Loadings

Parameter	Unit	67 MGD Min Load			67 MGD AD		
		Wood Media	Hybrid Media	Plastic Media	Wood Media	Hybrid Media	Plastic Media
Solids Retention Time	days	1.2	1.2	1.2	1.2	1.2	1.2
AOR, Contact	lb O_2/day	68,000	58,000	53,000	108,000	95,000	88,000
AOR, RAS Reaeration	lb O_2/day	23,000	22,000	22,000	38,000	37,000	37,000
Total AOR	lb O_2/day	91,000	80,000	77,000	146,000	132,000	125,000

Table 2-9 AOR During Winter Conditions at Design Loadings

Parameter	Unit	90 MGD AD			90 MGD ADMM			90 MGD MD		
		Wood Media	Hybrid Media	Plastic Media	Wood Media	Hybrid Media	Plastic Media	Wood Media	Hybrid Media	Plastic Media
Solids Retention Time	days	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
AOR, Contact	lb O_2/day	122,000	112,000	104,000	150,000	137,000	132,000	161,000	145,000	138,000
AOR, RAS Reaeration	lb O_2/day	54,000	53,000	51,000	67,000	66,000	65,000	73,000	71,000	70,000
Total AOR	lb O_2/day	176,000	165,000	155,000	217,000	203,000	197,000	234,000	216,000	208,000

Table 2-10 Design Minimum and Maximum AOR for Aeration System

Parameter	Unit	Design Condition, Total		Design Condition, Per Train[1]	
		Minimum	Maximum	Minimum	Maximum
Governing Condition	---	67 MGD Min Load Winter Plastic Media	90 MGD MD Summer Wood Media	67 MGD Low Load Winter Plastic Media	90 MGD MD Summer Wood Media
Contact, Zone 1	lb O_2/day	15,400	65,100	1,100	4,650
Contact, Zone 2	lb O_2/day	12,800	48,300	910	3,450
Contact, Zone 3	lb O_2/day	12,400	48,300	890	3,450
Contact, Zone 4	lb O_2/day	12,400	48,300	890	3,450
Contact, Total	lb O_2/day	53,000	210,000	3,790	15,000
RAS Reaeration, Zone 1	lb O_2/day	11,000	44,500	6,000	14,830
RAS Reaeration, Zone 2	lb O_2/day	11,000	45,500	5,500	14,830
RAS Reaeration, Total	lb O_2/day	22,000	89,000	11,500	29,660

[1] Contact Basins assume 14 two-pass aeration basins. RAS Reaeration Basin assumes 3 one-pass reaeration basins.

The second bullet above noted that there was not sufficient information to suggest that EPDM material standard for 9-inch membrane diffusers would foul at a higher rate (due to possibility of high soybean oil content) and that EPDM had not been tested at the Maxson WWTF. Due to the amount of diffusers recommended for this project, both Sanitaire and EDI provided in-situ piloting of their standard EPDM diffusers as well as additional diffusers made either of different materials or specifically designed EPDM designs. Sanitaire's in-situ piloting started in July 2016 and ended in March 2017. EDI's in-situ piloting started roughly the same time and operated through April 2017.

Both vendors have stated that the wastewater at the T.E. Maxson WWTF is not unique enough to require special formulations of membrane materials and recommended their standard EPDM material. Therefore, we have continued to use the 9-inch EPDM disk membranes as the basis of design. **Appendix D** provides the detailed pilot report provided by Sanitaire and EDI. **Table 2-11** provides the design criteria in addition to the field transfer rates provided in Table 2-8.

Table 2-11 Aeration System Design Criteria

Parameter	Unit	Contact Basin	RAS Reaeration Basin
Alpha	---	0.35	0.35
Beta	---	0.95	0.95
Dissolved oxygen concentration	mg/L	2.0	2.0
Temperature (min/max)	degrees C	14/33	14/33
Sidewater depth	ft	13.75	13.75
Diffuser submergence	ft	13.00	13.00
Site elevation	ft MSL	230	230

The values in Tables 2-8 and 2-9 were used to provide diffused aeration system parameters for the solids contact process. **Table 2-12** provides a high-level summary of range of air flow requirements for the solids contact process depending on the media upstream in the trickling filters.

Table 2-12 Aeration System Requirements Summary

Parameter	Unit	Contact Basin	RAS Reaeration Basin	Total
Minimum SOR required[1]	lb O_2/d	200,700	83,400	284,100
Minimum air flow required[1]	scfm	25,600	10,700	36,300
Maximum SOR required[2]	lb O_2/d	792,000	340,000	1,132,000
Maximum air flow required[2]	scfm	120,600	52,000	172,600

[1] Design condition is 67 MGD, minimum loading with plastic media.
[2] Design condition is 90 MGD, maximum day load with wood media.

Table 2-13 summarizes the detailed design criteria for the fine-bubble diffused aeration system for the solids contact process.

Table 2-13 Fine-Bubble Diffused Aeration System Detailed Design Criteria

Parameter	Unit	Design Condition, Total		Average Design Condition, Per Train[1]	
		Minimum	Maximum	Minimum	Maximum
Governing Condition	---	67 MGD Low Load Winter Plastic Media	90 MGD MD Summer Wood Media	67 MGD Low Load Winter Plastic Media	90 MGD MD Summer Wood Media
Contact, Diffuser Zone 1 – Two Grids per Zone					
AOR	lb O_2/d	16,400	65,100	1,174	4,650
SOR	lb O_2/d	62,200	245,700	4,445	17,448
Air flow	scfm	7,900	37,200	564	2,659
Number of diffusers	--	13,664		976	
Avg air flow/diffuser	scfm/diffuser	0.58	2.72	0.58	2.72
Pressure at dropleg	psig	---	---	6.06	6.70
Dropleg diameter	inches	---	---	6	
Contact, Diffuser Zone 2 – Two Grids Per Zone					
AOR	lb O_2/d	12,200	48,300	871	3,450
SOR	lb O_2/d	46,800	182,300	3,340	13,000
Air flow	scfm	5,900	27,900	421	1,990
Number of diffusers	--	10,528		752	
Air flow/diffuser	scfm/diffuser	0.56	2.65	0.56	2.65
Pressure at dropleg	psig	---	---	6.06	6.65
Dropleg diameter	inches	---	---	6	

Table 2-13 Fine-Bubble Diffused Aeration System Detailed Design Criteria, continued

Parameter	Unit	Design Condition, Total		Design Condition, Per Train[1]	
		Minimum	Maximum	Minimum	Maximum
Contact, Diffuser Zone 3 – Two Grids Per Zone					
AOR	lb O_2/d	12,200	48,300	871	3,450
SOR	lb O_2/d	46,800	182,300	3,340	13,000
Air flow	scfm	5,900	27,900	421	1,990
Number of diffusers	--	10,528		752	
Air flow/diffuser	scfm/diffuser	0.56	2.64	0.56	2.64
Pressure at dropleg	psig	---	---	6.06	6.63
Dropleg diameter	inches	---	---	6	
Contact, Diffuser Zone 4 – Two Grids Per Zone					
AOR	lb O_2/d	12,200	48,300	871	3,450
SOR	lb O_2/d	46,800	182,300	3,340	13,000
Air flow	scfm	5,900	27,900	421	1,990
Number of diffusers	--	10,528		752	
Air flow/diffuser	scfm/diffuser	0.56	2.64	0.56	2.64
Pressure at dropleg	psig	---	---	6.06	6.63
Dropleg diameter	inches	---	---	6	
RAS Reaeration, Zone 1 – Two Grids Per Zone					
AOR	lb O_2/d	11,000	45,000	3,670	15,000
SOR	lb O_2/d	41,700	170,000	13,900	56,700
Air flow	scfm	5,350	26,200	1,780	8,730
Number of diffusers	--	9,072		3,024	
Air flow/diffuser	scfm/diffuser	0.59	2.89	0.59	2.89
Pressure at dropleg	psig	---	---	5.93	6.69
Dropleg diameter	inches	---	---	10	
RAS Reaeration, Zone 2 – Two Grids Per Zone					
AOR	lb O_2/d	11,000	45,000	3,670	15,000
SOR	lb O_2/d	41,700	170,000	13,900	56,700
Air flow	scfm	5,350	26,200	1,780	8,730
Number of diffusers	--	9,072		3,024	
Air flow/diffuser	scfm/diffuser	0.59	2.89	0.59	2.89
Pressure at dropleg	psig	---	---	5.93	6.69
Dropleg diameter	inches	---	---	10	

[1] Existing aeration basins have fourteen-two pass trains. Proposed RAS Reaeration Basin have three one-pass trains.
[2] First AT/AD is for Basins 1-10; Second AT/AD is for Basins 11-14.

Membrane diffusers typically require replacement ranging from seven to ten years. In addition, membrane diffusers are recommended to be cleaned routinely in order to extend life and minimize pressure drop across the diffuser. Based on the capital investment of the diffusers for this project, one vendor (Sanitaire) has recommended an in-situ hydrochloric acid cleaning system that would involve pumping 15-percent solution of the acid into the grid piping network be installed.

The hydrochloric acid cleaning system can be done in-situ. Acid is dosed into the grids while the system is operational. The heat from the compressed air evaporates the acid, causing fume to be carried through the diffuser over a period of several days to a week and liquefy removing any chemical scale from the system.

Hydrochloric acid is available for bulk purchase in 30 to 34-percent trade strength. The acid would need to be diluted to 15-percent at the plant in the 90-gallon cleaning system that the vendor would provide. It is estimated that a total volume of approximately 1,700 gallons of 30-percent acid solution, or 3,400 gallons of diluted 15-percent solution, would be needed to clean all the grids in the Contact and RAS Reaeration Basins. This would require a total of 38 batches of 15-percent solution to be made. The vendor has indicated that 8 to 12 batches per day could be introduced to the diffuser system meaning that a complete cleaning could be done over one week. The material cost for this system is estimated at around $50,000.

2.1.2.1 Existing Air Piping Modifications

The air piping to the existing aeration basins will remain in-place except for dropleg piping that will provide air to the floor of the existing aeration basins. The dropleg piping will be stainless steel. The existing butterfly valves will be replaced based on feedback from plant operations staff that all the existing dropleg valves do not work.

Visual inspection of the piping indicates that leaks have developed over the years. It is recommended that the leaks be fixed as part of Package 2A. New piping, which will be part of Package 2B, will be installed to convey air to the new RAS Reaeration Basins. This piping will be discussed in the Package 2B PER.

2.1.2.2 Revised Blower Operating Conditions

The Maxson WWTF is served by six 1,500 horsepower single stage centrifugal blowers manufactured by Roots. These units have been in service for approximately 30 years. There are some improvements that have been designed to the blowers that the City will be performing in the next several years. **Figure 2-3** shows a copy of the existing blower curve.

The blower was originally designed at an airflow of 40,000 cubic feet per minute (cfm) for summer conditions of 100 degrees Fahrenheit at a discharge pressure of 7.5 psig. This results in an air flow at standard conditions of approximately 35,500 scfm. The blower appears to be able to be operated up to 8.6 to 8.7 psig at reduced air flows prior to reaching unstable (surging) conditions. Air from the blowers discharges through two separate air mains that run through a pipe gallery. There are two interconnections between the air headers that remain permanently open to balance the air flow and pressure in the system.

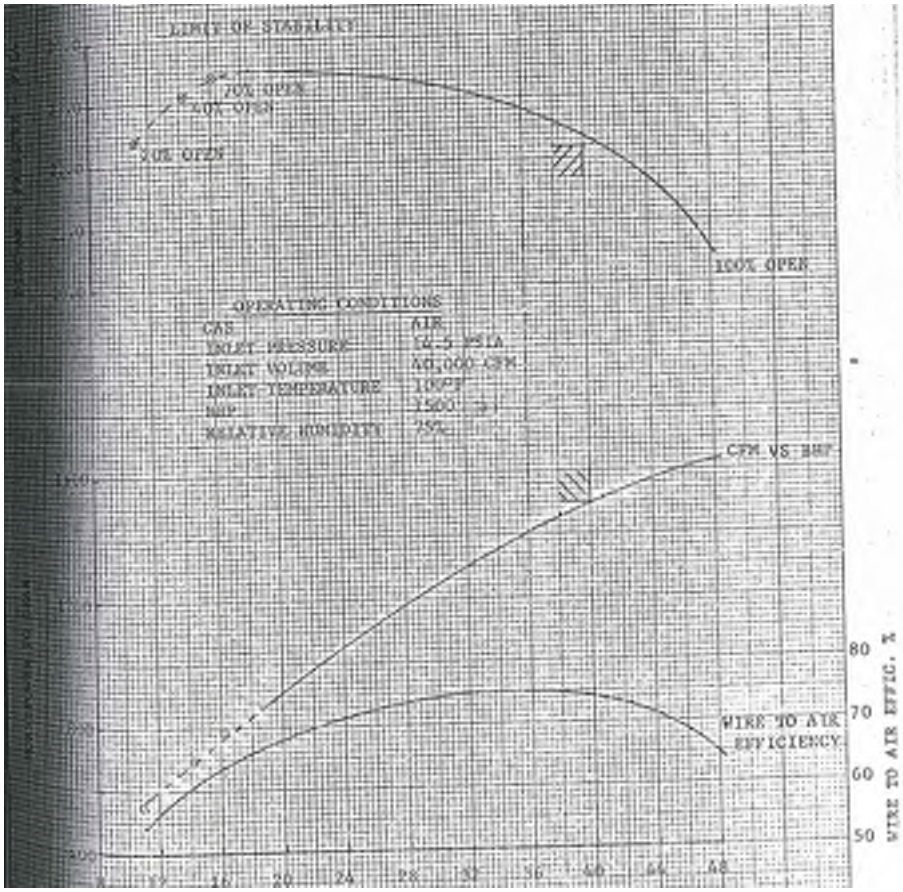

Figure 2-3 Existing Single Stage Blower Curve

The pneumatic characteristics of the air distribution system for the existing Contact Basins and the proposed new piping to the RAS Reaeration Basin were evaluated. Utilizing the predicted maximum day air flows required at the 90 MGD design capacity from Table 2-11 along with the expected pressure at the diffuser dropleg connection which was provided by Sanitaire. **Table 2-14** summarizes the expected discharge pressures at maximum day air flows.

Table 2-14 Blower Operating Point Determination at Maximum Day Conditions

Parameter	Unit	Reactor	
		Contact	RAS Reaeration
Air flow	scfm	120,600	52,000
Pressure at dropleg	psig	6.68	6.69
Pressure drop in air main	psig	0.74	0.57
Diffuser fouling allowance	psig	0.20	0.20
New throttling control valves	psig	---	0.20
Discharge pressure (without/with control valve)	psig	7.62/7.62	7.48/7.68
Governing pressure zone		X	

As noted in Table 2-12 the existing Contact Basins would have a higher pressure than the RAS Reaeration Basin without the proposed throttling control valves that will be provided in Package 2B. The valves will be needed balance the pressure between the Contact and RAS Reaeration Basins.

A pneumatic system curve was developed utilizing pressure requirements at varying flows (provided by Sanitaire) coupled with pneumatic calculations of the existing air distribution system as well as the proposed air piping to the RAS Reaeration Basin (provided in Package 2B) for one, two, five and six blowers in service. This was done to identify the variability in blower operating conditions at the calculated maximum and minimum air flow rates. **Figure 2-4** shows the blower and system curve.

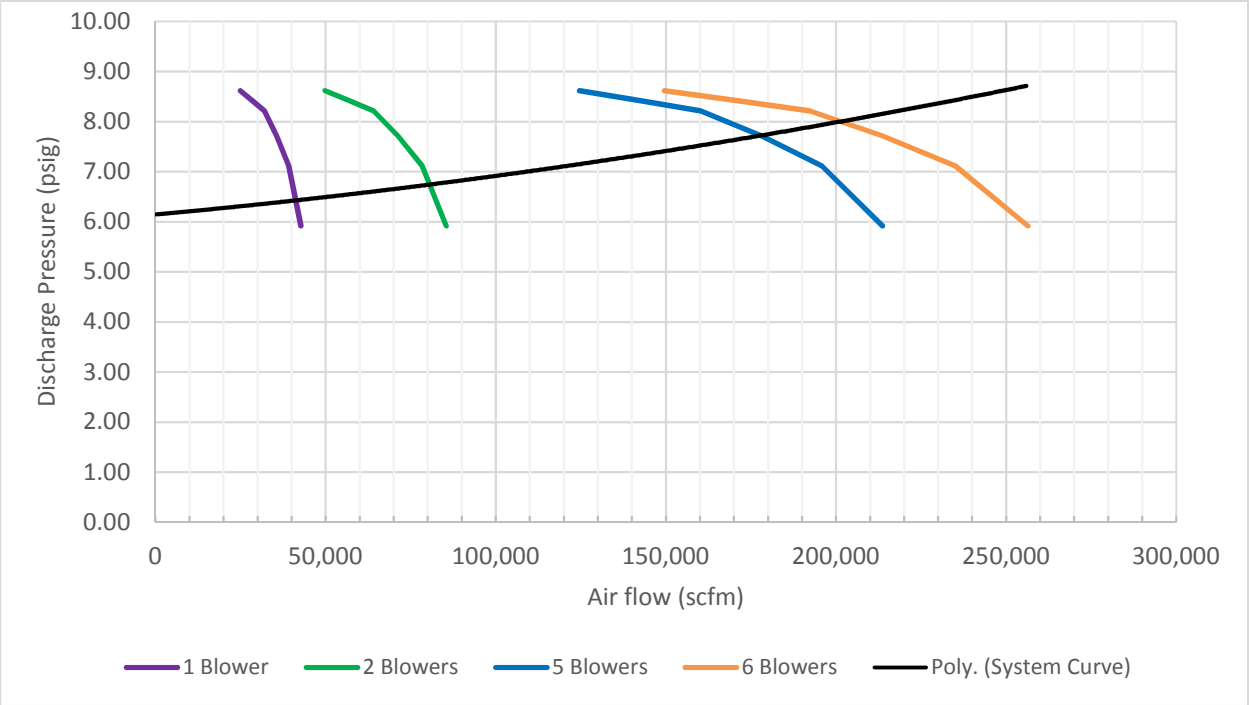

Figure 2-4 Blower and System Curve for Proposed Diffused Aeration and Air Conveyance System

It appears that one blower, operating at some degree of turndown, will be required at minimum air flow conditions of 38,000 scfm. The system curve indicates that five to six blowers operating at their original design curve would be needed to operate at the 172,000 scfm maximum day air requirement in the 90 MGD design year if wood media is kept in the trickling filters and a dissolved oxygen of 2 mg/L is maintained. This may leave the facility without a redundant blower at these conditions.

Erosion of dissolved oxygen between 1 and 2 mg/L for a one-day peak load would certainly allow for five blower operation and would alleviate concerns of not having a redundant blower. Conversion of the trickling filters to the hybrid media option would also alleviate this condition and would decrease air requirements to where five blowers would be adequate while still maintaining a 2 mg/L dissolved oxygen concentration. Therefore at this time we are not recommending an additional blower.

2.1.3 Final Clarifier Process Design

The results of the BioWin modeling provided mixed liquor suspended solids at each design condition. Winter conditions will govern the design MLSS due to the increased SRT utilized to remove soluble BOD_5. The predicted MLSS concentration in the Contact Basins for the wood media and hybrid media option at these conditions only vary by two percent and indicate that the design MLSS concentration at this condition is 2,400 mg/L. Therefore, the secondary clarifiers are evaluated at 2,400 mg/L at a maximum day flow of 156 MGD. A maximum underflow from the secondary clarifier of 47 MGD was utilized to be consistent with the 2016 CDR noting hydraulic limitations at the intermediate pump station.

The January, 2016 CDR evaluated the final clarifiers utilizing a state-point analysis assuming 10 clarifiers were in service at a design sludge volume index (SVI) of 150 mL/g utilizing an underflow of 47 MGD. The SVI was chosen at that time due to flocculation enhancement provided by the RAS Reaeration Basin along with a high percentage of soluble BOD_5 removal in the plastic media trickling filters.

The trickling filter will act as a bioselector due to its ability to remove readily available substrate in the primary effluent. The amount of substrate removed should impact the performance of the selector for sludge volume index (SVI) control. Historical data was evaluated to determine if SVI was affected the percentage of soluble BOD_5 removed in the trickling filters under roughing mode. There was not a correlation found between these parameters.

Information in the Water Environment Research Federation (WERF) "*Develop and Demonstrate Fundamental Basis for Selectors to Improve Activated Sludge Settleability*" noted that selector design should remove 80-percent of the biodegradable chemical oxygen demand (COD). A well performing selector should consistently provide SVIs of 120 mL/g or lower. Review of the trickling filter performance data from analyses performed indicated that 80-percent of the readily biodegradable COD is removed with the hybrid option and 60- to 70-percent of the readily biodegradable COD is removed keeping the existing wood media in service. This would infer that conversion to the hybrid media option would meet the selector design criteria and that keeping the existing wood media in service would fall 10- to 20-percent short of meeting the selector criteria in the WERF manual.

It is believed that SVI control will be further enhanced by the employment of the RAS reaeration basin. Jenkins and Orhon (1972) stated that contact stabilization systems produce a sludge that settles better than conventional systems noting that this is due to enhanced flocculation of the biomass due to bacterial polymers. Data presented in their paper indicated SVIs of 100 to 150 mL/g at substrate removal rates between 0.4 and 1.0 g COD removed/g VSS per day. Results of the BioWin modeling indicate that the substrate removal rates at maximum month conditions fall between 0.4 and 0.5 g COD removed/g VSS per day.

A design SVI of 150 mL/g is utilized for this evaluation given the trickling filter's ability to remove a significant amount of sCOD coupled with the correlation from the Jenkins and Orhon paper correlating SVI and substrate removal for contact stabilization processes. **Figure 2-5** shows the state point analysis at a maximum day flow of 156 MGD, a SVI of 150 mL/g and an underflow of 47 MGD with 10 clarifiers in service.

The state-point evaluation also uses a 30-percent safety factor on solids loading rate. The analysis indicates that the final clarifier system should be adequate at these conditions.

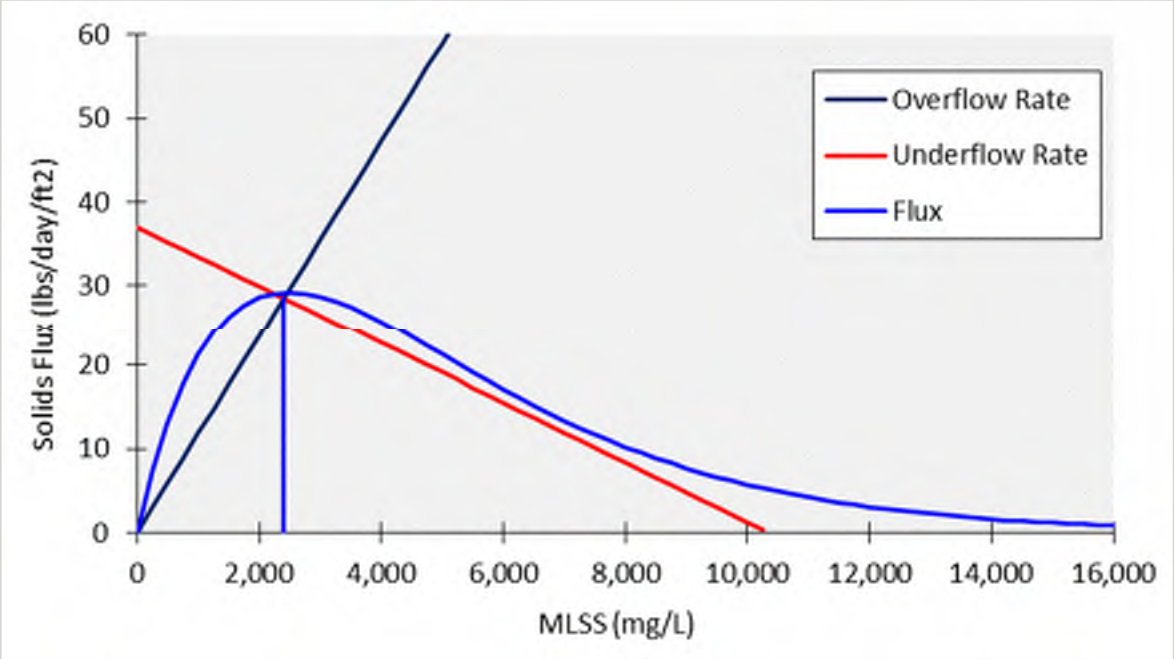

Figure 2-5 State Point Analysis With 10 Clarifiers in Service At Max Day Flow at 150 mL/g SVI and 1.3 Safety Factor

2.1.3.1 Structural

Based on the available as-built record drawings for the aeration basins, the existing reinforced concrete mat foundation is roughly 11-in. thick at its low point. It is anticipated that the new diffuser supports will be anchored to the existing concrete using a drill and epoxy adhesive anchor system. The diffuser manufacturer should space the supports such that the embedment of the epoxy adhesive anchors is limited to 6-in. maximum.

2.1.3.2 Electrical

There are no electrical improvements anticipated to be associated with the fine-bubble diffused air conversion.

2.1.3.3 Instrumentation and Controls

There are no instrumentation and controls improvements anticipated to be associated with the fine-bubble diffused air conversion. Existing instruments systems, such as dissolved oxygen, will be reused.

2.2 Construction Sequencing and Constraints for Fine-Bubble Diffuser Conversion

The fine-bubble diffuser conversion will be done by isolating mixed liquor flow to each aeration basin. Butterfly valves at the air droplegs will be closed allowing for isolation of the air system. Demolition can occur after these two items occur without the need for an outage. It is anticipated that two two-pass aeration basins can be taken out of service at a time without impacting plant operations. See Section 9 for the overall project schedule.

References

Jenkins, David and Deron Orhon. The Mechanism and Design of the Contact Stabilization Activated Sludge Process. Advances in Water Pollution Research. Proceedings of the Sixth International Conference. Pergamon Press, Oxford, England, June 1972.

Water Environment Research Foundation. Develop and Demonstrate Fundamental Basis for Selectors to Improve Activated Sludge Settleability. IWA Publishing, London

Section 3

Final Clarifier 5N/5S Demolition and Replacement

When the Maxson WWTF's eight 135-foot-diameter final clarifiers were constructed in 1971, they were initially outfitted with suction pipe sludge removal mechanisms and steel inboard effluent launders. In 1982, the sludge suction pipes were removed, and the clarifier arms were converted to conventional scraper arms. A central return sludge hopper was also cast into the bottom of each tank to facilitate sludge removal. In 1985, the clarifiers' steel effluent launders were replaced with cast-in-place, peripheral concrete launders, and their scum skimmers and troughs were replaced. Finally, as part of a 1991 primary and secondary clarifier optimization project, each final clarifier mechanism was upgraded with a larger flocculating feedwell, an energy dissipating inlet (EDI), and spiral scrapers.

Also constructed in 1971 were two circular Chlorine Contact Tanks, located to the west of the eight final clarifiers (5-N and 5-S). These 120-foot-diameter tanks were both equipped with conventional sludge scraper mechanisms, scum skimmers, and steel inboard effluent launders. In 1996, the clarifier mechanisms and scum baffles were removed, and the steel effluent launders were replaced with cast-in-place, peripheral concrete launders. These tanks currently serve as wet wells for the Effluent Pump Station, but they are rarely used.

The Conceptual Design Report (CDR) recommended the construction of two additional 135-foot-diameter final clarifiers to settle the mixed liquor. The existing Clarifiers 5-N and 5-S tanks, which are too small to meet the requirements for the proposed new clarifiers, will be demolished, and the new Clarifiers 5-N and 5-S will be built in their place. The new clarifiers' sidewater depth and floor slope will match the existing clarifiers.

This section further details the design basis for Clarifiers 5-N and 5-S and discusses construction sequencing and constraints. 30-percent drawings, the clarifier equipment specification, and equipment data sheets (EDS) are included in **Appendices A, B,** and **C,** respectively.

3.1 Design Basis

3.1.1 Process Mechanical

Table 3-1 summarizes the design criteria for Final Clarifiers 5-N and 5-S. Process and Instrumentation Diagrams for these clarifiers are included in Appendix A.

Table 3-1 Final Clarifier 5-N and 5-S Design Criteria

Parameter	Units	Value
Number of Clarifiers	n/a	Two
Tank Type	n/a	Circular, cast-in-place concrete
Tank Diameter	ft	135
Sidewater Depth	ft	15
Freeboard	ft	2.7
Bottom Slope	in / in	1/4" / 12"
Surface Area	ft2	14,314 each, 28,628 total

Table 3-1 Final Clarifier 5-N and 5-S Design Criteria, continued

Parameter	Units	Value
Tank Volume	MG	2.1 each, 4.2 total
Configuration	n/a	Center column supported, center feed, peripheral overflow
Drive Type	n/a	Cast iron
Mechanism Type	n/a	Spiral scraper blades
Scum Skimmer	n/a	Peripheral, Z-shaped
Design Sludge Volume Index (SVI)	mL/g	150
Design Mixed Liquor Suspended Solids	mg/L	2,400
Hydraulic Loading Rate		
Average Daily Flow	gpd/ft2	629
Maximum Daily Flow		
Peak Hourly Flow	gpd/ft2	1,188
Solids Loading Rate		
Average Daily Flow	lb/d/ft2	19.2
Maximum Daily Flow		
Peak Hourly Flow	lb/d/ft2	30.4
Effluent BOD5 Concentration	mg/L	30
Effluent TSS Concentration	mg/L	30

The two proposed Final Clarifiers (5-N and 5-S), as well as all associated upstream and downstream piping and fittings were added to the hydraulic model. The model was then run at several flow conditions to understand the resulting flow split balance between the eight existing and two new Final Clarifiers.

The existing Final Clarifier pipes will be repurposed to connect the Final Clarifiers 5-N and 5-S to the common culvert at the west end of the Aeration Tank pipe gallery. Additional headlosses are incurred through the 36-inch butterfly valve (BFV) assemblies and piping that are unique to the existing influent pipes for Final Clarifiers 5-N and 5-S (see **Figure 3-1**, below). These assemblies are not present on the eight-existing final clarifier influent pipes. Therefore, the new Final Clarifier effluent weirs for 5-N and 5-S will need to be set at a lower elevation than the existing final clarifiers in order to compensate for the additional headlosses on these trains to achieve an approximately equal flow split between all ten final clarifiers.

Due to differences in pipe lengths, fittings, and surveyed weir elevations, there is a slightly uneven flow split between the eight existing Final Clarifiers. For the purposes of design, the effluent weirs on Final Clarifiers (5-N and 5-S) were set at elevations that would provide 10-percent of flow to each clarifier at the maximum daily flow (MDF) of 156 mgd (15.6 mgd of plant flow to each final clarifier). By setting the weirs on Final Clarifiers 5-N and 5-S to receive one-tenth of flow each at MDF, it is expected that 5-N and 5-S will receive slightly more flow at the average daily flow (ADF) of 90 mgd (12.8-percent and 13.1-percent of flow, respectively), and slightly less flow at the peak hour flow (PHF) of 170 mgd (9.8-percent and 9.8-percent% of flow, respectively). A summary of existing and proposed effluent weir invert elevations and anticipated flow splits between the eight existing and two proposed final clarifiers is summarized in **Table 3-2** below, for the range of design flows. RAS flow to each clarifier is the same proportion of the design plant flows.

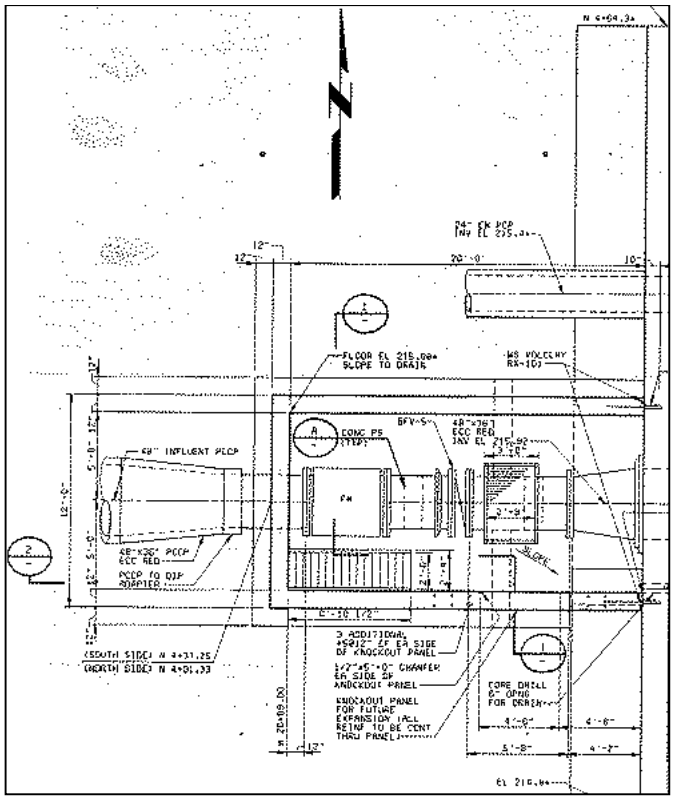

Figure 3-1 Existing 36-inch BFV Assemblies on Influent Piping for Final Clarifiers 5-N and 5-S

Table 3-2 Summary of Final Clarifier Effluent Weir Inverts and Expected Flow Split

Clarifier	Weir Invert	Flow Split at ADF	Flow Split at MDF	Flow Split at PHF
1-N	225.67’	9.99 mgd (11.1%)	19.91 mgd (12.8%)	21.90 mgd (12.9%)
2-N	225.63’	7.44 mgd (8.3%)	13.77 mgd (8.8%)	15.00 mgd (8.8%)
3-N	225.53’	8.30 mgd (9.2%)	14.38 mgd (9.2%)	15.67 mgd (9.2%)
4-N	225.64’	7.77 mgd (8.6%)	14.34 mgd (9.2%)	15.73mgd (9.3%)
5-N (New)	**224.95’**	**11.50 mgd (12.8%)**	**15.60 mgd (10%)**	**16.70 mgd (9.8%)**
1-S	225.64’	9.98 mgd (11.1%)	19.47 mgd (12.5%)	21.32 mgd (12.5%)
2-S	225.65’	7.61 mgd (8.5%)	14.06 mgd (9%)	15.42 mgd (9.1%)
3-S	225.64’	7.63 mgd (8.5%)	14.09 mgd (9%)	15.45 mgd (9.1%)
4-S	225.65’	8.03 mgd (8.9%)	14.79 mgd (9.5%)	16.21 mgd (9.5%)
5-S (New)	**224.87’**	**11.75 mgd (13.1%)**	**15.60 mgd (10%)**	**16.60 mgd (9.8%)**

After the two Final Clarifiers 5-N and 5-S are brought online, there is potential to throttle the existing 36-inch BFVs on the influent lines to finetune the desired flow split to the new units.

Effluent from the eight existing Final Clarifiers will combine upstream of the Clarifier Effluent Junction Box that serves 5-N and 5-S. Effluent from Final Clarifiers 5-N and 5-S will join the flow path to the PAA contact tank constructed in Package 1.

3.1.2 Civil/Site Work

Final Clarifiers 5-N and 5-S are being built in the same location as the demolished clarifiers. Excess excavation will be required beyond the demolition of the existing tanks to accommodate the larger diameter clarifiers. Temporary shoring may be required to protect the adjacent perimeter road and existing utility lines during construction.

Finished site grading will be similar to existing conditions. However, because of the hydraulic conditions of the effluent channel for the proposed design, the existing stormwater drain pipes that currently connect to the effluent channel between Final Clarifiers 5-N and 5-S will have to be removed. As a result, stormwater drainage for the area north of the effluent channel will have to be surface drainage until the stormwater reaches the south side of the effluent channel. A concrete swale will be built along the east side of the clarifier to accommodate street drainage northeast of Clarifier 5-N. The existing drain inlets in the street west of Clarifier 5-S will be relocated to just south of the effluent channel where new storm drain pipes will be installed to handle drainage.

3.1.3 Structural

The new Final Clarifiers 5-N and 5-S will be constructed of reinforced cast-in-place concrete. The top of the new clarifiers will be at grade. The structures will be designed with the use of a perimeter underdrain system to reduce the effects of buoyancy from groundwater. There are no protective coatings planned for the interior surfaces of the structure.

3.1.4 Electrical

The new clarifier drives will be fed from motor control centers MCC303N and MCC304E located in the Disinfection Electrical IPA Building. These motor control centers were installed under Package 1. A clarifier alarm panel will be provided locally at each clarifier rake drive to protect the system from high torque conditions.

The area around the Final Clarifiers is an unclassified space since this process is preceded by primary clarification. The scum pit integral to each final clarifier is a Class I, Division 2, Group D hazardous area, extending out ten (10) feet around equipment and any open channel, per NFPA 820, Table 6.2.2(a), Row 4(c). Conduit and wire going to the final clarifiers may be required to pass through this area. Any electrical equipment, conduit, wire, etc. will be installed in accordance with NEC Article 500 and 501 if it is within or passes through the hazardous area envelope.

3.1.5 Instrumentation and Controls

Instrumentation and controls for Final Clarifiers 5-N and 5-S are described below:

- Operators will control the RAS pumps to maintain a consistent sludge concentration in each clarifier.
- The clarifier scum pits will be equipped with three level floats each, low, high, and high-high, to control the level of the pit by starting and stopping the respective scum pump.

- Clarifier alarm panels will be provided by the clarifier manufacturer as specified. Torque switches will be installed to stop clarifiers during a torque warning condition, which will be indicated with a pilot light and as an alarm in the Ovation DCS. Each panel will also have a high torque pilot light and a torque shutdown indicated with a pilot light and alarm in the DCS. The panel will also be equipped with a reset pushbutton to clear all interlocks after the high torque fault conditions have been cleared. Hand/Off/Remote switches will be installed at the Clarifier motors for local control and a pilot light to indicate locally and in the DCS that the Clarifier is running.

3.2 Construction Sequencing and Constraints

Improvements to the Maxson WWTF's effluent piping and structures, part of Package 1, include preparations for the demolition of the wet wells and the construction of Final Clarifiers 5-N and 5-S. The existing Chlorine Contact Tank Distribution Box, a hydraulic choke point, will be demolished and replaced with a new Effluent Junction Box. In Package 2A, the effluent pipes from Final Clarifiers 5-N and 5-S will be connected to this box. As part of the hydraulic bypass arrangement of the Package 1 construction process, the existing Clarifiers must remain in service as wet wells until hydraulic improvements are complete. Thus, this Package 2A final clarifier construction cannot start until Package 1 is completed.

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Section 4

Final Clarifier 5N/5S RAS and Scum Pumping

Section 3 described the Final Clarifiers 5-N and 5-S. This section describes the design basis of the return activated sludge (RAS) and scum pumps that serve these clarifiers. 30-percent drawings, pump specifications, and equipment data sheets (EDS) can be found in Appendices A, B, and C**,** respectively.

4.1 Design Basis

The mixed liquor that settles to the bottom of Final Clarifiers 5-N and 5-S will be transported by the spiral scrapers to a central sludge hopper. The RAS pumps will draw sludge from this hopper and deliver it to the new RAS Reaeration Tank interim connections are described elsewhere in this section. The January 2016 CDR indicated that the minimum RAS flow needed at maximum day plant flows is 47 MGD or 4.7 MGD per final clarifier (10 final clarifiers on-line). Plant staff indicate that current RAS pumping is approximately 30 MGD or 3.75 MGD per final clarifier (8 final clarifiers online). The target range for the new RAS pumps for Final Clarifiers 5-N and 5-S will be between 3 and 6 MGD.

Final Clarifiers 5-N and 5-S will share a common RAS pump station consisting of three pumps (one duty pump per clarifier, plus a center "swing" spare pump) on a single concrete pad. The new RAS pump station will need a priming system, as the centerline of the RAS pumps will be 1 to 2 feet above the Clarifier discharge weir. The design team will evaluate two priming system alternatives; an automatic vacuum priming system and an automatic priming system that uses Effluent Water.

The new RAS pumps will be designed to pump to the RAS Reaeration Tank; however, until the RAS Reaeration Tank is completed (as part of Package 2B), the new RAS pump station discharge main will be tied to the existing discharge mains from the existing RAS pump station. RAS from both the new and existing pump stations will then discharge to either the Biotower Pump Station (ABF Mode) or the 102-inch main downstream of the Intermediate Pump Station (Normal Operation). Limitations for the RAS system during this interim condition are discussed in **Section 4.2**.

Scum removed from the surface of Final Clarifiers 5-N and 5-S will fall into a rectangular concrete scum pit on the side of each clarifier tank. Each scum pit will have its own dedicated, double-disc scum pump, located on a concrete pad at grade next to its respective scum pit. The pumps will operate on either level control or on a timer, which will periodically pump the contents of the scum pit via a new 6-inch scum pipe into the existing 42-inch WAS-HDPE pipe that runs along the north side of the plant site. A shelf spare scum pump will be provided so that plant staff may quickly replace a pump in the event that the installed pump requires service or repair. The scum piping and pumps are sized so that the scum pumps may operate individually or at the same time.

The scum pit is a Class I, Division 2, Group D hazardous area, extending out ten (10) feet around equipment and any open channel, per NFPA 820, Table 6.2.2(a), Row 4(c). The level instruments in the scum pit must be rated for this area classification. Any pump motors, controls, instruments, electrical equipment, conduit, wire, etc., will be installed in accordance with NEC Article 500 and 501 if it is within the hazardous area envelope.

4.1.1 Process Mechanical

Table 4-1 presents the design criteria for the RAS and scum pumps. Process and Instrumentation Diagrams for the RAS and scum pumps are included in Appendix A.

Table 4-1 Final Clarifiers 5-N and 5-S RAS and Scum Pumping Design Criteria

Parameter	Units	Value
RAS Pumps		
Number of Pumps	---	Three (one duty pump per clarifier, plus a center "swing" spare pump)
Location	---	Outdoors, pad mounted between the clarifiers
Pump Type	---	Horizontal, end suction, solids handling
Pump Capacity	gpm	4,200 min at full speed
Pump Total Dynamic Head (TDH)	ft	40 ft max
Pump Horsepower	hp	60
Drive Type	---	Variable speed
Scum Pumps		
Number of Pumps	---	Three (one duty pump per clarifier and one complete shelf share pump)
Location	---	Outdoors, pad mounted, adjacent to clarifier scum pit
Pump Type	---	Free floating, reciprocating double disc
Pump Capacity	gpm	150
Pump TDH	ft	35
Pump Horsepower	hp	7.5
Drive Type	n/a	Constant speed

Figure 4-1 shows the pump and system curve for the proposed RAS pumps with one pump in operation and the expected turndown with the variable frequency drives. **Figure 4-2** shows the pump and system curve for the proposed RAS pumps with two pumps in operation and the expected turndown with the variable frequency drives. When either Clarifier 5N or 5S is out of service and only one RAS pump is in service for this pump station, it may be necessary to limit the pump to 90 percent speed. This condition will be verified based on the final pump selection at the 60 percent design milestone.

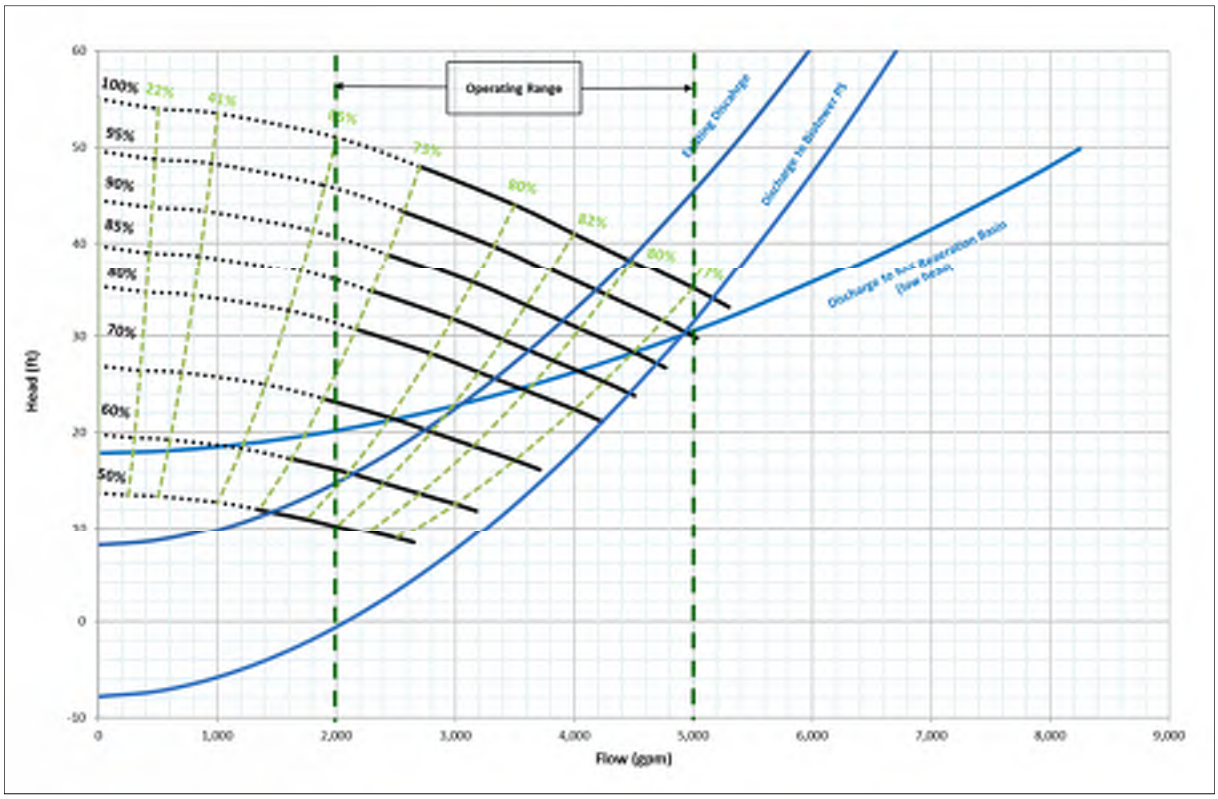

Figure 4-1 Final Clarifiers 5-N and 5-S RAS Pump Curve: Single Pump Operation

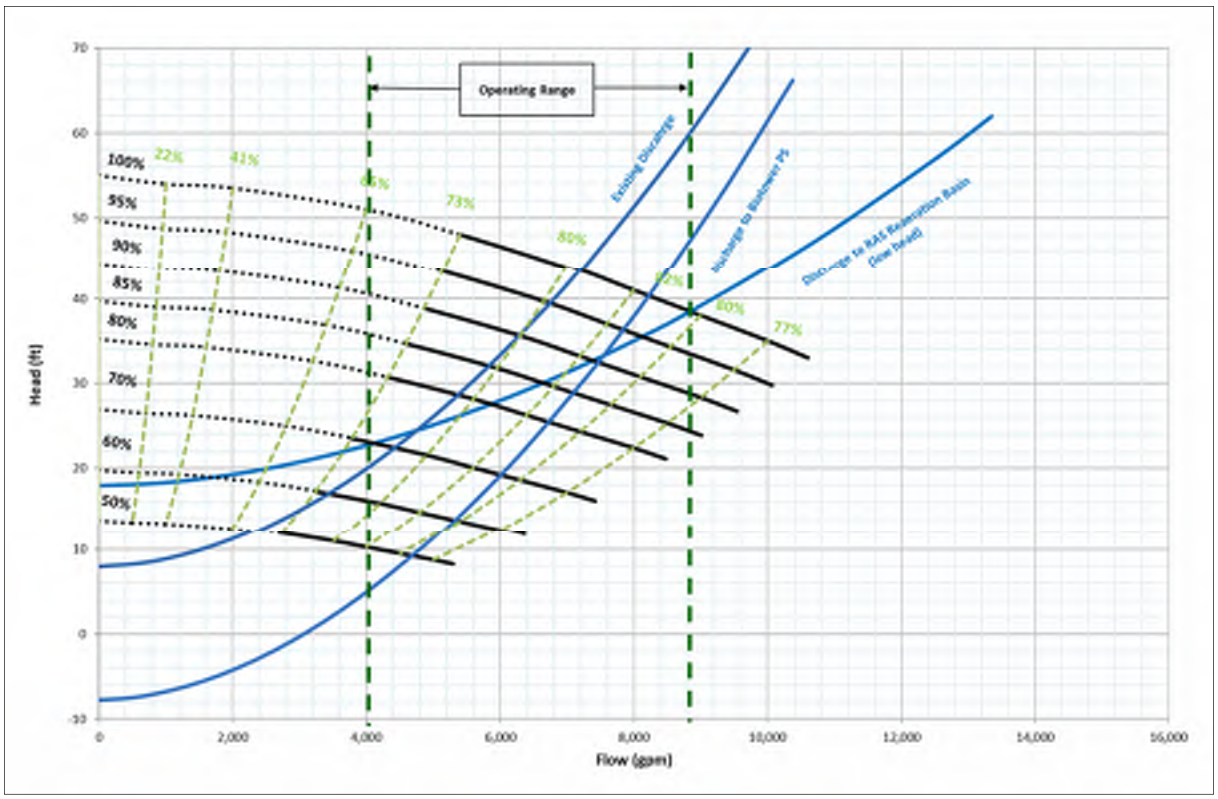

Figure 4-2 Final Clarifiers 5-N and 5-S RAS Pump Curve: Dual Pump Operation

The hydraulics of the existing RAS pump station was evaluated to determine the capacity of the existing RAS pumps discharging to the new RAS Reaeration Tank to be completed in Package 2B. **Table 4-2** summarizes the anticipated maximum pumping capacity of the existing RAS pumps assuming all throttling valves are open.

Table 4-2 Summary of Expected Flows from Existing RAS Pump Station

Number of Pumps Operating	Units	Value
1	MGD	17
2	MGD	31
3	MGD	38
4	MGD	45
5	MGD	48
6	MGD	51

4.1.2 Civil/Site Work

Site grading adjacent to Final Clarifiers 5-N and 5-S will be done to accommodate the RAS equipment pads. Much of the RAS yard piping and part of the scum piping will be installed where future site pavement will be constructed. Pipe depths will be based on future pavement elevations to accommodate the proposed pavement work to follow in future packages.

4.1.3 Yard Piping

18-inch ductile iron pipes (DIP) will connect the Final Clarifier 5-N and 5-S sludge withdrawal hoppers to the suction side of the RAS pumps. The RAS pumps will discharge to a common 24-inch manifold and force main leading to the RAS Reaeration Tank. Work will include approximately 225 linear feet of 18-inch DIP and 1,000 linear feet of 24-inch DIP.

Scum yard piping will initiate from the effluent of the scum pump of Final Clarifiers 5-N and 5-S and will continue to the existing 42-inch WAS-HDPE pipe on the north side of the plant. Work will include approximately 1,000 linear feet of 6-inch Porcelain Enamel-lined DIP. Non-potable water will be supplied to Final Clarifiers 5-N and 5-S co-located with the RAS and scum pumps.

4.1.4 Structural

The RAS pumps will be supported by a reinforced, cast-in-place concrete slab on grade with a thickened edge. The scum pumps will be supported by individual reinforced cast-in-place concrete slabs on grade.

4.1.5 Electrical

The scum pumps will be fed from motor control centers MCC303N and MCC304E located in the Disinfection Electrical IPA Building. The RAS Pumps will be powered and controlled from variable frequency drives (VFDs) which are also powered from these motor control centers (MCCs). The MCCs were installed under Package 1, and the VFDs are installed under Package 2A.

The RAS pump station is considered a sludge pumping station physically separated from any wet well and considered an unclassified space, per NFPA 820, Table 6.2.2(a), Row 9(b). The scum pumps are also physically separated from any wet well and would be considered an unclassified space, per NFPA 820, Table 6.2.2(a), Row 6(c). However, since the scum pumps are within the classified envelope of the scum pit (See Section 3), they will require motors rated for Class I, Division 2, Group D locations. Any electrical equipment, conduit, wire, etc. will be installed in accordance with NEC Article 500 and 501 if it is within or passes through the hazardous scum pit envelope.

4.1.6 Instrumentation and Controls

Instrumentation and controls for RAS and scum pump stations are described below:

- The scum pumps will be automatically controlled based on float switches monitoring level in the scum pit of each clarifier. A scum pump will start on high level float, and stop on low level float, plus a high-high level float will generate an alarm. In the event of a high float failure, the high-high level float will also be used to start the scum pump. A scum pump will shut down and alarm if a high discharge pressure switch is tripped.
- A pulsation dampener will be installed on the suction and a liquid-filled pressure gauge and switch assembly mounted on a pulsation dampener will be installed on the discharge of each new pump.
- A Scum Pump Control Panel, one for each pump and floats set, will contain local Hand/Off/Auto switches, status and alarm pilot lights for both scum pumps. Alarms will be relayed to the plant SCADA system.
- An ABB magnetic flow meter utilizing the Calmaster calibration system will be installed on the common effluent RAS Pump Station pipe measuring the combined RAS flow to the RAS Aeration Basin.
- RAS pumps will include high pressure switches, discharge check valve limit switches, and high motor temperature switches on the pumps for pump protection. In addition, a liquid-filled pressure gauge will be installed on the suction and discharge of each new pump.
- RAS pumps will be controlled off a user entered flow set point (in MGD) for the effluent RAS pump station flow meter. RAS Pump No. 1 will be designated to Clarifier 5-S; RAS Pump No. 3 will be designated to Clarifier 5-N; RAS Pump No. 2 is a manual standby that can serve either clarifier. The operator will start one or more RAS pumps after manual confirmation of the position of the isolation knife gate valves. The speed of all running pumps will adjust to meet the required flow rate set point.

4.2 Construction Sequencing and Constraints

The RAS and scum pumps will need to be operational to bring Final Clarifiers 5-N and 5-S on-line and into service. The interim pumping condition will require the new RAS pump discharge to be manifolded together with the existing RAS pumps to convey RAS to the head of the aeration basins. RAS will be able to be conveyed to both the Biotower (Trickling Filter) Pump Station (ABF Mode) or into the 102-inch main downstream of the Intermediate Pump Station (Normal Operation). This condition will affect both the new RAS pumps and the backpressure of the existing RAS pumps.

Table 4-3 summarizes the anticipated maximum pumping capacity of the existing RAS pump station assuming all throttling valves are open and the new RAS pump Station when conveying flow during the interim condition to the existing two discharge points.

Table 4-3 Maximum RAS Pumping During Interim Condition

Pump Station	Normal Operation RAS Flow	ABF Mode RAS Flow
Existing RAS pump station	36.1	46
New RAS pump station	10.4	11.9
Total RAS Flow	46.5	57.9

As stated in the January 2016 CDR, the quantity of RAS flow that the gravity hydraulics of the plant can handle is dependent upon the plant flow. **Table 4-4** summarizes the maximum total RAS flow for average day, maximum day and peak hour flow for this interim condition based on RAS discharge point.

Table 4-4 Maximum RAS Gravity Flow During Interim Condition

Plant Flow	Normal Operation RAS Flow (MGD)	ABF Mode RAS Flow (MGD)
ADF (90 MGD)	60 MGD (Max RAS Flow)	60 MGD (Max RAS Flow)
MDF (156 MGD)	47 MGD (Design)	14 MGD (Max)
PHF (170 MGD)	41.5 MGD (Max)	0 MGD (Max)

Lastly, we do not recommend that only one of the new RAS pumps be operated by itself when sending RAS to the Biotower Pump Station (ABF Mode). We recommend always operating two pumps in the new pump station with additional pumps operating in the existing pump station during this interim condition to either discharge location.

Section 5

Odor Control Improvements

5.1 Design Basis

The current design for the Maxson facility uses four dedicated biotrickling filter systems to treat four locations located throughout the plant that were targeted for odor control through a dispersion analysis. **Appendix E** includes a copy of the results of the dispersion analysis presented to the City on June 2, 2016.

- Headworks: Location 1
- Influent Junction Box: Location 2
- Intermediate Pump Station: Location 3
- Fine Screens: Location 4

Air flow calculations for the Influent Junction Box were based on the amount of air that could potentially be dragged down the gravity influent pipe to the junction box and released at the junction box. Calculations for the Headworks was based on 12 air changes per hour (ACH) to accommodate the National Fire Protection Code (NFPA 820-16). 12 ACH declassifies the coarse screening building space from Class 1 Division 1 to Class 1 Division 2 with requirements for:

- Balancing the exhaust airflow with supply air from the HVAC system
- Combustible gas detector (CGD)
- Duct smoke detector
- Alternative power supply
- Low fan pressure alarm

The Fine Screen and Intermediate Pump Station channels and the wet wells were calculated as 12 ACH and cross-checked with an analysis of the potential leakage through unsealed cracks. The ventilation calculations for the Primary Settling Tank weirs was based on a 150-cubic foot per minute (cfm) sweep velocity through the launders. H_2S data was collected during March 2016 sampling session. **Table 5-1** outlines the design criteria for each location and whether there are code considerations. The odor control system design for each of the locations uses a biotrickling filter designed for the specific airflow and H_2S loading rate.

Table 5-1 Odor Control Design Criteria

Location	Airflow (cfm)	H_2S levels (ppm)	Code Considerations
Headworks	21,500	150/500	NFPA 820
Influent Junction Box	7,000	150/500	NA
Primary Clarifiers 3 and 4 and Intermediate Pump Station	11,000	250/700	NA
Primary Clarifiers1 and 2 and Fine Screens	7,600	250/700	NA

5.1.1 Process Mechanical

Biotrickling filters are advanced versions of the biofilters that currently operating at the Maxson Facility. Biotrickling filters operate as countercurrent scrubbers with air moving upward across a plastic media bed while water is sprayed over the top. A biofilm develops on the media that facilitates the movement of contaminants in the airstream into the biofilm. Bacteria in the biofilm degrade the contaminants for energy and in doing so the odorous compounds are removed from the airstream. Performance is a function of the residence time in the biotrickling filter as well as the face velocity across the media bed. High loading rates in terms of gms H_2S/hr, require more residence time and a lower face velocity.

Each biotrickling filter requires a fan to move air from the odor source to the scrubber, an irrigation system to transfer water over the media bed, and a nutrient source to add to the irrigation fluid. Redundant (duty/standby) fans are provided for Location 1 in order assure continuous ventilation to declassify that space. **Table 5-2** below outlines the design for each location using Bioair Solutions as basis of design.

Table 5-2 Biotrickling Filter Design

	Headworks	Influent Junction Station	Primary Clarifiers 3 and 4 and Intermediate Pump Station	Primary Clarifiers 1 and 2 and Fine Screens
Number of Vessels	2	1	1	1
Vessel Diameter (ft)	12	10	13	12
Vessel Height (ft)	27	23	27	27
Vessel Weight (lbs)	49,100	32,400	78,500	78,500
Residence Time (sec)	10	10	10	12
Redundant Fans	Yes	No	No	No

5.1.2 Civil/Site Work/Structural

Each system will be located on a concrete pad that supports the vessel, fan(s), electrical control panel, and water control panel. **Table 5-3** includes dimensions for the pad for each location.

Table 5-3 Odor Control Pad Dimensions

	Headworks	Influent Junction Box	Primary Clarifiers 3 and 4 and Intermediate Pump Station	Primary Clarifiers 1 and 2 and Fine Screens
Pad Size (L X W)	44 ft. X 44 ft.	32 ft. X 22 ft.	34 ft. X 22 ft.	34 ft. X 22 ft.

Ductwork will be installed above ground with a minimum of eight feet clearance and 18 feet. over roadways to convey air from each odor source to the designated odor control system. The layout will be coordinated with existing underground ground piping with supports designed to accommodate local wind loading and the weight of the duct itself.

5.1.3 Yard Piping

Plant effluent water will need to be provided to the biotrickling filters for irrigation and drainage will be provided away from each location. Water requirements for each location are indicated in **Table 5-4**.

Table 5-4 Water Use

	Headworks	Influent Junction Box	Primary Clarifiers 3 and 4 and Intermediate Pump Station	Primary Clarifiers 1 and 2 and Fine Screens
Irrigation water	120 gpm	47 gpm	80 gpm	62 gpm
Intermittent	YES	YES	YES	YES
Water Use	61,514 gpd	20,028 gpd	52,454 gpd	36,421 gpd

5.1.4 Electrical

The odor control systems will be fed from two different power sources. The Headworks, Influent Junction Box, and Fine Screens odor control systems will be powered from existing transformer PC-14N and panelboard DP-6. This equipment is located outdoors adjacent to the existing odor control system. Panelboard DP-6 will replace the existing panelboard that is currently in place. The Intermediate Pump Station odor control system will be fed from existing panelboard DP-5 located in the Electrical Building north of the Intermediate Pump Station.

The area around the odor control fans, dampers, ductwork, vessels, and other leakage sources is a Class I, Division 2, Group D hazardous area, extending (3) feet around the equipment, per NFPA 820, Table 4.2.2, Rows 20 (d) and (e). Any electrical equipment, conduit, wire, etc. will be installed in accordance with NEC Article 500 and 501 if it is within or passes through the hazardous area envelope.

Electrical loads for the fans and pumps are summarized in **Table 5-5**.

Table 5-5 Electrical Requirements

	Headworks	Influent Junction Box	Primary Clarifiers 3 and 4 and Intermediate Pump Station	Primary Clarifiers 1 and 2 and Fine Screens
Fan HP (BHP/HP)	(2 fans) 35.75/40	11.82/15	19.1/25	12.69/15
Nutrient Pump (HP)	0.5	0.5	0.5	0.5
Motorized Dampers (HP)	Yes	No	Yes	No
Heat Trace	No	No	No	No

5.1.5 Instrumentation and Control

The biotrickling filters require oversight but only minor operations and maintenance requirements. The equipment is provided and controlled completely from the vendor-supplied control panel; SCADA interface shall be monitoring only. The Headworks Odor Control (Location 1) located at the coarse screening and grit tanks will be monitored for combustible gas detection, isolation damper position and duct smoke sensor since the building is being declassified. The Odor Control Systems will include fans, water recirculation pumps, and miscellaneous safety features that will be controlled, displayed, and monitored from the vendor-supplied local control panels. Each control panel will include an Ethernet-capable PLC and fiber optic cable connectivity for monitoring in the plant SCADA system. Pump running, pump fail, and other various statuses will be available for remote monitoring. **Table 5-6** shows signals to be remotely monitored from each location. The Intermediate Pump Station Odor Control Panel will not be monitored in the Ovation DCS Network until the New Electrical building is built in a future package.

Table 5-6 Instrumentation and Control

	Headworks	Influent Junction Box	Primary Clarifiers 3 and 4 and Intermediate Pump Station	Primary Clarifiers 1 and 2 and Fine Screens
Fan Status	Yes	Yes	Yes	Yes
Damper Position	Yes	No	No	No
Duct Pressure	Yes	Yes	Yes	Yes
Smoke in Duct	Yes	No	No	No
Combustible Gas	Yes	No	No	No

5.2 Construction Sequencing

For safety reasons ventilation, must be maintained for each location. For Location 3 odor control system the power will be drawn from a new power source and therefore that system can be brought on line without affecting the existing biofilter system or existing ductwork.

For Location 1, Location 2, and Location 4 coordination of the electrical supply is more complicated. These systems are proposed to draw power from the same power supply that feeds the existing odor control (biofilter) system. Therefore, odor control equipment for Location 1, 2 and 4 must be completely installed and ready for mechanical commissioning before shutting down the current odor control ventilation. In addition, the HVAC system for Location 1 must be complete and the power supply located at the existing odor control facility ready to switch over to the new equipment to provide ventilation to Locations 1, 2 and 4 without delay.

Following the shut-down of the existing ventilation and biofilter system and the successful start-up and commissioning of the new odor control systems, existing underground ductwork will be abandoned in place. The biofilter media, air distribution system, concrete pad, and paving will be removed and the area graded and hydroseeded.

Section 6

SCADA Upgrades

This section summarizes the proposed modifications and improvements of the existing Supervisory Control and Data Acquisition (SCADA) system at the Maxson WWTF.

6.1 Design Basis

The design will be based around Emerson's Ovation line of process controllers. There is an existing Ovation Controller with redundant processors located in the Administration Building. This controller monitors all the existing equipment and instrumentation and displays the data using the Ovation Graphics Package. All existing I/O is hardwired and terminated in a room located within the Administration Building. The Distributed Control Unit (DCU-1) provided by Emerson in Package 1 contains additional spares to accommodate the instrumentation associated with the Return Activated Sludge (RAS) Pump Station and Final Clarifiers 5-N and 5-S. The Odor Control Systems will be specified for Ethernet and fiber optic compatibility to allow them to be monitored by the SCADA system via fiber optic communication.

6.1.1 Communication Network

Fiber optic cable for communication between controllers and back to SCADA will be used as the media for connection between control panels. Fiber optic communication is preferred due to its high bandwidth and inherent lightning protection. The standard fiber optic cable type is multimode 62.5/150um (OM1). Modbus over Ethernet communication protocol will be used as the standard for all packages. The communication protocol used by the Ovation DCU controllers to the SCADA fiber optic network will be Modbus TCP. All I/O from the instruments, vendor control panels, VFDs, MCCs and other appurtenances will be hardwired to the DCUs as indicated in the drawings. There are several vendor-supplied panels specified to be using Allen Bradley MicroLogix 1400 series PLCs which communicate Modbus on top of Ethernet-TCP/IP. The existing Ovation controller is able to communicate using both protocols. Each new vendor-supplied panel will be furnished with an Ethernet switch with fiber optic ports, a fiber optic patch panel, and appropriate cables for connection to the network. Additional fiber optic media converters will be installed into the existing media converter rack in the Administration building for connection to the new panels.

6.1.2 Control Panels

The Emerson Ovation control panel designated DCU-1 will be located in the new Disinfection IPA Building near the new Disinfection Tank and Final Clarifier 5-N. A Phoenix Contact industrial PC workstation will be mounted to the front of the control panel to serve as a Human Machine Interface (HMI) connected to the Emerson Ovation SCADA Network. The operator will have the ability to monitor and control all the RAS Pump Station and Final Clarifiers 5-N and 5-S instrumentation and equipment as well as monitor any instrumentation located throughout the plant that is connected to the Ovation Network. Two Scum Pump control panels will be vendor supplied, one panel per pump and floats set, provided by the scum pump manufacturer. Final Clarifier 5-N and 5-S control panels will be vendor supplied, one per each clarifier, provided by the clarifier manufacturer. The MCCs powering the Final Clarifiers 5-N and 5-S were provided under Package 1.

The Odor Control Systems will be pre-packaged manufacturer-supplied units with stand-alone local control panels that will include Allen-Bradley MicroLogix 1400 series PLCs provided and programmed by the biotrickling filter vendor. The Odor Control Systems will be monitored, but not controlled, from the SCADA system via Ethernet over fiber optic cable run to the Administration Building. The control panels will meet NEMA 12 classification and will be constructed of 316 stainless steel and in accordance with UL508A standards. The Primary Clarifiers No 1& 2 and Intermediate Pump Station Odor Control panel will be locally monitored only, until the New Electrical Building is constructed in a future package with provisions for connecting to the Ovation Network.

Section 7

Facility Hydraulic Improvements

This section describes the design basis for the facility hydraulic improvements proposed to accommodate design flows downstream of the Intermediate Pumping Station (IPS). Thirty percent drawings can be found in **Appendix A**.

7.1 Design Basis

In the existing configuration of the WWTF, the Intermediate Pump Station (IPS) flows to a steep portion of the 102-inch main, which flows to the downstream Flow Control Structure, and on to the north and south Aeration Tank batteries and Final Clarifiers. The hydraulic analysis identified potential bottlenecks in the existing WWTF. It was determined that the configuration of the IPS effluent box is likely reducing the capacity of the existing 102-inch main leaving the box. The existing configuration impairs hydraulic capacity because the crown of 102-inch main is not submerged under most flow conditions, which results in significant turbulence in the effluent box. Therefore, changes are recommended at this structure.

Hydraulic modifications are proposed to accommodate design flows through the new treatment units downstream of the IPS, including the following:

- A new Flow Diversion Structure which will connect to the existing IPS effluent box to the existing 102-inch main at a lower elevation to avoid sending flow through the steeply ramped portion during normal plant operation.
- A new section of 102-inch main with minimal slope will be installed to connect the new Flow Diversion Structure to the existing 102-inch main at a point located north of the steeply sloped portion.
- The existing 102-inch main at the IPS's effluent box will remain in place, isolated by a gate, which could be opened to bypass the new Flow Diversion Box, if necessary.

7.1.1 Process Mechanical

To mitigate the turbulent flow conditions that exist in the IPS effluent box, the proposed Flow Diversion Structure would be constructed adjacent to the north side of the IPS effluent box, on the downstream side of the IPS. This structure would be set 14 feet deeper than the Intermediate Pump Station to achieve maximum capacity of the 102-inch main. As shown in **Drawing IPS-M-1**, the Flow Diversion Structure would include four openings (5-feet by 6-feet each) saw cut into the north side of the existing IPS effluent box wall. A new section of 102-inch main would be installed to connect the new Flow Diversion Structure with the existing 102-inch main. This new portion of 102-inch main would be installed at the bottom of the new structure, with an invert of approximately 214.00 feet, nearly 13 feet lower than where the existing 102-inch main leaves the IPS effluent box. This modification would eliminate the steeply ramped portion of pipe and ensure that the pipe's crown remains submerged during all anticipated flow rates. The existing 102-inch main at the IPS's effluent box will remain in place, isolated by a gate, which could be opened to bypass the new Flow Diversion Box, if necessary. The proposed hydraulic profile, which includes these modifications, is shown on **Drawing GP-M-5**.

In order to better assess the hydraulic capacity proposed Flow Diversion Structure at the IPS, CDM Smith has contracted with a hydraulics lab to build and test a physical hydraulic model of the proposed structure. Results from this physical model will be used to validate the proposed hydraulic design of this structure and make improvements where necessary. The physical modeling effort is discussed further in Section 8.

7.1.2 Civil/Site Work

Site grading will be modified as required to accommodate the new IPS Flow Diversion Structure. The existing storm drain system on site will be used to the greatest extent possible to accommodate surface drainage around the new structure. Some elements of the existing storm drain system will need to be cleaned and/or repaired to restore adequate site drainage.

7.1.3 Yard Piping

The new portion of 102-inch reinforced concrete pipe will be installed at the deepest part of the new Flow Diversion Structure and will extend northward in a straight run until it intercepts the existing 102-inch main. Some field inspection/adjustment will be required to accurately locate the existing main in the yard and coordinate the tie-in of the new pipe. A custom 102-inch by 102-inch wye fitting will be used to join the new 102-inch pipe to the existing main. The existing 102-inch main in the existing portion of the IPS effluent box will be abandoned.

7.1.4 Structural

The new flow diversion structure will consist of reinforced cast-in-place concrete walls and mat foundations. The new structure will tie into the existing IPS exterior wall using drilled and epoxied reinforcing steel dowels. A new expansion joint will isolate any differential settlement between the new and existing concrete structures. The existing exterior (16-inch thick) reinforced concrete wall of the IPS will be modified to include four new saw-cut openings, approximately 5-feet by 6-feet each. At the deepest part of the new structure (~28.29-feet deep), a new section of 102-inch reinforced concrete pipe will be attached through the wall using drilled and epoxied reinforcing steel dowels. The structure will be sized to counteract any buoyant forces caused by design ground water elevations, based on mass alone and without the use of a perimeter underdrain system or pressure relief valves.

7.1.5 Electrical

The construction of the new flow diversion structure requires the relocation of multiple exposed conduits routed along the north side of the IPS. These conduits contain the power wiring for the intermediate pumps and grease pumps, instrumentation/control wiring, lighting wiring, and receptacle wiring.

New conduits will be routed from Electrical Building north of the IPS. This will allow for new power and control wiring to be connected to all the electrical equipment at the pump station.

7.2 Construction Sequencing and Constraints

From a constructability standpoint, the proposed Flow Diversion Structure could be built with the existing IPS and 102-inch main left in operation. However, plant flow would need to be sent through the existing plant bypass that connects the existing Headworks Structure to the Flow Control Structure during construction of the four openings between the existing IPS effluent box and the new Flow Diversion structures, as well as during installation and connection of the new 102-inch main section.

Section 8

Hydraulic and Physical Modeling

This section describes the development of the hydraulic model for the proposed improvements, as well as hydraulic implications associated with running the WWTF in ABF Mode, taking Primary Clarifier 4 out-of-service. The hydraulic capacity of 42-inch WAS-HDPE line to Lagoon 2A and proposed hydraulic profile are also discussed. 30-percent drawings, including the proposed IPS Flow Diversion Structure and can be found in Appendix A.

8.1 Hydraulic Model Development

8.1.1 Computer Hydraulic Model

As described in the CDR and Package 1 PER, a calibrated hydraulic model was developed for two distinct profiles at the T.E. Maxson WWTF, separated by the hydraulic break at the IPS located downstream of the primary clarifiers. Downstream hydraulic control points were determined for each profile and all hydraulic losses were added one-by-one back to the upstream side of the profile while also incorporating intermediate hydraulic controls and devices. The comprehensive hydraulic model included a combination of calculations and the hydraulic modeling software, Visual Hydraulics (version 4.2).

The model of the existing WWTF was calibrated using surface water elevations measured at flow conditions experienced during the field hydraulic testing calibration. Testing included taking specific tanks and process units off-line which allowed for collected data to reflect a simulated high flow conditions that are anticipated after the proposed improvements. The collected data provided more accurate estimates of roughness and minor loss coefficients for the calibration.

The calibrated hydraulic model for the existing plant was modified to reflect the proposed modifications for Package 1 and 2A. Return Activated Sludge (RAS) was incorporated into the model upstream of the Final Clarifiers and downstream of the IPS.

Hydraulics were evaluated for the following design flows and associated RAS flows:

- Average Day Flow (ADF) = 90 mgd; RAS = 30 mgd
- Max Day Flow (MDF) = 156 mgd; RAS = 47 mgd
- Peak Hour Flow (PHF) = 170 mgd; RAS = 48 mgd
- RAS flows were evaluated for several scenarios, including the normal operating condition when RAS is added to the flow stream in the 102-inch main upstream of the existing Flow Control Structure via the two existing 24-inch RAS pipes. The addition of RAS flow was also evaluated for the Activated Biofilter (ABF) Mode, when RAS is rerouted to the existing trickling filters and combines with plant flow upstream of the IPS.

The following assumptions were made for this analysis:

- Steady state flow conditions exist throughout the plant.

- Dimensions and flow paths in units were constructed as per the contract drawings (1970 through 2011) and input from plant staff.
- Elevations were adjusted per survey data.
- The water surface elevation in the IPS influent wet well was assumed to be 215.64 ft, the level measured during the first round of field stress testing at the plant on July 8, 2015. It is understood that this level is variable and can be modified based on operating conditions at the pump station.

The proposed hydraulic profile is included as **Drawings GP-M-5** and **GP-M-6**.

8.1.2 Physical Hydraulic Models

In order to better assess the hydraulic capacity proposed Flow Diversion Structure at the IPS, CDM Smith has contracted a hydraulics lab to build and test a physical hydraulic model of the proposed structure. Limited physical modeling of this structure is needed to verify the elimination or minimization of three adverse hydraulic conditions which could limit the capacity of the 102-inch main between the IPS Flow Diversion Structure and the downstream Flow Control Structure. Physical modeling of the proposed structure will verify the following:

- In the existing IPS effluent box, the discharge at the screw pumps is very turbulent and likely entrains a significant amount of air that can cause a hydraulic choke point in the 102-inch main. The physical model will look to make sure air is not making it into the 102-inch main for the proposed Flow Diversion Structure.
- The physical model will verify that the redesigned Flow Diversion Structure will not cause surface vortexing activity or other adverse hydraulic conditions that could limit capacity.
- The model will also confirm that overall headloss through the new Flow Diversion Structure is minimized.

Results from this physical model will be used to validate that proposed design of this structure and make improvements where necessary.

During the field stress testing, turbulent wave conditions were observed in the existing Flow Control Structure at the downstream end of the 102-inch main. These conditions made it difficult to fully calibrate the computer hydraulic model for this unit. Therefore, the hydraulics lab will also be developing a physical model for this structure. Results from this model will be used to gain a better understanding of the flow characteristics for this structure, and will give a better assessment if its hydraulic capacity for combined plant and RAS flows.

8.2 Hydraulic Limitations Operating in ABF Mode (During Construction)

During Activated Biofilter (ABF) Mode(current normal mode of operation), RAS flow is sent southward to the Biofilter Pump Station. During alternate operation, the RAS flow joins the forward plant flow in the 102-inch main downstream of the IPS, upstream of the Flow Control Structure. Due to additional headlosses that are incurred by the combined flow through the effluent box during ABF mode, the IPS Flow Diversion Structure, and the downstream extent of the 102-inch main, RAS flows will need to be limited during peak flows conditions through the plant.

Based on available data input from plant staff, the existing screw pumps at the IPS are expected to have a maximum capacity of 170 mgd, equal to the design peak hour flow for the proposed improvements. Therefore, the amount of combined plant and RAS flow that can be conveyed through the IPS during ABF mode will be limited to this amount. The IPS's conveyance of the ADF of 90 mgd, plus the additional design RAS flow of 60 mgd would have no anticipated hydraulic issues in ABF Mode. However, at the MDF of 156 mgd, the additional RAS flow that could be conveyed would be limited to approximately 14 mgd in ABF Mode. At the PHF of 170 mgd, additional RAS flows would not be possible in ABF Mode. See **Table 8-1** below for a summary plant and RAS flows during ABF Mode.

Table 8-1 Summary of Allowable Plant and RAS Flows during ABF Mode (RAS Flowing to Biotowers)

Plant Flow	PHF (170 mgd)	MDF (156 mgd)	ADF (90 mgd)
RAS Flow	0 mgd	14 mgd	60 mgd (maximum design flow)

8.3 Hydraulic Limitations Operating with Three Primary Clarifiers

On certain occasions, Primary Clarifier 4 (PC 4) will be taken off-line to serve as a primary sludge thickener. During this condition, hydraulic loading to Primary Clarifiers 1 through 3 (PCs 1 through 3) will be increased to compensate for the reduced combined capacity of the three PCs. There are hydraulic limitations associated with this mode of operation, and the adjustable weirs in the Primary Clarifier Splitter Box will need to be manipulated to accommodate higher flows while also maintaining free discharge to the three in-service clarifiers.

Based on the hydraulic model for the WWTF, the maximum allowable plant flow that can be conveyed through the three in-service clarifiers when PC 4 is taken out-of-service is approximately 145 mgd. At this flow, the PC Splitter Box weirs for PCs 1 through 3 will need to be raised to an elevation of approximately 227.50 ft to maintain around 3 inches of free discharge below the splitter weirs to each clarifier train. This free discharge is necessary to ensure an even flow split between the three in-service clarifiers. Limiting the maximum flow to 145 mgd when PC 4 is out-of-service will ensure adequate hydraulic freeboard in the upstream structures when the splitter weirs are raised. If flows are above 145 mgd taking PC 4 out-of-service is not recommended because it would risk submerging the PC splitter weirs and/or compromising adequate freeboard in the upstream structures.

Below, **Table 8-2** summarizes operating conditions and resulting upstream hydraulic impacts to the most sensitive upstream structures for various flows when PC 4 is taken out-of-service.

Table 8-2 Summary of Operating Conditions and Hydraulic Impacts When PC 4 is Out-of-Service

Plant Flow	145 mgd (max)	140 mgd	120 mgd	90 mgd	60 mgd
Minimum PC 1-3 Splitter Weir Elevation	227.50 ft	227.35 ft	226.85 ft	226.20 ft	225.96 ft (lowest possible setting)
Minimum Free Discharge below PC Splitter Weirs	0.26 ft (~3 in)	0.25 ft (~3in)	0.27 ft (~3in)	0.27 ft (~3in)	0.52 ft (~6 in)
Freeboard to TOW in PC Splitter Structure	1.00 ft	1.19 ft	1.87 ft	2.80 ft	3.36 ft
Freeboard to TOW in Fine Screen Influent Chamber	0.91 ft	1.21 ft	2.25 ft	3.65 ft	4.54 ft

8.4 Evaluation of Hydraulic Capacity of 42-inch WAS Forcemain

The existing 42-inch HDPE WAS forcemain extends northward from the north side of the Dewatering Building for approximately 350 feet where it reaches its highest point with an invert elevation of approximately 223.90 feet. At this point, the main turns eastward and maintains the same elevation for approximately 1,000 feet, before reaching a steeply sloped portion of pipe that drops the main's invert elevation to approximately 202.70 feet. In total, the 42-inch main consists of approximately 7,000 feet from its highest point at the air release valve to its lowest invert elevation of 201.00 feet, before briefly sloping upward and ending on the north side of Lagoon 2A at an invert elevation of approximately 205.00 feet. During normal operation, WAS flow from the 42-inch main then tees into a dedicated 18-inch line, where flows for approximately 110 feet before discharging into Lagoon 2A.

In the proposed design, the existing WAS force main will carry both WAS and an additional scum flow from the new final clarifiers to Lagoon 2A. The proposed RAS and scum pumps have been sized to provide pressurized flow through the first northward leg of the 42-inch HDPE force main, at least as far as the air release valve at the highest point of that pipe, located in the vicinity of where the main first turns eastward. From that point forward, the combined WAS and scum will flow by gravity through the remaining piping until it discharges to Lagoon 2A.

In order to assess the gravity flow capacity of the existing WAS force main, and to confirm that it is adequate for the anticipated WAS/Scum design flows, the existing 42-inch main and 18-inch discharge pipe were modeled in Visual Hydraulics (version 4.2). The model including piping between the high point of the 42-inch main at the air release valve, to the discharge point in Lagoon 2A. For the proposed design, total WAS flows are anticipated to be ≤10 mgd and the added scum flows are expected to be less than 1 mgd. Therefore, the gravity portion of the existing WAS force main was modeled assuming a total worst-case combined flow of 11 mgd for WAS and scum.

As shown in the Record Drawings, the water surface level in Lagoon 2A is expected to range between 215 feet and 217 feet. Assuming a worst-case hydraulic condition, the downstream hydraulic control point for the gravity model was first set to the higher level of 217 feet. In the model, all hydraulic friction and minor losses in the WAS/scum line were added one-by-one, back to the high point of the line at the air release valve.

Based on the model results, the worst-case WAS/scum flow of 11 mgd is expected to flow by gravity from the high point in the 42-inch HDPE main to the 18-inch discharge into Lagoon 2A. When the water level in Lagoon 2A is at its highest level of 217 feet, the WAS/scum flow is expected to transition from partially full condition to a fully submerged condition, somewhere near the upstream end of the first steeply sloped segment of the 42-inch line, where it flows from the pipe's high point invert elevation of 223.90 feet, down to an invert elevation of 202.70 feet. This transition point is expected at least 1,000 feet downstream of the air release valve at the pipe's highest point.

When the water level in Lagoon 2A is at its lowest level of 215 feet, the worst-case WAS/scum flow of 11 mgd is expected to transition from a partially full to a fully submerged condition at a point further downstream in that first steeply sloped segment.

Based on the hydraulic analysis, the existing WAS force main is expected to have enough capacity to convey the anticipated worst-case WAS and scum flows by gravity from the high point of the line to the point of discharge in Lagoon 2A.

8.5 Proposed Hydraulic Profile

Results for the gravity hydraulics analysis, including design flows for all improvements included in Package 1 and 2A, are summarized in the proposed Hydraulic Profile. Refer to **Drawings GP-M-5** and **GP-M-6** in **Appendix A**.

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Section 9

Package 2A – Schedule

A detailed project schedule has been included for Package 2A work which includes the demolition of the coarse-bubble diffused aeration system in the Aeration Basins and conversion to fine-bubble diffused aeration; demolition of existing Final Clarifiers 5-N and 5-S and construction of new Final Clarifiers 5-N and 5-S with dedicated scum pumping for each new clarifier; a dedicated RAS pump station for Final Clarifiers 5-N and 5-S; odor control systems for the influent junction box, coarse screens, grit removal system, fine screens, primary clarifiers and the IPS; and hydraulic improvements to the discharge box of the IPS as described in this PER.

The schedule shows 60-percent design completed by June 14, 2017, 90-percent design completed by August 10 2017, and the GMP submitted at this time. From the work included in this package, we estimate a total of 13 bid packages, including equipment and subcontractors. Bid packages included are:

- Diffusers Equipment Package
- Clarifier Mechanism Equipment
- Scum Pumps
- RAS Pumps
- Odor Control Equipment
- Odor Control Ductwork
- FRP Covers (Odor Control)
- Concrete Subcontractor
- Electrical Subcontractor
- Mechanical Subcontractor
- Sitework Subcontractor
- Yard Piping Subcontractor
- Miscellaneous Metal Subcontractor

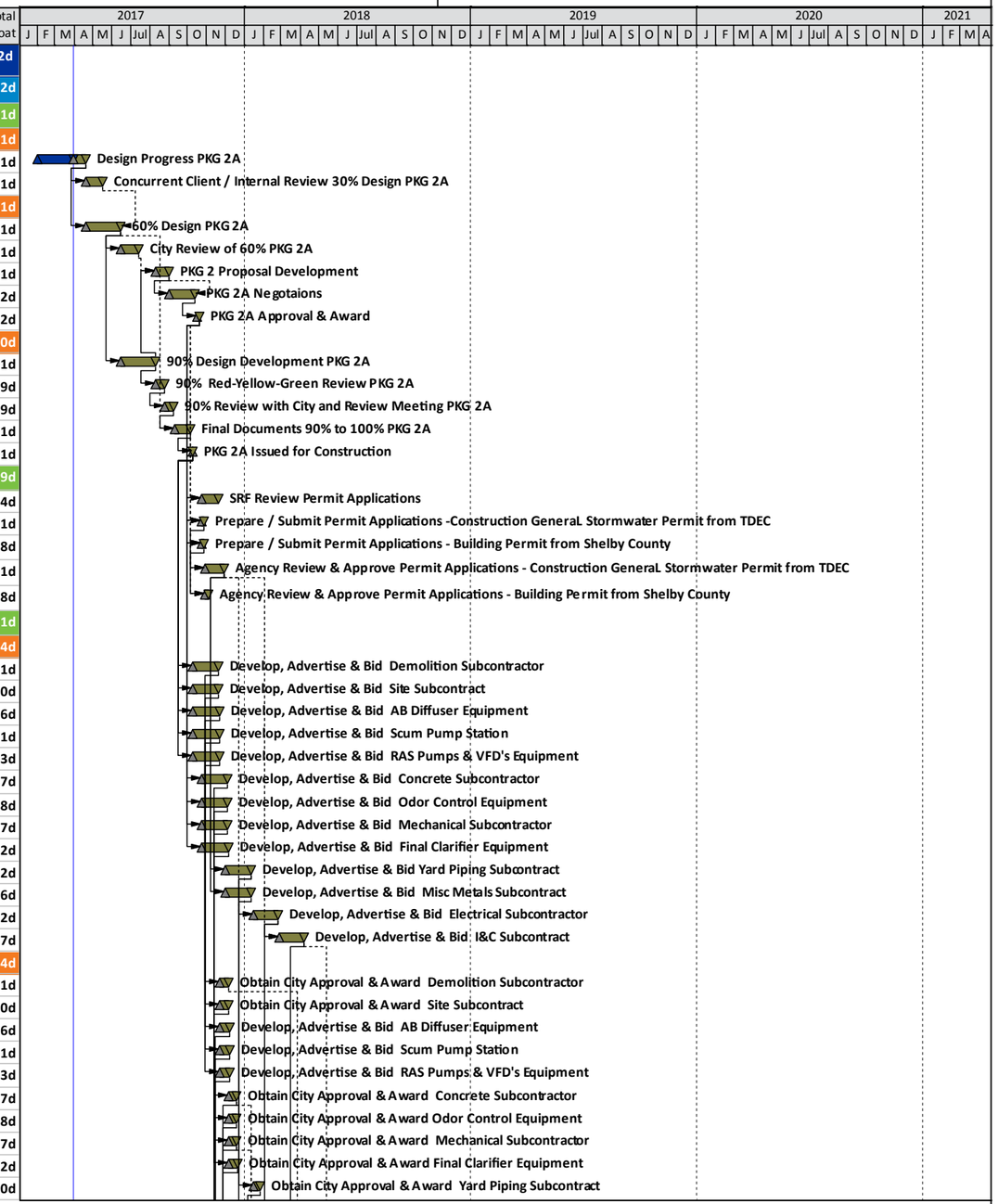
Procurement for the bid packages listed above will be done in accordance to the City's and SRF's procurement requirements.

The schedule shows construction activities starting in October 2017 (with procurement), and ending in August 2020. Critical path on this schedule runs through the clarifier work as this work can not start until the PAA tank is complete and online.

CITY of MEMPHIS
T.E. Maxson Wastewater Treatment Facility
PROCESS UPGRADES

DATE:20-Apr-17 TIME: 10:42

Activity ID	Disp	Activity Name	Dur	Start	Finish	Total Float
T.E. Maxson WWTF Process Upgrades (Pkg 2A)			895d	01-Feb-17 A	26-Aug-20	192d
PKG 2A FINAL CLARIFIERS, FINE BUBBLE DIFFUSER, ODOR CONTROL & INTERMEDIATE PUMP STATION IMPROVEMENTS			895d	01-Feb-17 A	26-Aug-20	192d
DESIGN-2A			183d	01-Feb-17 A	20-Oct-17	41d
PKG 2A Design Progression (30%)			75d	01-Feb-17 A	16-May-17	61d
DN2_A2350	Pkg2	Design Progress PKG 2A	56d	01-Feb-17 A	19-Apr-17	41d
DN2_A2330	Pkg2	Concurrent Client / Internal Review 30% Design PKG 2A	20d	19-Apr-17	16-May-17	61d
PKG 2A Development and Negotiation (60%)			129d	19-Apr-17	20-Oct-17	41d
DN2_A2300	Pkg2	60% Design PKG 2A	40d	19-Apr-17	14-Jun-17	41d
DN2_A5640	Pkg2	City Review of 60% PKG 2A	20d	15-Jun-17	13-Jul-17	61d
DN2_A2400	Pkg2	PKG 2 Proposal Development	15d	11-Aug-17	31-Aug-17	41d
DN2_A2370	Pkg2	PKG 2A Negotaions	30d	01-Sep-17	13-Oct-17	42d
DN2_A2360	Pkg2	PKG 2A Approval & Award	5d	16-Oct-17	20-Oct-17	42d
PKG 2A Finalize Design			80d	15-Jun-17	09-Oct-17	50d
DN2_A2420	Pkg2	90% Design Development PKG 2A	40d	15-Jun-17	10-Aug-17	41d
DN2_A2430	Pkg2	90% Red-Yellow-Green Review PKG 2A	10d	11-Aug-17	24-Aug-17	49d
DN2_A2440	Pkg2	90% Review with City and Review Meeting PKG 2A	10d	25-Aug-17	08-Sep-17	49d
DN2_A2320	Pkg2	Final Documents 90% to 100% PKG 2A	20d	11-Sep-17	06-Oct-17	51d
DN2_A2310	Pkg2	PKG 2A Issued for Construction	1d	09-Oct-17	09-Oct-17	51d
PERMITTING			25d	23-Oct-17	29-Nov-17	879d
DN2_A6270	Pkg2	SRF Review Permit Applications	20d	23-Oct-17	20-Nov-17	884d
DN2_A1790	Pkg2	Prepare / Submit Permit Applications -Construction GeneraL Stormwater Permit from TDEC	5d	23-Oct-17	27-Oct-17	41d
DN2_A1780	Pkg2	Prepare / Submit Permit Applications - Building Permit from Shelby County	5d	23-Oct-17	27-Oct-17	238d
DN2_A1810	Pkg2	Agency Review & Approve Permit Applications - Construction GeneraL Stormwater Permit from TDEC	20d	30-Oct-17	29-Nov-17	41d
DN2_A1800	Pkg2	Agency Review & Approve Permit Applications - Building Permit from Shelby County	5d	30-Oct-17	03-Nov-17	238d
PROCUREMENT			222d	10-Oct-17	28-Aug-18	691d
PKG 2A Develop, Advertise & Bid			122d	10-Oct-17	06-Apr-18	554d
DN2_A4230	Pkg2	Develop, Advertise & Bid Demolition Subcontractor	30d	10-Oct-17	20-Nov-17	301d
DN2_A4350	Pkg2	Develop, Advertise & Bid Site Subcontract	30d	10-Oct-17	20-Nov-17	200d
DN2_A6425	Pkg2	Develop, Advertise & Bid AB Diffuser Equipment	30d	10-Oct-17	21-Nov-17	206d
DN2_A6455	Pkg2	Develop, Advertise & Bid Scum Pump Station	30d	10-Oct-17	21-Nov-17	461d
DN2_A6463	Pkg2	Develop, Advertise & Bid RAS Pumps & VFD's Equipment	30d	10-Oct-17	21-Nov-17	403d
DN2_A4220	Pkg2	Develop, Advertise & Bid Concrete Subcontractor	30d	23-Oct-17	05-Dec-17	477d
DN2_A4250	Pkg2	Develop, Advertise & Bid Odor Control Equipment	30d	23-Oct-17	05-Dec-17	98d
DN2_A4440	Pkg2	Develop, Advertise & Bid Mechanical Subcontractor	30d	23-Oct-17	05-Dec-17	187d
DN2_A6370	Pkg2	Develop, Advertise & Bid Final Clarifier Equipment	30d	23-Oct-17	06-Dec-17	402d
DN2_A4390	Pkg2	Develop, Advertise & Bid Yard Piping Subcontract	30d	30-Nov-17	12-Jan-18	42d
DN2_A4420	Pkg2	Develop, Advertise & Bid Misc Metals Subcontract	30d	30-Nov-17	12-Jan-18	616d
DN2_A4210	Pkg2	Develop, Advertise & Bid Electrical Subcontractor	30d	15-Jan-18	23-Feb-18	42d
DN2_A4410	Pkg2	Develop, Advertise & Bid I&C Subcontract	30d	26-Feb-18	06-Apr-18	227d
PKG 2A Obtain City Approval & Award			103d	21-Nov-17	20-Apr-18	554d
DN2_A4290	Pkg2	Obtain City Approval & Award Demolition Subcontractor	10d	21-Nov-17	06-Dec-17	301d
DN2_A4360	Pkg2	Obtain City Approval & Award Site Subcontract	10d	21-Nov-17	06-Dec-17	200d
DN2_A6435	Pkg2	Develop, Advertise & Bid AB Diffuser Equipment	10d	22-Nov-17	07-Dec-17	206d
DN2_A6465	Pkg2	Develop, Advertise & Bid Scum Pump Station	10d	22-Nov-17	07-Dec-17	461d
DN_2A6466	Pkg2	Develop, Advertise & Bid RAS Pumps & VFD's Equipment	10d	22-Nov-17	07-Dec-17	403d
DN2_A4280	Pkg2	Obtain City Approval & Award Concrete Subcontractor	10d	06-Dec-17	19-Dec-17	477d
DN2_A4320	Pkg2	Obtain City Approval & Award Odor Control Equipment	10d	06-Dec-17	19-Dec-17	98d
DN2_A4450	Pkg2	Obtain City Approval & Award Mechanical Subcontractor	10d	06-Dec-17	19-Dec-17	187d
DN2_A6380	Pkg2	Obtain City Approval & Award Final Clarifier Equipment	10d	07-Dec-17	20-Dec-17	402d
DN2_A4400	Pkg2	Obtain City Approval & Award Yard Piping Subcontract	10d	15-Jan-18	26-Jan-18	60d



Run Date: 20-Apr-17
Date Date: 31-Mar-17
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Remaining Level of Effort
Milestone
Actual Work
Remaining Work
Critical Remaining Work

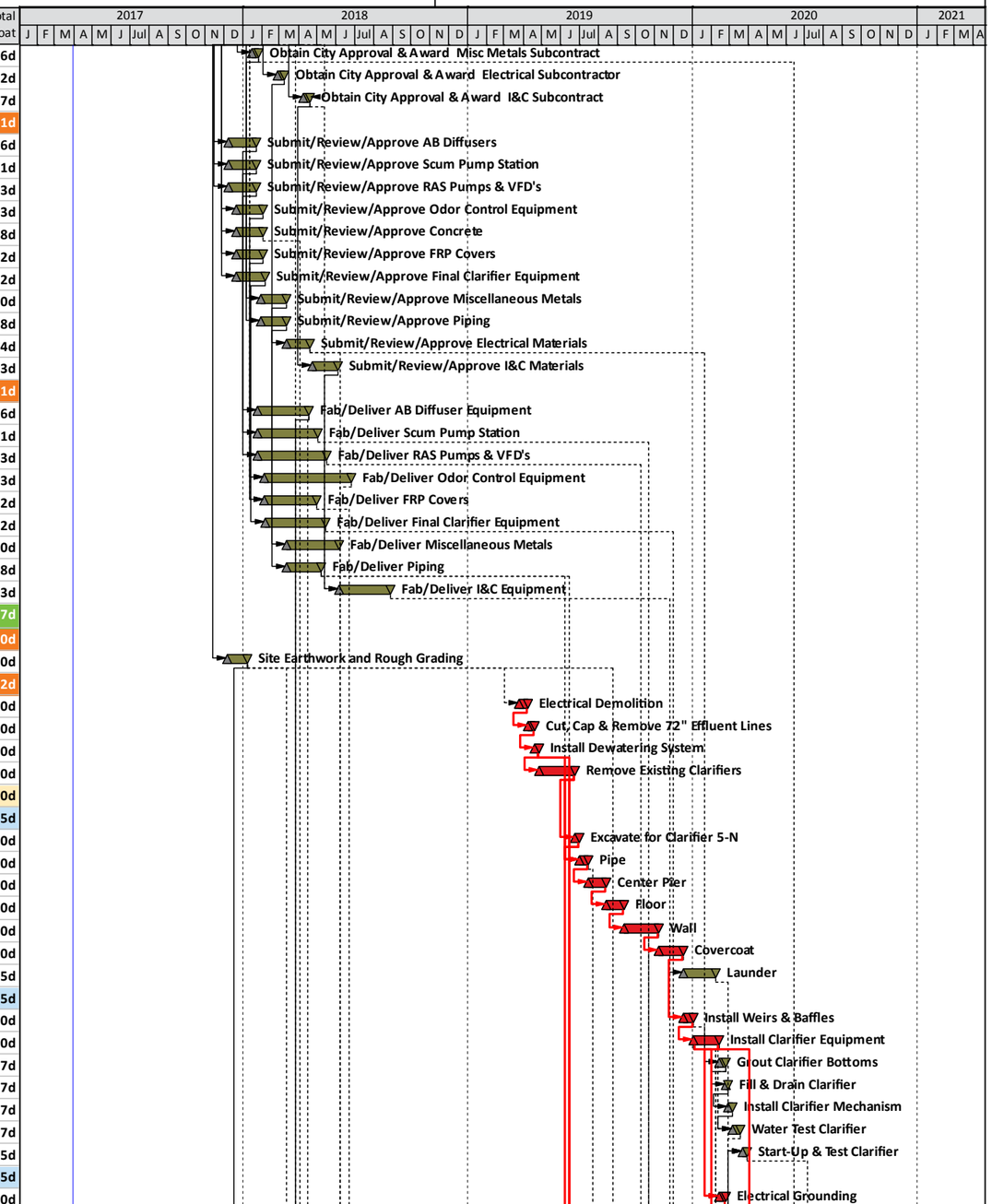
Package 2A PER Schedule
Figure 9-1

Date	Revision	Checked	Approved
18-Nov-16	Updated Data Date to 18Nov16, some CN activity ad...	NMjr	YH
13-Jan-17	Updated Data Date to 13Jan17, some revised pProc ...	NMjr	RJG
03-Apr-17	Updated Data Date to 31mar17 - design status	NMjr	YH
17-Apr-17	Update Package#2 PER Schedule	NMjr	YH

CITY of MEMPHIS
T.E. Maxson Wastewater Treatment Facility
PROCESS UPGRADES

DATE:20-Apr-17 TIME: 10:42

Activity ID	Disp	Activity Name	Dur	Start	Finish	Total Float
DN2_A4430	Pkg2	Obtain City Approval & Award Misc Metals Subcontract	10d	15-Jan-18	26-Jan-18	616d
DN2_A4270	Pkg2	Obtain City Approval & Award Electrical Subcontractor	10d	26-Feb-18	09-Mar-18	42d
DN2_A4340	Pkg2	Obtain City Approval & Award I&C Subcontract	10d	09-Apr-18	20-Apr-18	227d
Submittals			122d	08-Dec-17	04-Jun-18	691d
DN2_A6415	Pkg2	Submit/Review/Approve AB Diffusers	30d	08-Dec-17	23-Jan-18	206d
DN2_A6345	Pkg2	Submit/Review/Approve Scum Pump Station	30d	08-Dec-17	23-Jan-18	461d
DN2_A6467	Pkg2	Submit/Review/Approve RAS Pumps & VFD's	30d	08-Dec-17	23-Jan-18	403d
DN2_MX830	Pkg2	Submit/Review/Approve Odor Control Equipment	30d	20-Dec-17	02-Feb-18	443d
DN2_A6420	Pkg2	Submit/Review/Approve Concrete	30d	20-Dec-17	02-Feb-18	498d
DN2_A6470	Pkg2	Submit/Review/Approve FRP Covers	30d	20-Dec-17	02-Feb-18	492d
DN2_A6360	Pkg2	Submit/Review/Approve Final Clarifier Equipment	30d	21-Dec-17	05-Feb-18	402d
DN2_A6430	Pkg2	Submit/Review/Approve Miscellaneous Metals	30d	29-Jan-18	12-Mar-18	750d
DN2_A6480	Pkg2	Submit/Review/Approve Piping	30d	29-Jan-18	12-Mar-18	288d
DN2_A6350	Pkg2	Submit/Review/Approve Electrical Materials	30d	12-Mar-18	20-Apr-18	454d
DN2_A6410	Pkg2	Submit/Review/Approve I&C Materials	30d	23-Apr-18	04-Jun-18	373d
Fabrication & Delivery			152d	24-Jan-18	28-Aug-18	691d
DN2_A6495	Pkg2	Fab/Deliver AB Diffuser Equipment	60d	24-Jan-18	18-Apr-18	206d
DN2_A6497	Pkg2	Fab/Deliver Scum Pump Station	70d	24-Jan-18	02-May-18	461d
DN2_A6469	Pkg2	Fab/Deliver RAS Pumps & VFD's	80d	24-Jan-18	16-May-18	403d
DN2_A5470	Pkg2	Fab/Deliver Odor Control Equipment	100d	05-Feb-18	26-Jun-18	443d
DN2_A6460	Pkg2	Fab/Deliver FRP Covers	60d	05-Feb-18	30-Apr-18	492d
DN2_A6390	Pkg2	Fab/Deliver Final Clarifier Equipment	70d	06-Feb-18	15-May-18	402d
DN2_A6440	Pkg2	Fab/Deliver Miscellaneous Metals	60d	13-Mar-18	05-Jun-18	750d
DN2_A6490	Pkg2	Fab/Deliver Piping	40d	13-Mar-18	07-May-18	288d
DN2_A6400	Pkg2	Fab/Deliver I&C Equipment	60d	05-Jun-18	28-Aug-18	373d
CONSTRUCTION			647d	07-Dec-17	08-Jul-20	227d
00 SITE WORK			21d	07-Dec-17	08-Jan-18	200d
CN2_MX1230	Pkg2	Site Earthwork and Rough Grading	21d	07-Dec-17	08-Jan-18	200d
Clarifier 5-S and Clarifier 5-N Demoliton and Construction			581d	09-Jan-18	04-May-20	272d
CN2_MX2630	Pkg2	Electrical Demolition	11d	25-Mar-19	09-Apr-19	0d
CN2_MX2620	Pkg2	Cut, Cap & Remove 72" Effluent Lines	8d	09-Apr-19	19-Apr-19	0d
CN2_MX2670	Pkg2	Install Dewatering System	5d	19-Apr-19	26-Apr-19	0d
CN2_MX2550	Pkg2	Remove Existing Clarifiers	40d	26-Apr-19	24-Jun-19	0d
Clarifier 5-N Construction			195d	24-Jun-19	06-Apr-20	80d
Structural Work			155d	24-Jun-19	07-Feb-20	115d
CN2_MX2718	Pkg2	Excavate for Clarifier 5-N	5d	24-Jun-19	01-Jul-19	0d
CN2_MX2720	Pkg2	Pipe	10d	01-Jul-19	16-Jul-19	0d
CN2_MX2810	Pkg2	Center Pier	20d	16-Jul-19	13-Aug-19	0d
CN2_MX2910	Pkg2	Floor	20d	13-Aug-19	11-Sep-19	0d
CN2_MX2940	Pkg2	Wall	40d	11-Sep-19	07-Nov-19	0d
CN2_MX3060	Pkg2	Covercoat	25d	07-Nov-19	17-Dec-19	0d
CN2_MX3130	Pkg2	Launder	35d	17-Dec-19	07-Feb-20	115d
Mechanical Work			70d	17-Dec-19	30-Mar-20	85d
CN2_MX3290	Pkg2	Install Weirs & Baffles	10d	17-Dec-19	02-Jan-20	0d
CN2_MX3460	Pkg2	Install Clarifier Equipment	30d	02-Jan-20	14-Feb-20	0d
CN2_MX3850	Pkg2	Grout Clarifier Bottoms	5d	14-Feb-20	24-Feb-20	87d
CN2_MX3900	Pkg2	Fill & Drain Clarifier	3d	24-Feb-20	27-Feb-20	87d
CN2_MX3960	Pkg2	Install Clarifier Mechanism	5d	27-Feb-20	05-Mar-20	87d
CN2_MX4030	Pkg2	Water Test Clarifier	10d	05-Mar-20	19-Mar-20	87d
CN2_MX4060	Pkg2	Start-Up & Test Clarifier	5d	23-Mar-20	30-Mar-20	85d
Electrical Work			35d	14-Feb-20	06-Apr-20	75d
CN2_MX3722	Pkg2	Electrical Grounding	5d	14-Feb-20	24-Feb-20	0d



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Package 2A PER
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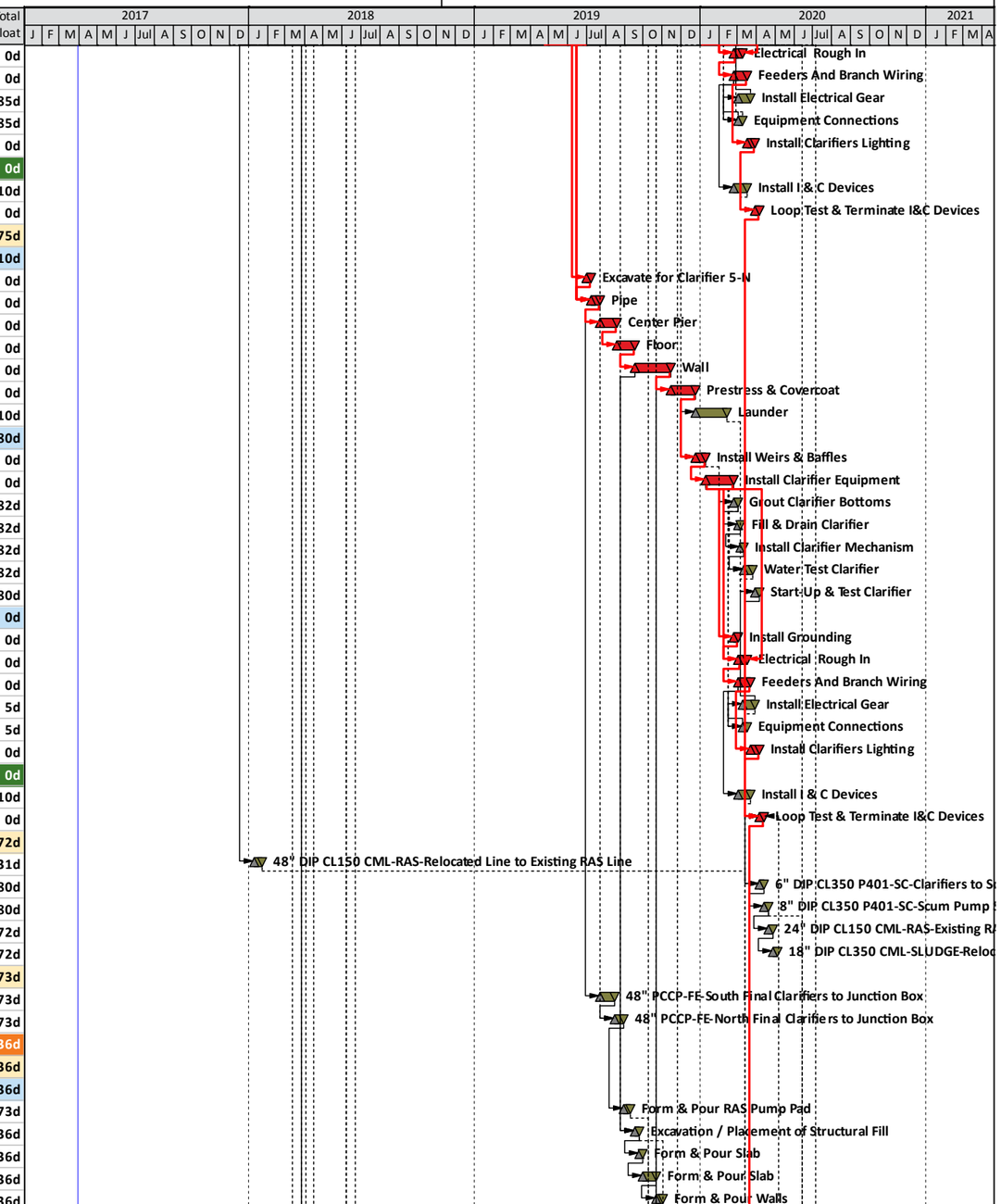
Figure 9-1

Date	Revision	Checked	Approved
18-Nov-16	Updated Data Date to 18Nov16, some CN activity ad...	NMjr	YH
13-Jan-17	Updated Data Date to 13Jan17, some revised pProc ...	NMjr	RJG
03-Apr-17	Updated Data Date to 31mar17 - design status	NMjr	YH
17-Apr-17	Update Package#2 PER Schedule	NMjr	YH

CITY of MEMPHIS
T.E. Maxson Wastewater Treatment Facility
PROCESS UPGRADES

DATE:20-Apr-17 TIME: 10:43

Activity ID	Disp	Activity Name	Dur	Start	Finish	Total Float
CN2_MX3730	Pkg2	Electrical Rough In	10d	24-Feb-20	09-Mar-20	0d
CN2_MX3720	Pkg2	Feeders And Branch Wiring	15d	24-Feb-20	16-Mar-20	0d
CN2_MX3860	Pkg2	Install Electrical Gear	15d	02-Mar-20	23-Mar-20	85d
CN2_MX3840	Pkg2	Equipment Connections	5d	02-Mar-20	09-Mar-20	85d
CN2_MX3845	Pkg2	Install Clarifiers Lighting	10d	16-Mar-20	30-Mar-20	0d
Instrumentation			30d	24-Feb-20	06-Apr-20	0d
CN2_MX3740	Pkg2	Install I & C Devices	15d	24-Feb-20	16-Mar-20	10d
CN2_MX3950	Pkg2	Loop Test & Terminate I&C Devices	5d	30-Mar-20	06-Apr-20	0d
Clarifier 5-S Construction			195d	01-Jul-19	13-Apr-20	75d
Structural Work			155d	01-Jul-19	14-Feb-20	110d
A6460	Pkg2	Excavate for Clarifier 5-N	5d	01-Jul-19	09-Jul-19	0d
CN2_MX2710	Pkg2	Pipe	10d	09-Jul-19	23-Jul-19	0d
CN2_MX2800	Pkg2	Center Pier	20d	23-Jul-19	20-Aug-19	0d
CN2_MX2900	Pkg2	Floor	20d	20-Aug-19	18-Sep-19	0d
CN2_MX2930	Pkg2	Wall	40d	18-Sep-19	15-Nov-19	0d
CN2_MX3050	Pkg2	Prestress & Covercoat	25d	15-Nov-19	24-Dec-19	0d
CN2_MX3120	Pkg2	Launder	35d	24-Dec-19	14-Feb-20	110d
Mechanical Work			70d	24-Dec-19	06-Apr-20	80d
CN2_MX3280	Pkg2	Install Weirs & Baffles	10d	24-Dec-19	09-Jan-20	0d
CN2_MX3440	Pkg2	Install Clarifier Equipment	30d	09-Jan-20	24-Feb-20	0d
CN2_MX3820	Pkg2	Grout Clarifier Bottoms	5d	24-Feb-20	02-Mar-20	82d
CN2_MX3890	Pkg2	Fill & Drain Clarifier	3d	02-Mar-20	05-Mar-20	82d
CN2_MX3940	Pkg2	Install Clarifier Mechanism	5d	05-Mar-20	12-Mar-20	82d
CN2_MX4020	Pkg2	Water Test Clarifier	10d	12-Mar-20	26-Mar-20	82d
CN2_MX4050	Pkg2	Start-Up & Test Clarifier	5d	30-Mar-20	06-Apr-20	80d
Electrical Work			35d	24-Feb-20	13-Apr-20	0d
CN2_MX3695	Pkg2	Install Grounding	5d	24-Feb-20	02-Mar-20	0d
CN2_MX3700	Pkg2	Electrical Rough In	10d	02-Mar-20	16-Mar-20	0d
CN2_MX3690	Pkg2	Feeders And Branch Wiring	15d	02-Mar-20	23-Mar-20	0d
CN2_MX3830	Pkg2	Install Electrical Gear	15d	09-Mar-20	30-Mar-20	5d
CN2_MX3810	Pkg2	Equipment Connections	5d	09-Mar-20	16-Mar-20	5d
CN2_MX3812	Pkg2	Install Clarifiers Lighting	10d	23-Mar-20	06-Apr-20	0d
Instrumentation			30d	02-Mar-20	13-Apr-20	0d
CN2_MX3710	Pkg2	Install I & C Devices	15d	02-Mar-20	23-Mar-20	10d
CN2_MX3930	Pkg2	Loop Test & Terminate I&C Devices	5d	06-Apr-20	13-Apr-20	0d
Ductile Iron Pipe (DIP)			581d	09-Jan-18	04-May-20	272d
CN2_MX1080	Pkg3	48" DIP CL150 CML-RAS-Relocated Line to Existing RAS Line	10d	09-Jan-18	23-Jan-18	631d
CN2_MX1160	Pkg3	6" DIP CL350 P401-SC-Clarifiers to Scum Pump Station	5d	06-Apr-20	13-Apr-20	80d
CN2_MX1200	Pkg3	8" DIP CL350 P401-SC-Scum Pump Station to Existing Headworks	5d	13-Apr-20	20-Apr-20	80d
CN2_MX1070	Pkg3	24" DIP CL150 CML-RAS-Existing RAS to RAS Aeration	5d	20-Apr-20	27-Apr-20	272d
CN2_MX1100	Pkg3	18" DIP CL350 CML-SLUDGE-Relocation @ RAS Aeration	5d	27-Apr-20	04-May-20	272d
Prestressed Concrete Cylinder Pipe			28d	23-Jul-19	30-Aug-19	73d
CN2_MX1620	Pkg3	48" PCCP-FE-South Final Clarifiers to Junction Box	17d	23-Jul-19	15-Aug-19	73d
CN2_MX1800	Pkg3	48" PCCP-FE-North Final Clarifiers to Junction Box	11d	15-Aug-19	30-Aug-19	73d
43 RAS PUMP STATION			116d	30-Aug-19	21-Feb-20	36d
RAS PS			116d	30-Aug-19	21-Feb-20	36d
Structural Work			43d	30-Aug-19	01-Nov-19	36d
MX3430	Pkg3	Form & Pour RAS Pump Pad	6d	30-Aug-19	10-Sep-19	73d
MX3310	Pkg3	Excavation / Placement of Structural Fill	5d	18-Sep-19	25-Sep-19	36d
MX3330	Pkg3	Form & Pour Slab	3d	25-Sep-19	30-Sep-19	36d
MX3390	Pkg3	Form & Pour Slab	15d	30-Sep-19	22-Oct-19	36d
MX3490	Pkg3	Form & Pour Walls	8d	22-Oct-19	01-Nov-19	36d



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Package 2A PER Schedule
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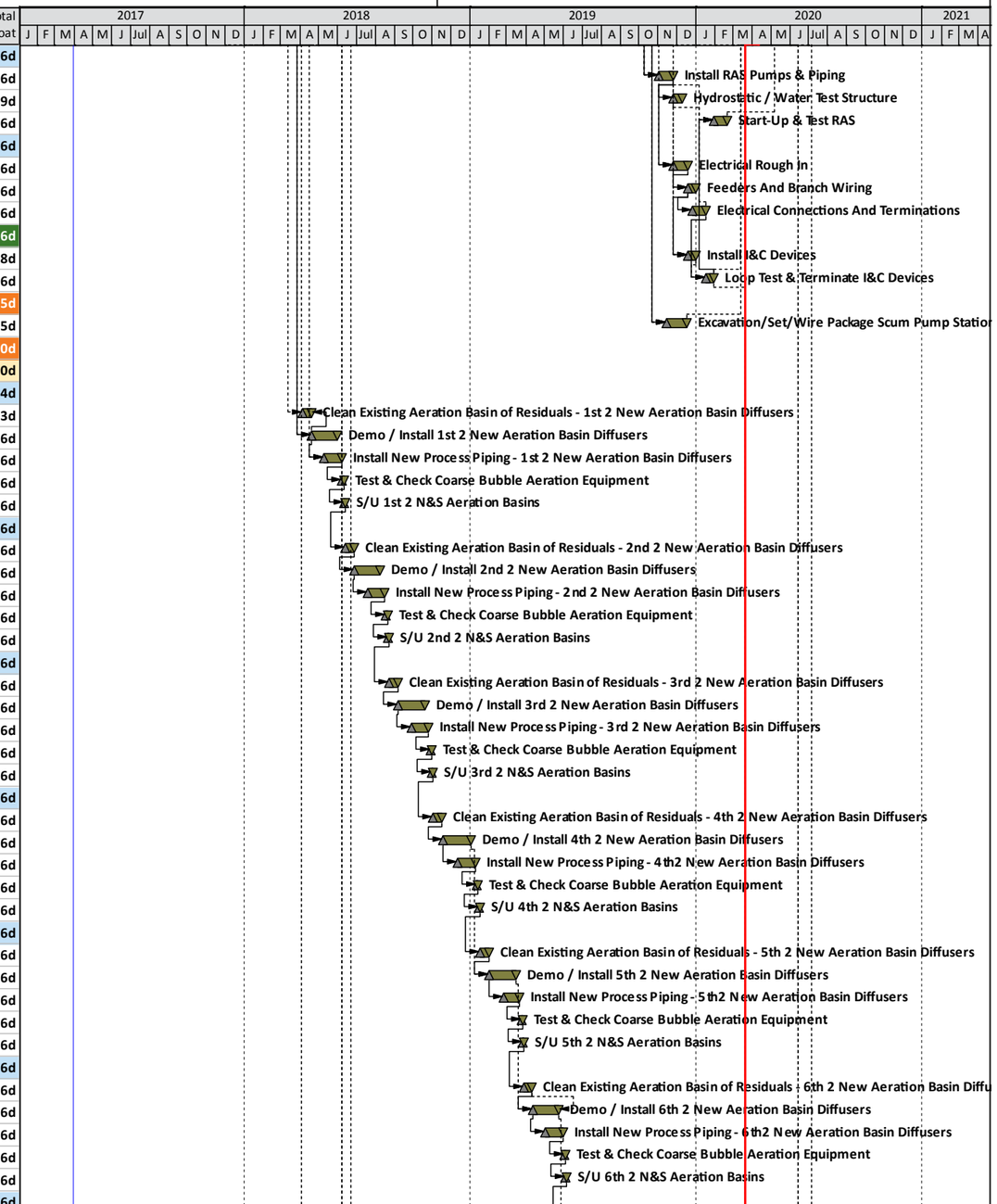
CITY of MEMPHIS
T.E. Maxson Wastewater Treatment Facility
PROCESS UPGRADES

DATE:20-Apr-17 TIME: 10:43

Activity ID	Disp	Activity Name	Dur	Start	Finish	Total Float
Mechanical Work			73d	01-Nov-19	21-Feb-20	36d
MX3530	Pkg3	Install RAS Pumps & Piping	15d	01-Nov-19	25-Nov-19	36d
MX3640	Pkg3	Hydrostatic / Water Test Structure	8d	25-Nov-19	09-Dec-19	79d
MX3920	Pkg3	Start-Up & Test RAS	15d	30-Jan-20	21-Feb-20	36d
Electrical Work			43d	25-Nov-19	30-Jan-20	36d
MX3650	Pkg3	Electrical Rough In	15d	25-Nov-19	18-Dec-19	36d
MX3660	Pkg3	Feeders And Branch Wiring	8d	18-Dec-19	31-Dec-19	36d
MX3770	Pkg3	Electrical Connections And Terminations	15d	26-Dec-19	17-Jan-20	36d
Instrumentation			28d	18-Dec-19	30-Jan-20	36d
MX3670	Pkg3	Install I&C Devices	8d	18-Dec-19	31-Dec-19	48d
MX3780	Pkg3	Loop Test & Terminate I&C Devices	8d	17-Jan-20	30-Jan-20	36d
Scum Pump Staiont			20d	15-Nov-19	17-Dec-19	75d
A6440		Excavation/Set/Wire Package Scum Pump Station	20d	15-Nov-19	17-Dec-19	75d
24 Existing Aeration Basin Upgrades			343d	05-Apr-18	15-Aug-19	450d
Aeration Basin - (14 Aeration Basins)			343d	05-Apr-18	15-Aug-19	450d
1st 2 N&S Aeration Basins			49d	05-Apr-18	13-Jun-18	744d
CN2_A3370	Pkg2	Clean Existing Aeration Basin of Residuals - 1st 2 New Aeration Basin Diffusers	10d	05-Apr-18	19-Apr-18	783d
CN2_MX1650	Pkg2	Demo / Install 1st 2 New Aeration Basin Diffusers	30d	19-Apr-18	31-May-18	206d
CN2_A3380	Pkg2	Install New Process Piping - 1st 2 New Aeration Basin Diffusers	20d	10-May-18	07-Jun-18	206d
CN2_A5410	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	08-Jun-18	11-Jun-18	206d
CN2_A5230	Pkg2	S/U 1st 2 N&S Aeration Basins	2d	12-Jun-18	13-Jun-18	206d
2nd 2 N&S Aeration Basins			49d	14-Jun-18	22-Aug-18	206d
CN2_A3410	Pkg2	Clean Existing Aeration Basin of Residuals - 2nd 2 New Aeration Basin Diffusers	10d	14-Jun-18	27-Jun-18	206d
CN2_MX1651	Pkg2	Demo / Install 2nd 2 New Aeration Basin Diffusers	30d	28-Jun-18	09-Aug-18	206d
A3420	Pkg2	Install New Process Piping - 2nd 2 New Aeration Basin Diffusers	20d	20-Jul-18	16-Aug-18	206d
A5390	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	17-Aug-18	20-Aug-18	206d
A5240	Pkg2	S/U 2nd 2 N&S Aeration Basins	2d	21-Aug-18	22-Aug-18	206d
3rd 2 N&S Aeration Basins			49d	23-Aug-18	01-Nov-18	206d
A3450	Pkg2	Clean Existing Aeration Basin of Residuals - 3rd 2 New Aeration Basin Diffusers	10d	23-Aug-18	06-Sep-18	206d
MX1652	Pkg2	Demo / Install 3rd 2 New Aeration Basin Diffusers	30d	07-Sep-18	19-Oct-18	206d
A3460	Pkg2	Install New Process Piping - 3rd 2 New Aeration Basin Diffusers	20d	28-Sep-18	26-Oct-18	206d
A5370	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	29-Oct-18	30-Oct-18	206d
A5250	Pkg2	S/U 3rd 2 N&S Aeration Basins	2d	31-Oct-18	01-Nov-18	206d
4th 2 N&S Aeration Basins			49d	02-Nov-18	16-Jan-19	206d
A3490	Pkg2	Clean Existing Aeration Basin of Residuals - 4th 2 New Aeration Basin Diffusers	10d	02-Nov-18	16-Nov-18	206d
MX1653	Pkg2	Demo / Install 4th 2 New Aeration Basin Diffusers	30d	19-Nov-18	03-Jan-19	206d
A3500	Pkg2	Install New Process Piping - 4th2 New Aeration Basin Diffusers	20d	12-Dec-18	10-Jan-19	206d
A5350	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	11-Jan-19	14-Jan-19	206d
A5260	Pkg2	S/U 4th 2 N&S Aeration Basins	2d	15-Jan-19	16-Jan-19	206d
5th 2 N&S Aeration Basins			49d	17-Jan-19	28-Mar-19	206d
A3530	Pkg2	Clean Existing Aeration Basin of Residuals - 5th 2 New Aeration Basin Diffusers	10d	17-Jan-19	31-Jan-19	206d
MX1654	Pkg2	Demo / Install 5th 2 New Aeration Basin Diffusers	30d	01-Feb-19	15-Mar-19	206d
A3540	Pkg2	Install New Process Piping - 5th2 New Aeration Basin Diffusers	20d	25-Feb-19	22-Mar-19	206d
A5330	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	25-Mar-19	26-Mar-19	206d
A5270	Pkg2	S/U 5th 2 N&S Aeration Basins	2d	27-Mar-19	28-Mar-19	206d
6th 2 N&S Aeration Basins			49d	29-Mar-19	06-Jun-19	206d
A3570	Pkg2	Clean Existing Aeration Basin of Residuals - 6th 2 New Aeration Basin Diffusers	10d	29-Mar-19	11-Apr-19	206d
MX1655	Pkg2	Demo / Install 6th 2 New Aeration Basin Diffusers	30d	12-Apr-19	23-May-19	206d
A3580	Pkg2	Install New Process Piping - 6th2 New Aeration Basin Diffusers	20d	03-May-19	31-May-19	206d
A5310	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	03-Jun-19	04-Jun-19	206d
A5280	Pkg2	S/U 6th 2 N&S Aeration Basins	2d	05-Jun-19	06-Jun-19	206d
7th 2 N&S Aeration Basins			49d	07-Jun-19	15-Aug-19	206d



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Date	Revision	Checked	Approved
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CITY of MEMPHIS
T.E. Maxson Wastewater Treatment Facility
PROCESS UPGRADES

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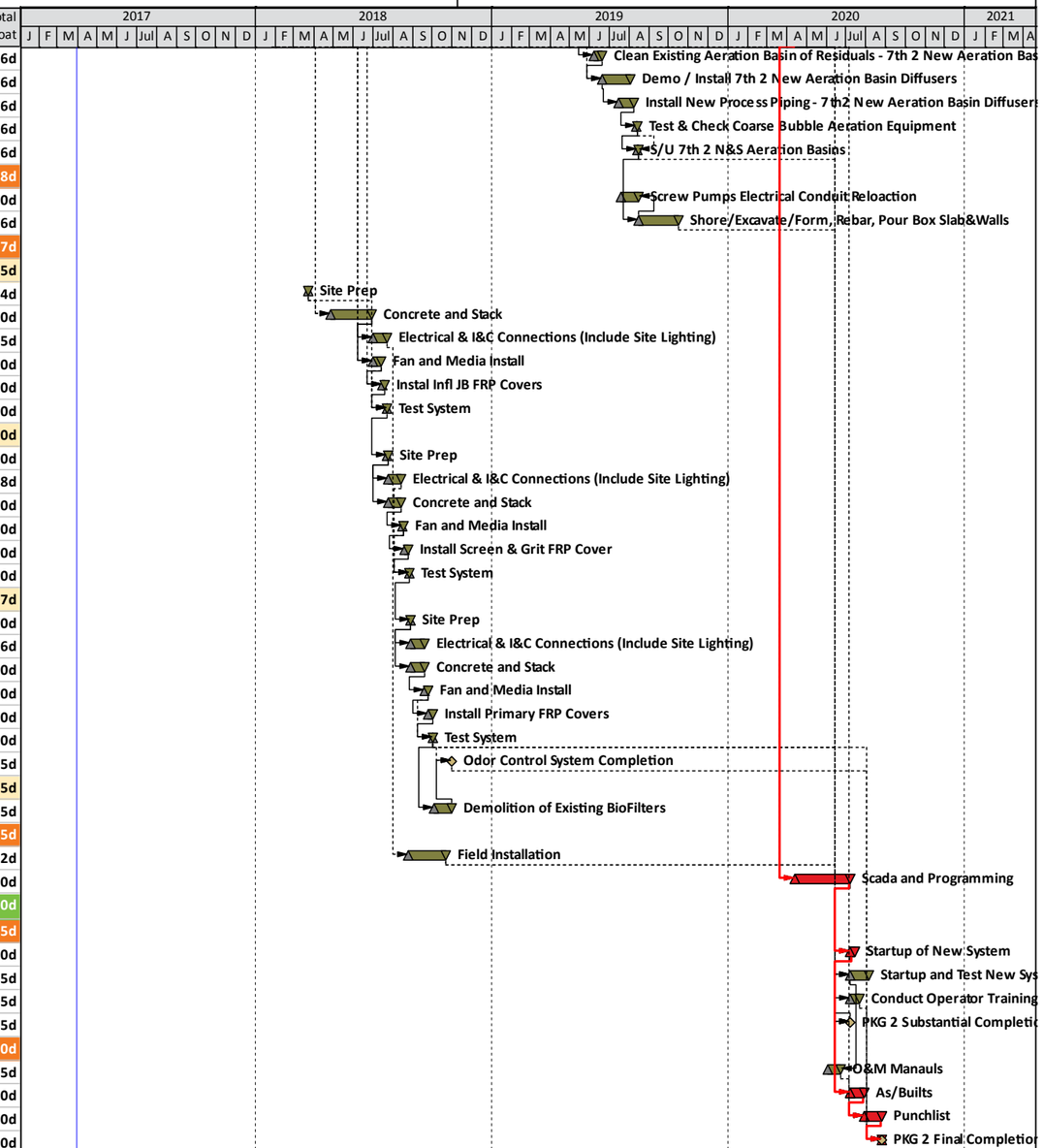
Activity ID	Disp	Activity Name	Dur	Start	Finish	Total Float
A3610	Pkg2	Clean Existing Aeration Basin of Residuals - 7th 2 New Aeration Basin Diffusers	10d	07-Jun-19	20-Jun-19	206d
MX1656	Pkg2	Demo / Install 7th 2 New Aeration Basin Diffusers	30d	21-Jun-19	02-Aug-19	206d
A3620	Pkg2	Install New Process Piping - 7th2 New Aeration Basin Diffusers	20d	15-Jul-19	09-Aug-19	206d
MX2740	Pkg2	Test & Check Coarse Bubble Aeration Equipment	2d	12-Aug-19	13-Aug-19	206d
A5290	Pkg2	S/U 7th 2 N&S Aeration Basins	2d	14-Aug-19	15-Aug-19	206d
Intermediate PS Flow Diversion			62d	19-Jul-19	16-Oct-19	408d
A6360	Pkg2	Screw Pumps Electrical Conduit Reloaction	20d	19-Jul-19	16-Aug-19	450d
A6350	Pkg2	Shore/Excavate/Form, Rebar, Pour Box Slab&Walls	42d	16-Aug-19	16-Oct-19	206d
Odor Control System - Throughout			155d	23-Mar-18	31-Oct-18	647d
OC:1 Influent Junction Box			85d	23-Mar-18	23-Jul-18	475d
MX1750	Pkg2	Site Prep	1d	23-Mar-18	23-Mar-18	464d
MX1770	Pkg2	Concrete and Stack	45d	27-Apr-18	29-Jun-18	440d
MX2180	Pkg2	Electrical & I&C Connections (Include Site Lighting)	15d	02-Jul-18	23-Jul-18	475d
MX2100	Pkg2	Fan and Media Install	9d	02-Jul-18	13-Jul-18	440d
A6370	Pkg2	Instal Infl JB FRP Covers	5d	16-Jul-18	20-Jul-18	440d
MX2220	Pkg2	Test System	1d	23-Jul-18	23-Jul-18	440d
OC:2 Screening and Grit			25d	24-Jul-18	27-Aug-18	440d
MX2240	Pkg2	Site Prep	1d	24-Jul-18	24-Jul-18	440d
MX2340	Pkg2	Electrical & I&C Connections (Include Site Lighting)	15d	25-Jul-18	14-Aug-18	448d
MX2250	Pkg2	Concrete and Stack	15d	25-Jul-18	14-Aug-18	440d
MX2290	Pkg2	Fan and Media Install	3d	15-Aug-18	17-Aug-18	440d
A6380	Pkg2	Install Screen & Grit FRP Cover	5d	20-Aug-18	24-Aug-18	440d
MX2390	Pkg2	Test System	1d	27-Aug-18	27-Aug-18	440d
OC:3 Primary Weirs, Primary Effluent, Intermediate PS			45d	28-Aug-18	31-Oct-18	647d
MX2440	Pkg2	Site Prep	1d	28-Aug-18	28-Aug-18	440d
MX2610	Pkg2	Electrical & I&C Connections (Include Site Lighting)	15d	29-Aug-18	19-Sep-18	676d
MX2450	Pkg2	Concrete and Stack	15d	29-Aug-18	19-Sep-18	440d
MX2590	Pkg2	Fan and Media Install	3d	20-Sep-18	24-Sep-18	440d
A6390	Pkg2	Install Primary FRP Covers	5d	25-Sep-18	01-Oct-18	440d
MX2640	Pkg2	Test System	1d	02-Oct-18	02-Oct-18	440d
DN2_MX2644	Pkg2	Odor Control System Completion	0d		31-Oct-18	455d
Demollition of Existing Biofilters			20d	03-Oct-18	31-Oct-18	455d
A6450	Pkg2	Demolition of Existing BioFilters	20d	03-Oct-18	31-Oct-18	455d
SCADA and Programming for the full system			467d	24-Aug-18	08-Jul-20	25d
A6150	Pkg2	Field Installation	40d	24-Aug-18	22-Oct-18	452d
A6160	Pkg2	Scada and Programming	60d	13-Apr-20	08-Jul-20	0d
CLOSEOUT			60d	02-Jun-20	26-Aug-20	10d
Testing			20d	08-Jul-20	05-Aug-20	25d
MX3990	Pkg2	Startup of New System	5d	08-Jul-20	15-Jul-20	0d
MX3580	Pkg2	Startup and Test New System	20d	08-Jul-20	05-Aug-20	25d
MX3980	Pkg2	Conduct Operator Training	10d	08-Jul-20	22-Jul-20	25d
MX3982	Pkg2	PKG 2 Substantial Completion	0d		08-Jul-20	25d
Closeout			60d	02-Jun-20	26-Aug-20	0d
A5940	Pkg2	O&M Manauls	15d	02-Jun-20	23-Jun-20	25d
MX3970	Pkg2	As/Builts	15d	08-Jul-20	29-Jul-20	0d
MX4070	Pkg2	Punchlist	20d	29-Jul-20	26-Aug-20	0d
MX4100	Pkg2	PKG 2 Final Completion	0d		26-Aug-20*	0d



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Section 10

Opinion of Probable Construction Cost (OPCC)

This section presents the opinion of probable construction cost (OPCC) for Package 2A at the preliminary engineering report (PER) stage of the design process. As presented in earlier sections of this PER, the scope for Package 2A includes the following items:

1. Sitework including excavation of Clarifier 5-N and 5-S;
2. Yard Piping consisting of new influent lines, scum lines, drain lines and underdrain lines for the new clarifiers, a new RAS line running from the new RAS pump station to tie into existing system, a new scum line running from the new scum pumps to tie into the existing system and new EW and DR lines for the odor control systems at all 4 locations;
3. Conversion from coarse bubble to fine bubble diffusers in the Aeration Basins;
4. Demolition of the existing Clarifiers 5-N and 5-S and construction of two new Clarifiers with new scum pumps and a new RAS Pump Station;
5. Miscellaneous hydraulic improvements at the Intermediate Pump Station;
6. Improvements to the Odor Control System to address the influent junction box, coarse screens, grit removal system, fine screens, primary clarifiers and the Intermediate Pump Station;
7. Electrical - Site Lighting, Feeder, Power, Starters, Equipment, Testing;
8. Package 2A CM GC's (not including design or CM GC Pre-Construction Services); and,
9. Allowances below the line for testing/leak repair of existing aeration basin air headers.

The OPCC for Package 2A is based on the PER-Percent Design Package submitted to the City of Memphis (City) in April 2017. The OPCC is shown in **Table 10-1** below.

Table 10-1 Package 2A Opinion of Probable Construction Cost

Package 2A Scope Item	OPCC w/ Add. Services (10%) [1]
Sitework (050)	$2,200,000
Intermediate PS Hydraulic Improvements (110 & 160)	$1,700,000
Secondary Clarifiers (170 & 180)	$11,000,000
Aeration Basin Improvements (200)	$4,500,000
Electrical and Instrumentation (220 & 240)	$1,600,000
Odor Control Improvements (300)	$13,200,000
DIRECT COST TOTAL	**$34,200,000**
Allowance for overexcavation of soft soils at Clarifiers 5N & 5S	$75,000
Allowance for testing/leak repair of existing aeration basin air headers	$200,000
TOTAL DIRECT COST WITH ALLOWANCE	**$34,500,000**

1. Additional Services includes General Conditions and Construction Phase Services.

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PRELIMINARY ENGINEERING REPORT

T.E. Maxson WWTF Process Upgrades

Package 2B

City of Memphis

January 2018

CDM Smith

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Section 1

Introduction

The City of Memphis (City) retained CDM Smith Inc. to design and construct disinfection, biological treatment and hydraulic capacity improvements at the City's T.E. Maxson Wastewater Treatment Facility (WWTF) via a construction management at risk (CMAR) project delivery method. These improvements include:

- Replacement of the Existing Headworks Manual Coarse Screens;
- Upgrades to the Effluent Pump Station Electrical Improvements;
- Biotower Upgrades and RAS Re-Aeration Basin;
- Conversion from coarse-bubble to fine bubble diffusers in the Aeration Basins;
- Addition of peracetic acid (PAA) disinfection system including contact tanks;
- Demolition of the existing Final Clarifier 5-N and 5-S and construction of two new Final Clarifiers;
- Miscellaneous hydraulic improvements; and,
- Improvements to the odor control system.

These improvements will be divided into multiple design packages throughout the project duration. Package 2B, as described in this Preliminary Engineering Report (PER), includes the return activated sludge (RAS) reaeration basin; a new electrical building consisting of an integrated power assembly (IPA) enclosure; modifications to the Flow Control Structure (FCS); and piping improvements.

The Package 2A PER included the process design and process air requirements for the RAS Reaeration Basin and, therefore, it will not be provided in this document.

The format for the report includes:

- Basis of Design;
- Construction Sequencing and Constraints;
- Project Schedule; and,
- 30-Percent Drawings.

Section 2

New Electrical Building

2.1 Design Basis

2.1.1 Civil/Site Work

The New Electrical Building is located adjacent to the existing site drive just north of Trickling Filter No. 2. Site preparation will involve placement of engineered fill to create a level area approximately 80 feet wide and 25 feet deep from the back of curb. This fill area will slope down to existing grade just north of the trickling filter. The electrical building will have sidewalk along the north and west sides and a 20 foot x 25 foot parking space along the east side. Drainage from these facilities will be directed north to the gutter along the existing site drive.

2.1.2 Structural

The electrical building will consist of a pre-fabricated, stainless steel, walk-in enclosure known as an Integrated Power Assembly (IPA). The new Electrical IPA foundation will be approximately 55 foot by 25 foot with an 18 inch thick turned down slab. The foundation will be constructed of reinforced, cast in place concrete. Concrete slab openings and housekeeping pads will be provided on the slab for cables and equipment respectively as required by electrical. Concrete stoops will be provided at doorways.

Codes referenced:

- 2012 International Building Code (IBC)
- ASCE 7-10

The concrete slab will be checked for slab punching shear under equipment and also for negative bending under wind loading in addition to the global checks for forces from IPA structure.

2.1.3 Electrical

The IPA will be NEMA 3R. The manufacturer of the IPA will be the same manufacturer as the major electrical equipment located inside the building.

Power to the IPA will be derived from the 23kV distribution loops originating from switchgear 'SWGR-MAIN'. The loops consist of a normal circuit and an emergency circuit for redundancy. The IPA building will utilize the spare circuits in the existing pad-mounted switches PS-9N and PS-10E for connection to the 23kV distribution loops.

The estimated load of the future trickling filter ventilation fans, RAS reaeration basin equipment, site lighting, and associated miscellaneous equipment is approximately 725KVA. The electrical system for the IPA will consist of two 1000kVA, 23kV-480Y/277V, pad-mounted transformers located outside the Electrical IPA structure that feed a 480V, 1200A main-tie-main motor control center (MCC) with automatic transfer control inside the IPA. A 75kVA step-down dry-type transformer and a 208Y/120V, 225A panelboard will also be located inside the IPA. The IPA will be air-conditioned with redundant wall-mounted HVAC units. Also, the IPA will contain a Purafil air filter system to ensure the performance of the electrical and control equipment contained inside.

The IPA vendor will be responsible for providing the MCC, 75kVA transformer, panelboards, HVAC units, and indoor IPA air filter system. The IPA vendor will also be responsible for providing LED lights and receptacles within the building.

2.1.4 Instrumentation and Controls

The design will be based around Emerson's Ovation line with dual Ethernet switches and process controllers as submitted in Package 1 for the Disinfection Integrated Power Assembly (IPA) Building. The Emerson Ovation control panel, designated DCU-2, will be located in the new Electrical IPA Building north of the trickling filters. The DCU-2 control panel shall be 316 stainless steel, rated NEMA 12 including spare I/O and panel space to accommodate for potential future equipment and I/O for future packages and plant expansion. A Phoenix Contact Valueline Industrial PC will be mounted on the front of the control panel to serve as a Human Machine Interface (HMI) connected to the Emerson Ovation Distributed Control System (DCS). The operator will have the ability to monitor the Dissolved Oxygen (DO) analyzers, and control the position of the motor actuated valves for the RAS Reaeration Basin and the trickling filter dispersion fans that will be installed under a future package. The control panel shall also include an Uninterruptible Power Supply (UPS) and Fiber Optic Patch Panel (FOPP). The FOPP shall be sized appropriately to accommodate the necessary primary and secondary Ethernet switch connections, as well as provide and connect the fiber optic cable for the Intermediate Pump Station Odor Control Panel (OCP-9300) provided in Package 2A. Emerson will also provide a primary and secondary controller in the DCU-2 control panel as well as any communication modules and appurtenances required to communicate with all equipment and signals as shown in the Package 2B drawings and future drawings.

Fiber optic cable will be the communication media between the controllers back to the Root (ES1), Backup (ES2) and Router Ethernet switches for connectivity to the plant wide DCS. The connection will be made from the FOPP in DCU-2 through the new fiber ductbank system, detailed in the Electrical drawings, to the media converter rack in the Administration Building Network Rack. The fiber will be run through the new ductbank with appropriate bend radius, not exceeding the manufacturers bend recommendation of the fiber optic cable. T.E. Maxson WWTF standard fiber optic cable type is multimode 62.5/150µm (OM1); Modbus over Ethernet communication protocol will be used as the communication standard. The communication protocol used by the Ovation DCU controllers to the DCS fiber optic network will be Modbus TCP. All I/O from the instruments, vendor control panels, VFDs, MCCs and any other appurtenances will be hardwired to the DCU as indicated in the Package 2B drawings. All fiber optic cabling and fiber optic patch panels provided shall be sized for future connections and expansion.

2.2 Construction Sequencing and Constraints

Providing power to the new IPA building pad-mount transformers will require coordination with the plant staff for a scheduled power outage. This will entail de-energizing existing pad-mounted switches PS-9N and PS-10E so that work can be safely performed inside of electrical manhole EMH-9. This will directly affect panels DP1 and DP2 located inside the adjacent existing electrical building. These panels in turn provide power to panels DP3 (grease pumps for the Intermediate Pump Station), DP4 (general purpose loads for the existing Main Substation/MCC-1 Building), DP5 (Fine Bar Screens and Odor Control System for the Intermediate Pump Station), MCC-P3 (Primary Clarifiers and Primary Sludge Pump Station Building), and P5 (general purpose loads for Trickling Filter Pump Station Building).

The power feeders for MCC-4 (Intermediate Pump Station and the Trickling Filter Pump Station) also run through EMH-9, and to ensure a safe workspace, those loads will also need to be shut down while work is performed inside EMH-9.

Once the cable terminations are complete and work is no longer required inside EMH-9, all the loads can be re-energized.

Section 3

RAS Reaeration Basin

Three new RAS Reaeration basins with a total volume of 3.5-million gallon (MG) will be provided in Package 2B as part of the trickling filter/solids contact design. Each basin will be 44 feet wide and 258-feet long with a design side water depth of 13.75 feet. The RAS Reaeration Basin will receive pumped clarifier underflow from the two existing 24-inch RAS pipes as well as a new 24-inch RAS line provided in Package 2A from new Clarifiers 5-N and 5-S. The basin will be provided with 9-inch membrane disk fine bubble diffusers. Three one-pass parallel basins will be provided for operational flexibility.

3.1 Design Basis

The process design basis for the RAS Reaeration Basin was provided in the Package 2A Preliminary Engineering Report. This included the diffuser quantity and process air flow requirements. That information will not be provided again in the Package 2B PER. In as much so, the design basis for the RAS Reaeration Basin in this section will focus on the design of the structure, the means of conveying air from the existing blowers to this basin, the yard piping which will convey RAS in and out of the basin, and the control methodology for the aeration system.

3.1.1 Process/Mechanical

Equal RAS flow splitting to the three basins is important to maintain equal hydraulic retention time and similar oxygen demand in the basins. Unequal flow splitting will result in varying oxygen demand among basins which may require adjustment of air flow. To provide equal flow splitting, a flow splitter box with three adjustable 14-foot wide motorized weir gates will be provided upstream of the basin. Three 36-foot effluent weirs will be provided at the discharge side of the basin where flow will discharge into a common channel. A dropbox will be provided on the southeast corner of the new channel and a new 54-inch RAS pipe will be installed to convey RAS to the existing Flow Control Structure. Section 4 of this report will discuss the tie-in at the Flow Control Structure.

The existing process air blowers will provide process air to the RAS Reaeration Basins via two new 48-inch diameter ductile iron pipes that will run from the blower building to the RAS Reaeration Basins. The connection on the east side of the existing air mains was chosen to minimize head loss in the system. A connection on the west side of the existing air mains was evaluated in 2016 but was not implemented due to the increased head loss in the existing air mains having to convey all the air from the east side to the west side of the pipe gallery which would have significantly impacted the performance of the existing blowers.

The existing blind flanges on the east side of the common blower discharge manifold will be removed and new motor operated butterfly valves installed for isolation of each air main to the RAS Reaeration Basin along with the ability to manually throttle air flow for DO (dissolved oxygen) control. The dual 48-inch ductile iron air mains will be elevated above the main throughway in the pipe gallery to continue to allow for vehicular access through the gallery. The piping will drop via two 90-degree bends prior to penetrating the south wall of the pipe gallery. An existing force main along that south wall and the concrete stairway outside the southeast corner of the pipe gallery will have to be relocated to accommodate the piping.

Once inside the footprint of the RAS Reaeration Basin, the parallel ductile iron mains will be installed in a channel that will be constructed at the top of the dividing wall between the trains. The air feed pipes will be installed under the walkways with removable grating over them for access. The piping will be coupled with Victaulic Depend-O-Lok couplings to facilitate removal of the pipe and to allow for thermal expansion. Reducing fittings will still be flanged, however, they can also be removed by removing the Depend-O-Lok couplings upstream and downstream of them.

The main air header pipe diameter will vary from 48- to 24-inches. Each pass will be installed with four diffuser grids. Each diffuser grid will receive air from a 10-inch welded boss connection that will provide the drop leg for the diffuser grid. The east and west trains only have four drop leg connections (one per grid). The center train has eight dropleg connections (two per grid). The eight dropleg connections for the center train was provided for flexibility in the event an air main was out of service. The other air main would still have the ability provide air to two of the three trains. During normal operation, only four of the eight dropleg valves should be open to allow for air to the center train to ensure even air flow splitting to all three trains.

Drop legs will be stainless steel and transitioned to PVC at the bottom of the basin. Each drop leg will be provided with a manually operated butterfly valve for isolation and air flow adjustment. These butterfly valves will be provided with extension stems and manual gear operators for access from the top of walkways. These butterfly valves will be adjusted during the plant start-up and should be maintained at that position without requiring any adjustment with varying RAS flows may be applied. The air flow split to each of the four diffuser grids should stay relatively similar not require any air flow adjustment.

3.1.2 Civil/Site Work

The RAS Reaeration Basin is located between the existing south Aeration Tanks and Clarifiers 1-S and 2-S. There does not appear to be existing infrastructure in the footprint of this tank that requires relocation. The only site utilities that must be relocated are one water line and hydrant and some electrical conduit. The area will require very little grading around the new basin. Existing storm water drainage from the area is by sheet flow to the south and west, and this pattern will be maintained with the new basin in place.

The perimeter underdrain system for the new basin will connect to the existing underground storm drain system at a manhole located about 200 feet south of the basin. This will require the installation of piping within the existing site access drive just west of Trickling Filter No. 1 for approximately 100 feet.

3.1.3 Yard Piping

Yard piping improvements required for the new RAS Reaeration Basin include RAS influent/effluent piping, air piping, and various utility relocations to accommodate construction. The RAS Reaeration Basin influent will be supplied by three 24-inch pipes, two from new wet-tapped tie-ins to the existing 24-inch pipes (that leave the RAS pump station towards the south) and one as the extension of the new 24-inch line from new Clarifiers 5-N and 5-S installed as part of Package 2A. Buried 24-inch RAS piping will be ductile iron with restrained mechanical joints.

The discharge from the RAS Reaeration Basin will be a 54-inch diameter ductile iron pipe (restrained mechanical joint) installed at approximately the same grade as the to-be-demolished 24-inch RAS lines running east/west that connect to the 102-inch main. The proposed route will have several utility crossings (several duct banks, 24-inch drain piping, 12-inch effluent water piping, storm sewer,

etc.), so the proposed deeper depth should mitigate conflicts. Prior to the 60-percent deliverable, a subsurface utility investigation/locates will be conducted along the proposed piping pathway, and a profile sheet will be added to show utility crossings.

48-inch ductile iron air piping will be located above grade on concrete pipe supports. Additional utility relocation within the area of the RAS Reaeration Basin includes potable water lines and yard hydrants, which are to be relocated. Drawings currently show an abandoned 18-inch waste sludge line near the tank footprint that will be removed as needed for construction and then capped and abandoned outside of the footprint.

3.1.4 Structural

The new RAS Reaeration Basin will be constructed of reinforced cast-in-place concrete and is approximately 272-foot-8-inch long by 136-foot-8-inch wide by 17-foot-1-inch high. Two center walls will divide the basin into three trains, and air piping will be supported under the walkways at the top of these walls. The structure will be designed with the use of a perimeter underdrain system to reduce the effects of buoyancy from groundwater. There are no protective coatings planned for the interior surfaces of the structure.

3.1.5 Instrumentation and Control

The RAS Reaeration Basins will be equipped with two motorized butterfly valves to throttle air from the existing blowers to fine bubble diffusers in the three new reaeration basins. The motorized butterfly valve positions will be operator adjustable in the Supervisory Control and Data Acquisition (SCADA) system by the operator to meet the desired DO concentrations and aeration. The butterfly valves will also have the capability to be controlled by a hand switch locally or from the Human Machine Interface (HMI). Valve position feedback will be monitored in the Ovation SCADA System.

DO measurements in the new RAS Reaeration Basins will be achieved using optical ball float type Hach analytical instruments. There will be two new DO ball float probes per RAS Reaeration Basin (six new DO ball float probes in total) measuring the influent and effluent DO. Each DO ball float probe will be pole-mounted and extended into each new basin with a handrail mounted analyzer, as required in the installation detail and specifications. This type of instrument needs frequent cleaning to keep the sensing head of the probe clear of debris, so a rotating probe mount assembly, manufactured by Hach, will be furnished with each new probe. This will ensure safe and easy access to the ball float probe for maintenance and reduce the time the probes will be down for cleaning. The DO measurements will be monitored in the Ovation SCADA System.

All I/O will be hardwired to DCU-2 located in the New Electrical Integrated Power Assembly (IPA) Building. The IPA building will also provide power for all electrical items at the RAS Reaeration Basins.

3.2 Construction Sequencing and Constraints

The tie-in for the air piping will require coordination with operations staff to provide a short outage of one to two days on each air main to allow for removal of the 48-inch blind flange and installation of the 48-inch butterfly valve. Once this connection is complete, the remaining air piping can be installed without impacts to the aeration system.

The construction of the new RAS Reaeration Basin will require the facility to operate in ABF mode only while the basin is being constructed. The existing 24-inch RAS piping running east to the 102-inch pipe will need to be removed under the footprint of the new basin. Two line stops would be provided for the 24-inch RAS lines running east to the 102-inch pipe that currently convey RAS to the 102-inch pipe.

In the event Package 2B is complete prior to Package 2A, the new 24-inch RAS pipe from Clarifier 5-N and 5-S (provided in Package 2A) will be conveyed directly to the RAS Reaeration Basin splitter box. A 24-inch plug valve will be provided to isolate the upstream flowmeter at the Package 2A RAS/WAS Pump Station. Only one existing 24-inch RAS pipe is utilized by operations staff to convey RAS presently. This will allow for tapping to be done "in the dry" by cutting the existing piping and installing a new tees and couplings as required to convey flow to the RAS Reaeration Basin. Two additional 24-inch line stops will be needed on the existing 24-inch RAS pipes downstream of these taps made to convey flow to the RAS Reaeration Basin to curtail flow from flowing to the trickling filter pump station when the plant operates in ABF mode.

In the event Package 2A is complete prior to Package 2B, the new 24-inch RAS pipe from Clarifiers 5-N and 5-S will need to be tied into both of the existing 24-inch RAS pipes. Only one existing 24-inch RAS pipe is utilized by operations staff to convey RAS presently. This will allow for tapping to be done "in the dry" by cutting the existing piping and installing a new tees and couplings as required. The 24-inch plug valve on the new 24-inch RAS pipe (provided in Package 2A) will allow for a seamless tie-in to the new RAS Reaeration Basin without the need for an outage on Clarifiers 5-N and 5-S as well as isolation of the upstream RAS flow meter provided in Package 2A.

Section 4

Flow Control Structure Upgrades

Reaerated sludge from the RAS Reaeration Basin will be discharged to the existing Flow Control Structure (FCS) to mix with incoming trickling filter effluent upstream of the aeration basins. This section describes the design basis for modifications that will be required in order to tie the new reaerated return activated sludge pipe into the FCS while also improving the hydraulic capacity of the structure to accommodate anticipated peak flows.

4.1 Design Basis

4.1.1 Process Mechanical

Reaerated sludge from the RAS Reaeration Basin will be discharged through a new 54-inch ductile iron pipe (DIP) running east along the southern edge of the southern aeration basin battery before joining the trickling filter effluent downstream of the Intermediate Pump Station (IPS). The proposed termination point of the 54-inch pipe would be in the center of the western wall of structure above the floor of the main influent chamber. This connection point avoids the challenges associated with tying into the 102-inch PCCP main upstream of the FCS while allowing for the reaerated RAS to mix with the forward plant flow upstream of the flow split between the north and south aeration basin batteries.

Additional modifications are proposed to improve the hydraulic capacity of the structure. These include:

- Utilizing all three 5-foot by 5-foot orifices to convey reaerated RAS and trickling filter effluent to the north and south influent conduits;
- A permanent bulkhead in the center conduit which served as the secondary treatment process bypass to prevent flow from entering this conduit downstream of the center 5-foot by 5-foot orifice;
- Demolition of the vertical walls between the center conduit and both the north and south conduits to allow flow from the center 5-foot by 5-foot orifice to flow to the north and south conduits; and,
- Installation of slide gates to isolate the north and south conduits in the event the north and south aeration basin batteries need to be isolated.

There are three existing 5-foot by 5-foot orifices that split incoming flow into three potential conduits in the pipe gallery below. Each square opening is dedicated to a conduit. The two outer (north and south) conduits send mixed liquor to the north and south aeration basin batteries, respectively. The middle conduit is a secondary treatment process bypass which runs along the center of the pipe gallery. Since the 1980s, the slide gate to the central conduit has been closed and all forward flow is split in half to the north and south aeration basin batteries through the north and south flow splitting openings.

4.1.2 Physical Model Study

During the field stress testing, turbulent wave conditions were observed in the existing FCS at the downstream end of the 102-inch main. These conditions made it difficult to fully calibrate the computer hydraulic model for this structure. CDM Smith contracted the hydraulics lab, Clemson Engineering Hydraulics (CEH), to build and test physical hydraulic models of the existing and modified FCS. Results from the model were used to assess its hydraulic capacity of the FCA for combined plant and RAS flows with and without the proposed modifications in place.

CEH also developed a physical model for the IPS Flow Diversion Structure included in Package 2A to gain a better understanding of the flow characteristics. Results from this physical model were used to validate the proposed design of the IPS Flow Diversion Structure.

The physical model study demonstrated that minimal air entrainment would be present during peak flows for both the proposed IPS Flow Diversion Structure and the modified FCS. The three adverse hydraulic conditions at the IPS described in the PER for Package 2A were shown to be minimized in the physical model for the Flow Diversion Structure. Results for the FCS also confirmed that the proposed hydraulic modifications were necessary to pass peak hour and RAS flow without adversely impacting upstream hydraulics at the IPS. The physical model results were used to calibrate the computer hydraulic model. Refer to **Appendix C** for the Physical Model Study Final Report, prepared by CEH.

4.1.3 Impact of FCS Modifications

The hydraulic analysis indicated that utilizing only two of the 5- by 5-foot square openings, each dedicated to a mixed liquor conduit feeding either the north or south aeration basin batteries, represented a significant hydraulic choke point at high flow conditions. The headloss added by sending peak hour and RAS flow through these two openings would risk pushing the water level in the FCS to an elevation that would provide little freeboard (less than one-and-a-half feet) below of the top of the structure. Furthermore, at this peak flow condition, the water level in the upstream IPS effluent box would be raised close to, if not above, the crest of the discharge chute from the screw pumps.

Based on the physical model and calibrated computer hydraulic model, when the primary effluent and reaerated RAS are combined in the influent chamber of the FCS, there is a significant increase in the capacity of the structure if the combined flow is allowed to pass through all three of the existing flow splitting openings. **Table 4.1** demonstrates the expected hydraulic improvements associated with the proposed improvements to the FCS during a peak flow event.

Table 4-1 Hydraulic Improvements Associated with Modifications to the FCS at Peak Flow (170 mgd Influent Plus 48 mgd RAS)

Flow Control Structure Status	Flow Control Structure Influent Chamber			Intermediate Pump Station Effluent Box		
	Water Surface Elevation	Top of Wall	Expected Freeboard	Water Surface Elevation	Pump Discharge Elevation	Expected Free Discharge
No Modifications in FCS (2 Splitting Gates Open)	237.42 ft	238.78 ft	1.36 ft	239.46 ft	239.33 ft	None
With Modifications in FCS (3 Splitting Gates Open)	236.17 ft	238.78 ft	2.61 ft	238.21 ft	239.33 ft	1.12 ft

As shown above, allowing the combined primary effluent and reaerated RAS to pass through the three flow splitting openings in the FCS would significantly improve the hydraulic conditions associated with the structure. Without the proposed FCS modifications, the reaerated RAS would need to be connected to the forward plant flow at a point in the pipe gallery downstream of the structure in order to avoid the adverse hydraulic conditions shown in the first row of the table above. This would likely involve more complex piping along with expensive valves in the yard between the aeration basins and the FCS. The cost implications for constructing such a piping system would be significantly higher than the proposed FCS modifications.

4.1.4 Civil/Site Work

Site grading adjacent to west side of the FCS will be done to accommodate the new 54-inch reaerated RAS pipe where it crosses above the aeration basin pipe gallery and connects to the structure. Site work will be performed without disturbing the existing roadway located to the north of this area.

4.1.5 Yard Piping

The 54-inch DIP carrying reaerated RAS from the new RAS Reaeration Basin will connect to the existing FCS through a new opening in the western wall of the structure. The 54-inch pipe will be set with an invert elevation at approximately 215.50 feet for the majority of its run in the yard in order to avoid conflicts with shallower air piping and other utilities. The pipe will turn up vertically and over the existing mixed liquor conduits before turning west to connect to the FCS at an invert elevation of approximately 224.50 feet. This invert elevation will ensure that the crown of the reaerated sludge pipe remains submerged in the Flow Control Structure. Because the 54-inch pipe will have less than three feet of ground cover where it is installed above the pipe gallery in the vicinity of the FCS, the shallow portion of pipe directly west of FCS will be encased in concrete to provide protection from heavy traffic. Details related to the shallow portion of pipe, concrete encasement, and connection to the FCS will be included in the Package 2A design submittal.

4.1.6 Structural

The existing exterior (14-inch thick) reinforced concrete wall of the west side of the FCS will be modified to include a circular saw-cut opening, approximately 5-feet in diameter, to accommodate the connection of the new 54-inch reaerated RAS pipe. Increased stresses due to the new opening in the side of the structure may require strengthening of the existing wall by adding more concrete and reinforcement.

4.2 Construction Sequencing and Constraints

Installation of the new 54-inch reaerated RAS pipe in the west wall of the FCS will require a bypass of plant flow from the Headworks Structure to the aeration basins since the 102-inch PCCP pipe cannot be in service during this connection. This portion of work could be completed during the same bypass period that will be required to make changes to the IPS effluent structure and the upstream end of the 102-inch main as described in Package 2A.

The three existing gates in the FCS can be closed to isolate and empty and the structure's main influent chamber at which point the opening in the western wall of the structure can be saw-cut and the new 54-inch reaerated sludge pipe can be installed. Once the 54-inch pipe is installed, forward flow can be sent back along its normal flow path through the primary clarifiers and trickling filters.

The bulkhead in the central conduit can be installed during normal plant operation with flow going to the north and south conduits. The central isolation gate in the FCS will be closed to isolate flow from the effluent chamber above the conduit prior to any work in the central conduit. Additional safety precautions will need to be in place to assure minimal leakage through the central gate and to keep the main bypass conduit dry during this work.

After the bulkhead is installed in the central bypass conduit, an entire aeration basin battery will need to be taken out of service to saw-cut the openings in the vertical conduit walls between the central and north (or south) conduit. During this work, the central gate will need to remain shut. It is recommended to sequence this work after half of the diffuser conversion in Package 2A is complete (for the first half plant outage) so that the aeration basin battery receiving flow has the fine-bubble diffuser conversion in place, tested, and operational and that the second half-plant outage occurs when the second half of the fine bubble diffuser conversion in Package 2A is complete.

The north (or south) aeration basin battery will be taken out of service first by closing the respective north (or south) isolation gate in the FCS and either draining the downstream aeration basins or isolating them at their influent gates/valves on the side of the plant being worked on. The new opening in the conduit wall can be cut from the central bypass conduit when the downstream aeration basins are not hydraulically connected to the FCS. A new slide gate will be mounted to cover this opening to allow for future isolation of the aeration tank battery. Once complete, the gate will be shut and the out-of-service side of the plant can be brought back online by opening the respective isolation gate in the FCS above. This process would be repeated for the south (or north) battery once the first battery is completed.

Section 5

Package 2B Schedule

A detailed project schedule has been included for Package 2B work which includes the construction of the new RAS Reaeration Basin, Electrical Building/IPA and Flow Control Structure modifications described in this PER.

The schedule shows 60-percent design completed by August 18, 2017, 90-percent design completed October 27, 2017 and the GMP submitted after that. From the work included in this package, we estimate a total of 10 bid packages, including equipment and subcontractors. Bid packages included are:

- Yard Piping Subcontractor;
- Electrical Gear;
- Electrical Subcontractor;
- Biological Process Aeration System;
- I&C Subcontractor;
- Mechanical Slide/Weir Gates;
- Sitework Subcontractor;
- Concrete Subcontractor;
- Plant Construction Subcontractor; and,
- Miscellaneous Metal Subcontractor.

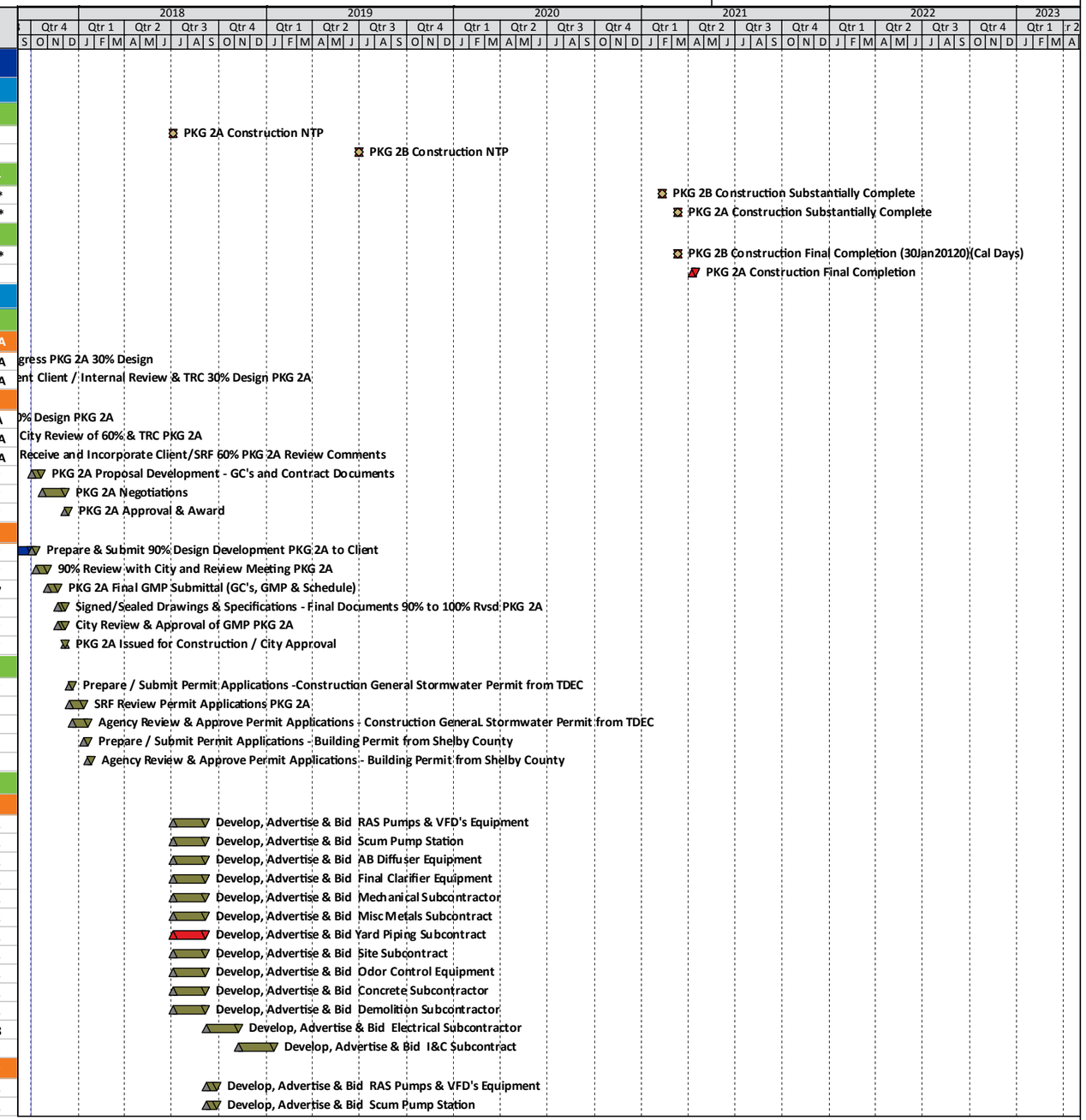
It is presumed that the diffusers for the RAS Reaeration Basin in Package 2B will be procured under Package 2A. Storage of the equipment will be discussed with the manufacturer at the time of procurement. We recommend storage of the equipment to be at their facility and delivery to occur when we are ready for installation. Procurement for the bid packages listed above will be done in accordance to the City's and SRF's procurement requirements. The schedule shows construction activities starting in January 2018 (with procurement) with final completion in December 2019. Critical path on this schedule runs through the final design, permitting, and construction of the RAS Reaeration Basin.

The City of Memphis

T.E. Maxson Wastewater Treatment Facility

DATE: 11-Oct-17 Time: 11:25

Activity ID	Activity Name	Dur	Start	Finish
T.E. Maxson WWTF Process Upgrades		1052	01-Feb-17 A	15-Apr-21
MILESTONES		696	03-Jul-18	15-Apr-21
PKG Milestones		250	03-Jul-18	01-Jul-19
MS2A-120	PKG 2A Construction NTP	0	03-Jul-18*	
MS2B-120	PKG 2B Construction NTP	0	01-Jul-19*	
Construction Substantial Completion Milestones (Cal Days)		20	10-Feb-21	11-Mar-21
MScn-210	PKG 2B Construction Substantially Complete	0		10-Feb-21*
MScn-200	PKG 2A Construction Substantially Complete	0		11-Mar-21*
Construction Final Completion Milestones (Cal Days)		25	11-Mar-21	15-Apr-21
MScn-2BFC	PKG 2B Construction Final Completion (30Jan20120)(Cal Days)	0		11-Mar-21*
MScn-2AFC	PKG 2A Construction Final Completion	5	09-Apr-21	15-Apr-21
PKG 2A FINAL CLARIFIERS, FINE BUBBLE DIFFUSER, ODOR CONTROL & INTERMEDIATE PUMP STAT		1047	01-Feb-17 A	08-Apr-21
DESIGN-2A		220	01-Feb-17 A	12-Dec-17
PKG 2A Design Progression (30%)		74	01-Feb-17 A	16-May-17 A
DN2_A2350	Design Progress PKG 2A 30% Design	58	01-Feb-17 A	24-Apr-17 A
DN2_A2330	Concurrent Client / Internal Review & TRC 30% Design PKG 2A	15	25-Apr-17 A	16-May-17 A
PKG 2A Development and Negotiation (60%)		145	17-May-17 A	12-Dec-17
DN2_A2300	60% Design PKG 2A	51	17-May-17 A	28-Jul-17 A
DN2_A5640	City Review of 60% & TRC PKG 2A	14	31-Jul-17 A	18-Aug-17 A
DN2_A5642	Receive and Incorporate Client/SRF 60% PKG 2A Review Comments	14	31-Jul-17 A	18-Aug-17 A
DN2_A2400	PKG 2A Proposal Development - GC's and Contract Documents	15	02-Oct-17	20-Oct-17
DN2_A2370	PKG 2A Negotiations	30	23-Oct-17	05-Dec-17
DN2_A2360	PKG 2A Approval & Award	5	06-Dec-17	12-Dec-17
PKG 2A Finalize Design		75	21-Aug-17 A	06-Dec-17
DN2_A2420	Prepare & Submit 90% Design Development PKG 2A to Client	36	21-Aug-17 A	10-Oct-17
DN2_A2440	90% Review with City and Review Meeting PKG 2A	15	11-Oct-17	31-Oct-17
DN2_A2442	PKG 2A Final GMP Submittal (GC's, GMP & Schedule)	15	01-Nov-17	21-Nov-17
DN2_A2320	Signed/Sealed Drawings & Specifications - Final Documents 90% to 100% Rvsd PKG 2A	8	22-Nov-17	05-Dec-17
DN2_A2444	City Review & Approval of GMP PKG 2A	8	22-Nov-17	05-Dec-17
DN2_A2310	PKG 2A Issued for Construction / City Approval	1	06-Dec-17	06-Dec-17
PERMITTING Pkg 2A		30	13-Dec-17	25-Jan-18
DN2_A1790	Prepare / Submit Permit Applications -Construction General Stormwater Permit from TDEC	5	13-Dec-17	19-Dec-17
DN2_A6270	SRF Review Permit Applications PKG 2A	20	13-Dec-17	11-Jan-18
DN2_A1810	Agency Review & Approve Permit Applications - Construction General Stormwater Permit from T	20	20-Dec-17	18-Jan-18
DN2_A1780	Prepare / Submit Permit Applications - Building Permit from Shelby County	5	12-Jan-18	18-Jan-18
DN2_A1800	Agency Review & Approve Permit Applications - Building Permit from Shelby County	5	19-Jan-18	25-Jan-18
PROCUREMENT		238	03-Jul-18	14-Jun-19
PKG 2A Develop, Advertise & Bid		135	03-Jul-18	15-Jan-19
DN2_A6463	Develop, Advertise & Bid RAS Pumps & VFD's Equipment	45	03-Jul-18	05-Sep-18
DN2_A6455	Develop, Advertise & Bid Scum Pump Station	45	03-Jul-18	05-Sep-18
DN2_A6425	Develop, Advertise & Bid AB Diffuser Equipment	45	03-Jul-18	05-Sep-18
DN2_A6370	Develop, Advertise & Bid Final Clarifier Equipment	45	03-Jul-18	05-Sep-18
DN2_A4440	Develop, Advertise & Bid Mechanical Subcontractor	45	03-Jul-18	05-Sep-18
DN2_A4420	Develop, Advertise & Bid Misc Metals Subcontract	45	03-Jul-18	05-Sep-18
DN2_A4390	Develop, Advertise & Bid Yard Piping Subcontract	45	03-Jul-18	05-Sep-18
DN2_A4350	Develop, Advertise & Bid Site Subcontract	45	03-Jul-18	05-Sep-18
DN2_A4250	Develop, Advertise & Bid Odor Control Equipment	45	03-Jul-18	05-Sep-18
DN2_A4220	Develop, Advertise & Bid Concrete Subcontractor	45	03-Jul-18	05-Sep-18
DN2_A4230	Develop, Advertise & Bid Demolition Subcontractor	45	03-Jul-18	05-Sep-18
DN2_A4210	Develop, Advertise & Bid Electrical Subcontractor	45	06-Sep-18	07-Nov-18
DN2_A4410	Develop, Advertise & Bid I&C Subcontract	45	08-Nov-18	15-Jan-19
PKG 2A Obtain City Approval & Award		105	06-Sep-18	06-Feb-19
DN_2A6466	Develop, Advertise & Bid RAS Pumps & VFD's Equipment	15	06-Sep-18	26-Sep-18
DN2_A6465	Develop, Advertise & Bid Scum Pump Station	15	06-Sep-18	26-Sep-18



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Remaining Level of Effort
Critical R...
Actual Work
Milestone
Remaining Work

Preliminary Schedule
PKG#2A2B Detail Schedule by WBS

Date	Revision	Checked	Approved
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The City of Memphis

T.E. Maxson Wastewater Treatment Facility

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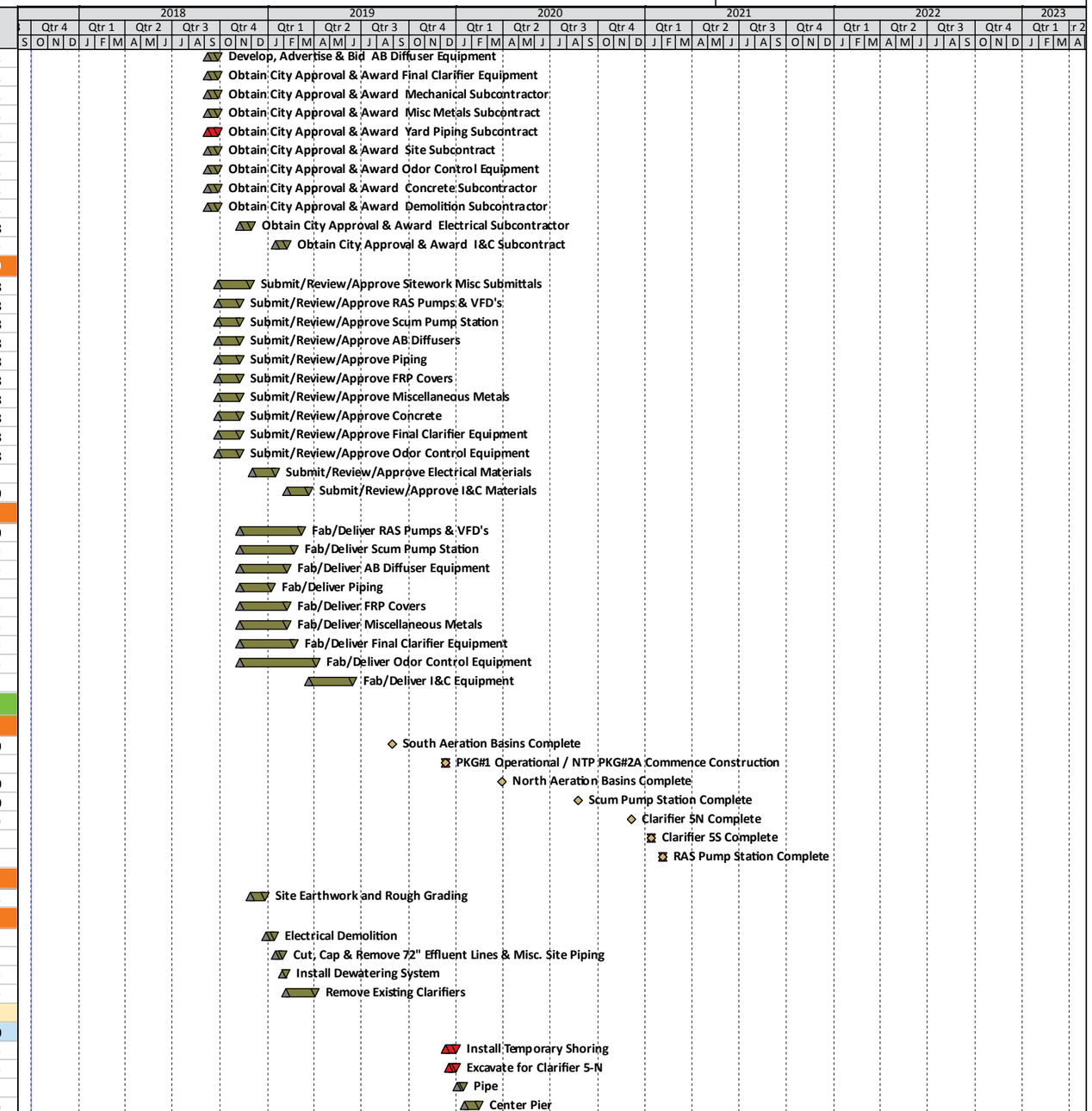
Activity ID	Activity Name	Dur	Start	Finish
DN2_A6435	Develop, Advertise & Bid AB Diffuser Equipment	15	06-Sep-18	26-Sep-18
DN2_A6380	Obtain City Approval & Award Final Clarifier Equipment	15	06-Sep-18	26-Sep-18
DN2_A4450	Obtain City Approval & Award Mechanical Subcontractor	15	06-Sep-18	26-Sep-18
DN2_A4430	Obtain City Approval & Award Misc Metals Subcontract	15	06-Sep-18	26-Sep-18
DN2_A4400	Obtain City Approval & Award Yard Piping Subcontract	15	06-Sep-18	26-Sep-18
DN2_A4360	Obtain City Approval & Award Site Subcontract	15	06-Sep-18	26-Sep-18
DN2_A4320	Obtain City Approval & Award Odor Control Equipment	15	06-Sep-18	26-Sep-18
DN2_A4280	Obtain City Approval & Award Concrete Subcontractor	15	06-Sep-18	26-Sep-18
DN2_A4290	Obtain City Approval & Award Demolition Subcontractor	15	06-Sep-18	26-Sep-18
DN2_A4270	Obtain City Approval & Award Electrical Subcontractor	15	08-Nov-18	30-Nov-18
DN2_A4340	Obtain City Approval & Award I&C Subcontract	15	16-Jan-19	06-Feb-19
Submittals		118	27-Sep-18	21-Mar-19
DN2_MX840	Submit/Review/Approve Sitework Misc Submittals	40	27-Sep-18	27-Nov-18
DN2_A6467	Submit/Review/Approve RAS Pumps & VFD's	30	27-Sep-18	07-Nov-18
DN2_A6345	Submit/Review/Approve Scum Pump Station	30	27-Sep-18	07-Nov-18
DN2_A6415	Submit/Review/Approve AB Diffusers	30	27-Sep-18	07-Nov-18
DN2_A6480	Submit/Review/Approve Piping	30	27-Sep-18	07-Nov-18
DN2_A6470	Submit/Review/Approve FRP Covers	30	27-Sep-18	07-Nov-18
DN2_A6430	Submit/Review/Approve Miscellaneous Metals	30	27-Sep-18	07-Nov-18
DN2_A6420	Submit/Review/Approve Concrete	30	27-Sep-18	07-Nov-18
DN2_A6360	Submit/Review/Approve Final Clarifier Equipment	30	27-Sep-18	07-Nov-18
DN2_MX830	Submit/Review/Approve Odor Control Equipment	30	27-Sep-18	07-Nov-18
DN2_A6350	Submit/Review/Approve Electrical Materials	30	03-Dec-18	15-Jan-19
DN2_A6410	Submit/Review/Approve I&C Materials	30	07-Feb-19	21-Mar-19
Fabrication & Delivery		150	08-Nov-18	14-Jun-19
DN2_A6469	Fab/Deliver RAS Pumps & VFD's	80	08-Nov-18	07-Mar-19
DN2_A6497	Fab/Deliver Scum Pump Station	70	08-Nov-18	21-Feb-19
DN2_A6495	Fab/Deliver AB Diffuser Equipment	60	08-Nov-18	06-Feb-19
DN2_A6490	Fab/Deliver Piping	40	08-Nov-18	08-Jan-19
DN2_A6460	Fab/Deliver FRP Covers	60	08-Nov-18	06-Feb-19
DN2_A6440	Fab/Deliver Miscellaneous Metals	60	08-Nov-18	06-Feb-19
DN2_A6390	Fab/Deliver Final Clarifier Equipment	70	08-Nov-18	21-Feb-19
DN2_A5470	Fab/Deliver Odor Control Equipment	100	08-Nov-18	04-Apr-19
DN2_A6400	Fab/Deliver I&C Equipment	60	22-Mar-19	14-Jun-19
CONSTRUCTION		546	28-Nov-18	03-Feb-21
Coordination Milestones		355	29-Aug-19	03-Feb-21
MScn-010	South Aeration Basins Complete	0		29-Aug-19
MScn-110	PKG#1 Operational / NTP PKG#2A Commence Construction	0	12-Dec-19	
MScn-060	North Aeration Basins Complete	0		30-Mar-20
MScn-020	Scum Pump Station Complete	0		24-Aug-20
MScn-040	Clarifier 5N Complete	0		04-Dec-20
MScn-030	Clarifier 5S Complete	0		12-Jan-21
MScn-050	RAS Pump Station Complete	0		03-Feb-21
00 SITE WORK		21	28-Nov-18	27-Dec-18
CN2_MX1230	Site Earthwork and Rough Grading	21	28-Nov-18	27-Dec-18
Clarifier 5-S and Clarifier 5-N Demoliton and Construction		510	28-Dec-18	12-Jan-21
CN2_MX2630	Electrical Demolition	11	28-Dec-18	14-Jan-19
CN2_MX2620	Cut, Cap & Remove 72" Effluent Lines & Misc. Site Piping	10	15-Jan-19	29-Jan-19
CN2_MX2670	Install Dewatering System	5	30-Jan-19	05-Feb-19
CN2_MX2550	Remove Existing Clarifiers	40	06-Feb-19	03-Apr-19
Clarifier 5-N Construction		271	12-Dec-19	12-Jan-21
Structural Work		163	12-Dec-19	04-Aug-20
CN2_MX2715	Install Temporary Shoring	13	12-Dec-19	31-Dec-19
CN2_MX2718	Excavate for Clarifier 5-N	10	17-Dec-19	31-Dec-19
CN2_MX2720	Pipe	10	02-Jan-20	15-Jan-20
CN2_MX2810	Center Pier	20	16-Jan-20	13-Feb-20



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The City of Memphis

T.E. Maxson Wastewater Treatment Facility

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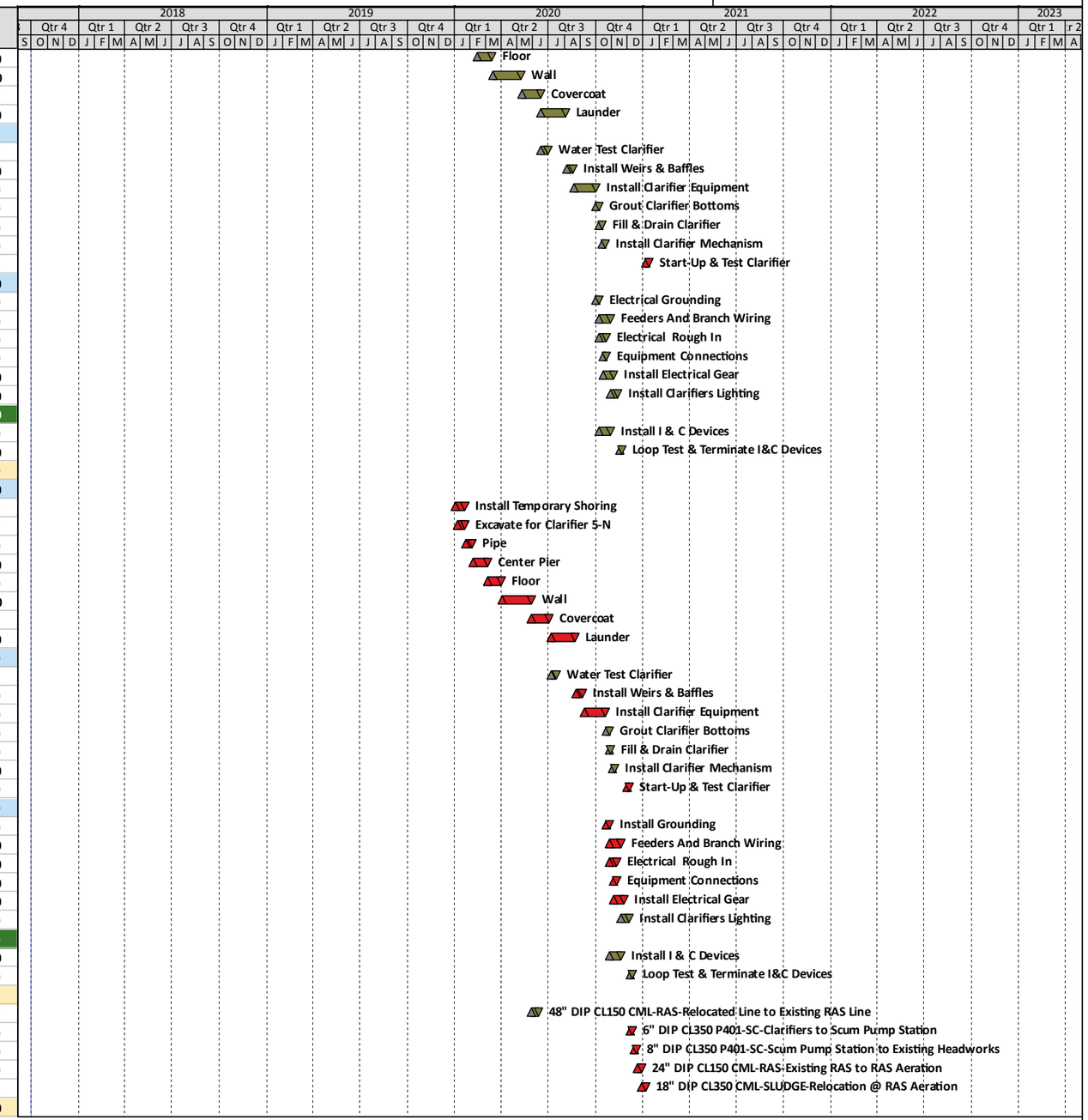
Activity ID	Activity Name	Dur	Start	Finish
CN2_MX2910	Floor	20	14-Feb-20	13-Mar-20
CN2_MX2940	Wall	40	16-Mar-20	08-May-20
CN2_MX3060	Covercoat	25	11-May-20	15-Jun-20
CN2_MX3130	Launder	35	16-Jun-20	04-Aug-20
Mechanical Work		143	16-Jun-20	12-Jan-21
CN2_MX4030	Water Test Clarifier	10	16-Jun-20	29-Jun-20
CN2_MX3290	Install Weirs & Baffles	10	05-Aug-20	18-Aug-20
CN2_MX3460	Install Clarifier Equipment	30	19-Aug-20	30-Sep-20
CN2_MX3850	Grout Clarifier Bottoms	5	01-Oct-20	07-Oct-20
CN2_MX3900	Fill & Drain Clarifier	3	08-Oct-20	13-Oct-20
CN2_MX3960	Install Clarifier Mechanism	5	14-Oct-20	20-Oct-20
CN2_MX4060	Start-Up & Test Clarifier	5	06-Jan-21	12-Jan-21
Electrical Work		35	01-Oct-20	20-Nov-20
CN2_MX3722	Electrical Grounding	5	01-Oct-20	07-Oct-20
CN2_MX3720	Feeders And Branch Wiring	15	08-Oct-20	29-Oct-20
CN2_MX3730	Electrical Rough In	10	08-Oct-20	22-Oct-20
CN2_MX3840	Equipment Connections	5	16-Oct-20	22-Oct-20
CN2_MX3860	Install Electrical Gear	15	16-Oct-20	05-Nov-20
CN2_MX3845	Install Clarifiers Lighting	10	30-Oct-20	13-Nov-20
Instrumentation		30	08-Oct-20	20-Nov-20
CN2_MX3740	Install I & C Devices	15	08-Oct-20	29-Oct-20
CN2_MX3950	Loop Test & Terminate I&C Devices	5	16-Nov-20	20-Nov-20
Clarifier 5-S Construction		238	02-Jan-20	11-Dec-20
Structural Work		163	02-Jan-20	21-Aug-20
A8300	Install Temporary Shoring	13	02-Jan-20	21-Jan-20
A6460	Excavate for Clarifier 5-N	10	07-Jan-20	21-Jan-20
CN2_MX2710	Pipe	10	22-Jan-20	04-Feb-20
CN2_MX2800	Center Pier	20	05-Feb-20	04-Mar-20
CN2_MX2900	Floor	20	05-Mar-20	01-Apr-20
CN2_MX2930	Wall	40	02-Apr-20	28-May-20
CN2_MX3050	Covercoat	25	29-May-20	02-Jul-20
CN2_MX3120	Launder	35	06-Jul-20	21-Aug-20
Mechanical Work		105	06-Jul-20	04-Dec-20
CN2_MX4020	Water Test Clarifier	10	06-Jul-20	17-Jul-20
CN2_MX3280	Install Weirs & Baffles	10	24-Aug-20	04-Sep-20
CN2_MX3440	Install Clarifier Equipment	30	08-Sep-20	20-Oct-20
CN2_MX3820	Grout Clarifier Bottoms	5	21-Oct-20	27-Oct-20
CN2_MX3890	Fill & Drain Clarifier	3	28-Oct-20	30-Oct-20
CN2_MX3940	Install Clarifier Mechanism	5	02-Nov-20	06-Nov-20
CN2_MX4050	Start-Up & Test Clarifier	5	30-Nov-20	04-Dec-20
Electrical Work		35	21-Oct-20	11-Dec-20
CN2_MX3695	Install Grounding	5	21-Oct-20	27-Oct-20
CN2_MX3690	Feeders And Branch Wiring	15	28-Oct-20	18-Nov-20
CN2_MX3700	Electrical Rough In	10	28-Oct-20	10-Nov-20
CN2_MX3810	Equipment Connections	5	04-Nov-20	10-Nov-20
CN2_MX3830	Install Electrical Gear	15	04-Nov-20	25-Nov-20
CN2_MX3812	Install Clarifiers Lighting	10	19-Nov-20	04-Dec-20
Instrumentation		30	28-Oct-20	11-Dec-20
CN2_MX3710	Install I & C Devices	15	28-Oct-20	18-Nov-20
CN2_MX3930	Loop Test & Terminate I&C Devices	5	07-Dec-20	11-Dec-20
Ductile Iron Pipe (DIP)		150	29-May-20	05-Jan-21
CN2_MX1080	48" DIP CL150 CML-RAS-Relocated Line to Existing RAS Line	10	29-May-20	11-Jun-20
CN2_MX1160	6" DIP CL350 P401-SC-Clarifiers to Scum Pump Station	5	07-Dec-20	11-Dec-20
CN2_MX1200	8" DIP CL350 P401-SC-Scum Pump Station to Existing Headworks	5	14-Dec-20	18-Dec-20
CN2_MX1070	24" DIP CL150 CML-RAS-Existing RAS to RAS Aeration	5	21-Dec-20	28-Dec-20
CN2_MX1100	18" DIP CL350 CML-SLUDGE-Relocation @ RAS Aeration	5	29-Dec-20	05-Jan-21
Prestressed Concrete Cylinder Pipe		28	05-Feb-20	16-Mar-20



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Remaining Level of Effort
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T.E. Maxson Wastewater Treatment Facility

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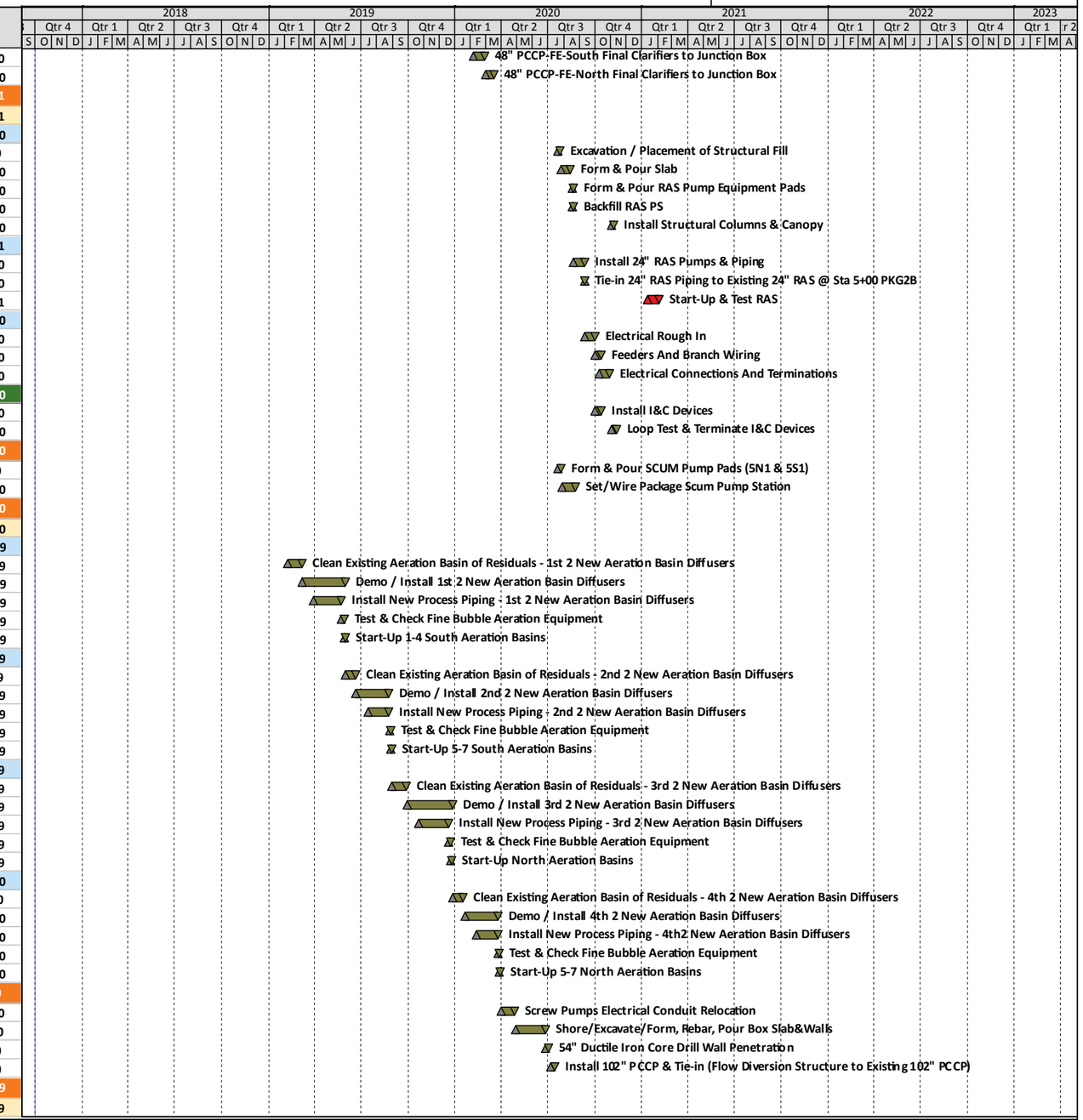
Activity ID	Activity Name	Dur	Start	Finish
CN2_MX1620	48" PCCP-FE-South Final Clarifiers to Junction Box	17	05-Feb-20	28-Feb-20
CN2_MX1800	48" PCCP-FE-North Final Clarifiers to Junction Box	11	02-Mar-20	16-Mar-20
43 RAS PUMP STATION		135	20-Jul-20	03-Feb-21
RAS PS		135	20-Jul-20	03-Feb-21
Structural Work		78	20-Jul-20	06-Nov-20
MX3310	Excavation / Placement of Structural Fill	5	20-Jul-20	24-Jul-20
MX3390	Form & Pour Slab	15	27-Jul-20	14-Aug-20
MX3330	Form & Pour RAS Pump Equipment Pads	3	17-Aug-20	19-Aug-20
MX3597	Backfill RAS PS	2	18-Aug-20	19-Aug-20
MX3600	Install Structural Columns & Canopy	5	02-Nov-20	06-Nov-20
Mechanical Work		112	20-Aug-20	03-Feb-21
MX3530	Install 24" RAS Pumps & Piping	15	20-Aug-20	10-Sep-20
MX3690	Tie-in 24" RAS Piping to Existing 24" RAS @ Sta 5+00 PKG2B	1	11-Sep-20	11-Sep-20
MX3920	Start-Up & Test RAS	15	13-Jan-21	03-Feb-21
Electrical Work		43	11-Sep-20	12-Nov-20
MX3650	Electrical Rough In	15	11-Sep-20	01-Oct-20
MX3660	Feeders And Branch Wiring	8	02-Oct-20	14-Oct-20
MX3770	Electrical Connections And Terminations	15	09-Oct-20	30-Oct-20
Instrumentation		28	02-Oct-20	12-Nov-20
MX3670	Install I&C Devices	8	02-Oct-20	14-Oct-20
MX3780	Loop Test & Terminate I&C Devices	8	02-Nov-20	12-Nov-20
Scum Pump Station		26	20-Jul-20	24-Aug-20
MX3430	Form & Pour SCUM Pump Pads (5N1 & 5S1)	6	20-Jul-20	27-Jul-20
A6440	Set/Wire Package Scum Pump Station	20	28-Jul-20	24-Aug-20
24 Existing Aeration Basin Upgrades		286	07-Feb-19	30-Mar-20
Aeration Basin - (14 Aeration Basins)		286	07-Feb-19	30-Mar-20
South Aeration Basins 1-4		80	07-Feb-19	31-May-19
CN2_A3370	Clean Existing Aeration Basin of Residuals - 1st 2 New Aeration Basin Diffusers	20	07-Feb-19	07-Mar-19
CN2_MX1650	Demo / Install 1st 2 New Aeration Basin Diffusers	60	08-Mar-19	31-May-19
CN2_A3380	Install New Process Piping - 1st 2 New Aeration Basin Diffusers	40	29-Mar-19	23-May-19
CN2_A5410	Test & Check Fine Bubble Aeration Equipment	2	24-May-19	28-May-19
CN2_A5230	Start-Up 1-4 South Aeration Basins	2	29-May-19	30-May-19
South Aeration Basins 5-7		64	31-May-19	29-Aug-19
CN2_A3410	Clean Existing Aeration Basin of Residuals - 2nd 2 New Aeration Basin Diffusers	15	31-May-19	20-Jun-19
CN2_MX1651	Demo / Install 2nd 2 New Aeration Basin Diffusers	45	21-Jun-19	23-Aug-19
A3420	Install New Process Piping - 2nd 2 New Aeration Basin Diffusers	30	15-Jul-19	23-Aug-19
A5390	Test & Check Fine Bubble Aeration Equipment	2	26-Aug-19	27-Aug-19
A5240	Start-Up 5-7 South Aeration Basins	2	28-Aug-19	29-Aug-19
North Aeration Basins 1-4		80	30-Aug-19	27-Dec-19
A3450	Clean Existing Aeration Basin of Residuals - 3rd 2 New Aeration Basin Diffusers	20	30-Aug-19	27-Sep-19
MX1652	Demo / Install 3rd 2 New Aeration Basin Diffusers	60	30-Sep-19	27-Dec-19
A3460	Install New Process Piping - 3rd 2 New Aeration Basin Diffusers	40	22-Oct-19	19-Dec-19
A5370	Test & Check Fine Bubble Aeration Equipment	2	20-Dec-19	23-Dec-19
A5250	Start-Up North Aeration Basins	2	24-Dec-19	26-Dec-19
North Aeration Basins 5-7		64	27-Dec-19	30-Mar-20
A3490	Clean Existing Aeration Basin of Residuals - 4th 2 New Aeration Basin Diffusers	15	27-Dec-19	17-Jan-20
MX1653	Demo / Install 4th 2 New Aeration Basin Diffusers	45	21-Jan-20	24-Mar-20
A3500	Install New Process Piping - 4th2 New Aeration Basin Diffusers	30	11-Feb-20	24-Mar-20
A5350	Test & Check Fine Bubble Aeration Equipment	2	25-Mar-20	26-Mar-20
A5260	Start-Up 5-7 North Aeration Basins	2	27-Mar-20	30-Mar-20
Intermediate PS Flow Diversion		74	31-Mar-20	14-Jul-20
A6360	Screw Pumps Electrical Conduit Relocation	20	31-Mar-20	27-Apr-20
A6350	Shore/Excavate/Form, Rebar, Pour Box Slab&Walls	42	28-Apr-20	25-Jun-20
FC0010	54" Ductile Iron Core Drill Wall Penetration	5	26-Jun-20	02-Jul-20
A6400	Install 102" PCCP & Tie-in (Flow Diversion Structure to Existing 102" PCCP)	7	06-Jul-20	14-Jul-20
Odor Control System - Throughout		173	28-Nov-18	05-Aug-19
OC:1 Influent Junction Box		103	28-Nov-18	25-Apr-19



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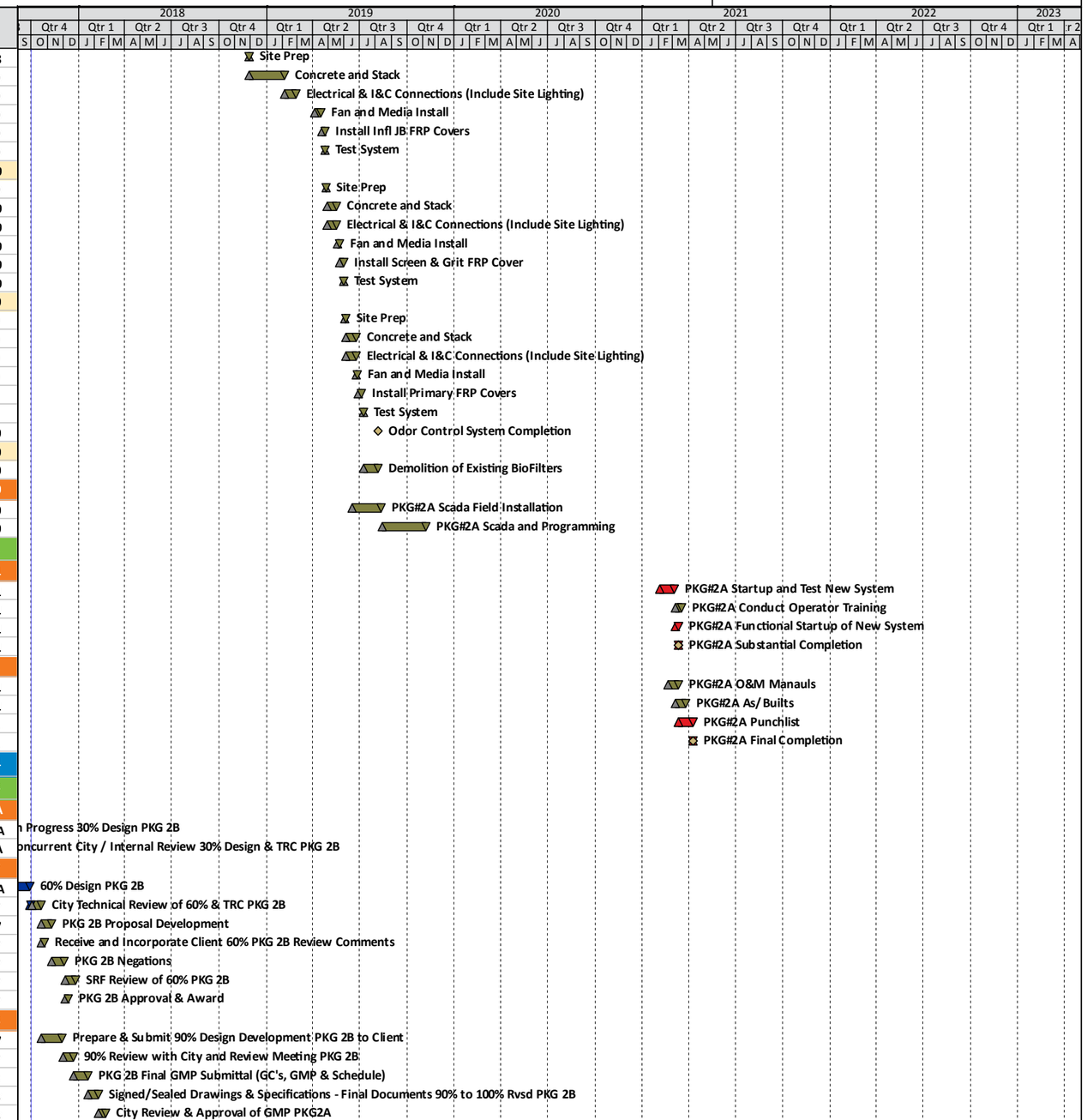
Activity ID	Activity Name	Dur	Start	Finish
MX1750	Site Prep	1	28-Nov-18	28-Nov-18
MX1770	Concrete and Stack	45	29-Nov-18	04-Feb-19
MX2180	Electrical & I&C Connections (Include Site Lighting)	15	05-Feb-19	26-Feb-19
MX2100	Fan and Media Install	9	05-Apr-19	17-Apr-19
A6370	Install Infl JB FRP Covers	5	18-Apr-19	24-Apr-19
MX2220	Test System	1	25-Apr-19	25-Apr-19
OC:2 Screening and Grit		25	26-Apr-19	31-May-19
MX2240	Site Prep	1	26-Apr-19	26-Apr-19
MX2250	Concrete and Stack	15	29-Apr-19	17-May-19
MX2340	Electrical & I&C Connections (Include Site Lighting)	15	29-Apr-19	17-May-19
MX2290	Fan and Media Install	3	20-May-19	22-May-19
A6380	Install Screen & Grit FRP Cover	5	23-May-19	30-May-19
MX2390	Test System	1	31-May-19	31-May-19
OC:3 Primary Weirs, Primary Effluent, Intermediate PS		45	03-Jun-19	05-Aug-19
MX2440	Site Prep	1	03-Jun-19	03-Jun-19
MX2450	Concrete and Stack	15	04-Jun-19	24-Jun-19
MX2610	Electrical & I&C Connections (Include Site Lighting)	15	04-Jun-19	24-Jun-19
MX2590	Fan and Media Install	3	25-Jun-19	27-Jun-19
A6390	Install Primary FRP Covers	5	28-Jun-19	05-Jul-19
MX2640	Test System	1	08-Jul-19	08-Jul-19
DN2_MX2644	Odor Control System Completion	0		05-Aug-19
Demollition of Existing Biofilters		20	09-Jul-19	05-Aug-19
A6450	Demolition of Existing BioFilters	20	09-Jul-19	05-Aug-19
SCADA and Programming for the full system		100	17-Jun-19	06-Nov-19
A6150	PKG#2A Scada Field Installation	40	17-Jun-19	12-Aug-19
A6160	PKG#2A Scada and Programming	60	13-Aug-19	06-Nov-19
CLOSEOUT		45	04-Feb-21	08-Apr-21
Testing		30	04-Feb-21	18-Mar-21
MX3580	PKG#2A Startup and Test New System	20	04-Feb-21	04-Mar-21
MX3980	PKG#2A Conduct Operator Training	10	05-Mar-21	18-Mar-21
MX3990	PKG#2A Functional Startup of New System	5	05-Mar-21	11-Mar-21
MX3982	PKG#2A Substantial Completion	0		11-Mar-21
Closeout		35	19-Feb-21	08-Apr-21
A5940	PKG#2A O&M Manauls	15	19-Feb-21	11-Mar-21
MX3970	PKG#2A As/Builts	15	05-Mar-21	25-Mar-21
MX4070	PKG#2A Punchlist	20	12-Mar-21	08-Apr-21
MX4100	PKG#2A Final Completion	0		08-Apr-21
PKG 2B RAS REAERATION BASINS, ELECTRICAL WORK(EL BLDG), & YARD PIPING		965	01-May-17 A	11-Mar-21
DESIGN- 2B		207	01-May-17 A	22-Feb-18
PKG 2B Design Progression (30%)		63	01-May-17 A	28-Jul-17 A
A6810	Design Progress 30% Design PKG 2B	33	01-May-17 A	16-Jun-17 A
A6820	Concurrent City / Internal Review 30% Design & TRC PKG 2B	29	19-Jun-17 A	28-Jul-17 A
PKG 2B Development and Negotiation (60%)		103	31-Jul-17 A	26-Dec-17
A6850	60% Design PKG 2B	42	31-Jul-17 A	28-Sep-17 A
A6780	City Technical Review of 60% & TRC PKG 2B	15	29-Sep-17 A	19-Oct-17
A6760	PKG 2B Proposal Development	15	20-Oct-17	09-Nov-17
A6770	Receive and Incorporate Client 60% PKG 2B Review Comments	5	20-Oct-17	26-Oct-17
A6790	PKG 2B Negations	15	10-Nov-17	04-Dec-17
A6750	SRF Review of 60% PKG 2B	15	05-Dec-17	26-Dec-17
A6800	PKG 2B Approval & Award	5	05-Dec-17	11-Dec-17
PKG 2B Finalize Design		86	20-Oct-17	22-Feb-18
A6740	Prepare & Submit 90% Design Development PKG 2B to Client	28	20-Oct-17	30-Nov-17
A6720	90% Review with City and Review Meeting PKG 2B	15	01-Dec-17	21-Dec-17
A6940	PKG 2B Final GMP Submittal (GC's, GMP & Schedule)	18	22-Dec-17	18-Jan-18
A6830	Signed/Sealed Drawings & Specifications - Final Documents 90% to 100% Rvsd PKG 2B	15	19-Jan-18	08-Feb-18
A6950	City Review & Approval of GMP PKG2A	10	09-Feb-18	22-Feb-18



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Remaining Level of Effort
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Preliminary Schedule
PKG#2A2B Detail Schedule by WBS

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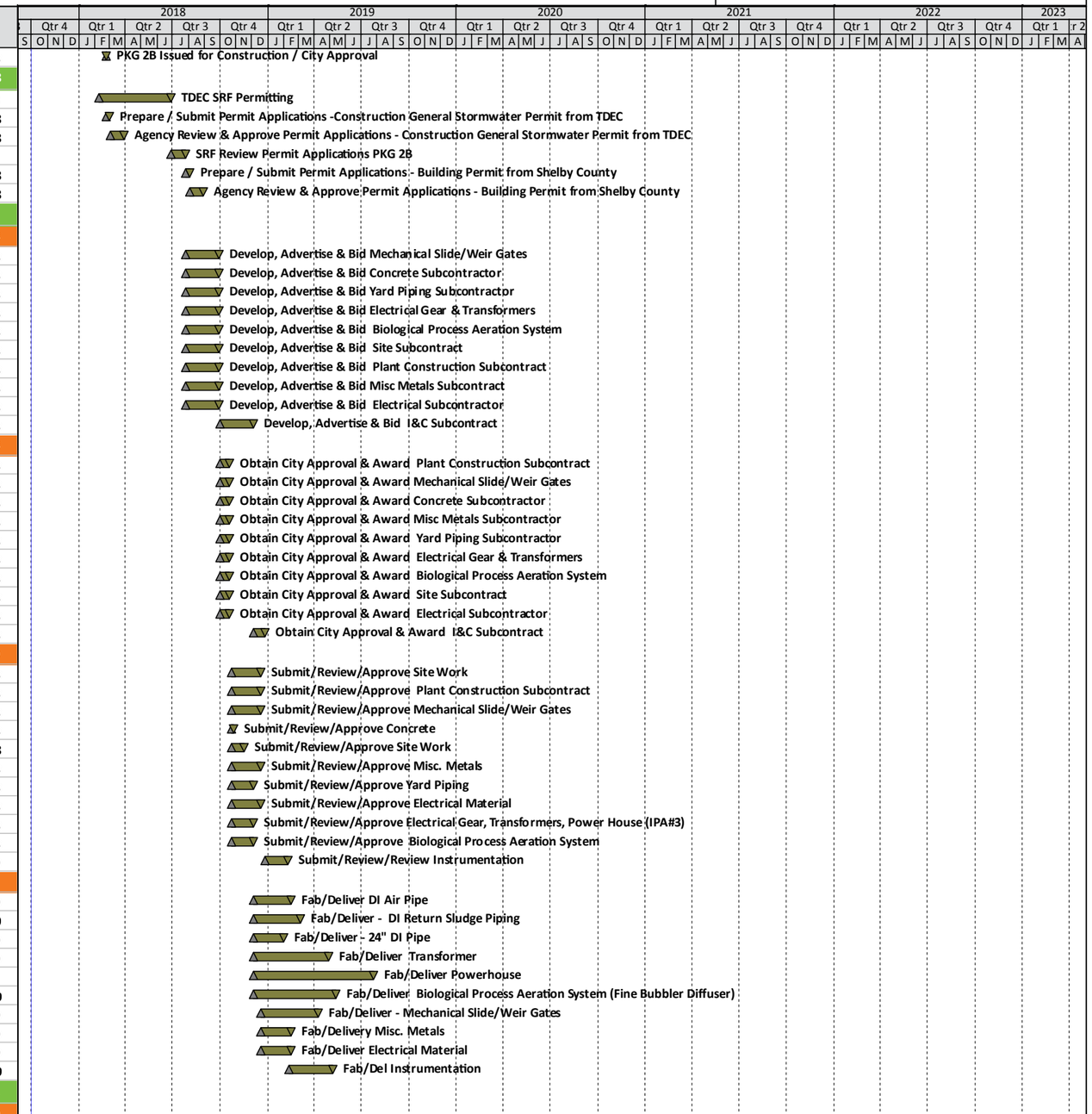
The City of Memphis

T.E. Maxson Wastewater Treatment Facility

DATE: 11-Oct-17 Time: 11:25

Activity ID	Activity Name	Dur	Start	Finish
A6840	PKG 2B Issued for Construction / City Approval	1	22-Feb-18	22-Feb-18
PERMITTING Pkg 2B		**142**	**09-Feb-18**	**30-Aug-18**
A8310	TDEC SRF Permitting	97	09-Feb-18	27-Jun-18
A6520	Prepare / Submit Permit Applications -Construction General Stormwater Permit from TDEC	5	23-Feb-18	01-Mar-18
A6530	Agency Review & Approve Permit Applications - Construction General Stormwater Permit from T	20	02-Mar-18	29-Mar-18
A6540	SRF Review Permit Applications PKG 2B	20	28-Jun-18	26-Jul-18
A6500	Prepare / Submit Permit Applications - Building Permit from Shelby County	5	27-Jul-18	02-Aug-18
A6510	Agency Review & Approve Permit Applications - Building Permit from Shelby County	20	03-Aug-18	30-Aug-18
PROCUREMENT-PKG 2B		**248**	**27-Jul-18**	**24-Jul-19**
PKG 2B Develop, Advertise & Bid		**90**	**27-Jul-18**	**04-Dec-18**
A7250	Develop, Advertise & Bid Mechanical Slide/Weir Gates	45	27-Jul-18	28-Sep-18
A7240	Develop, Advertise & Bid Concrete Subcontractor	45	27-Jul-18	28-Sep-18
A7200	Develop, Advertise & Bid Yard Piping Subcontractor	45	27-Jul-18	28-Sep-18
A6730	Develop, Advertise & Bid Electrical Gear & Transformers	45	27-Jul-18	28-Sep-18
A6640	Develop, Advertise & Bid Biological Process Aeration System	45	27-Jul-18	28-Sep-18
A6660	Develop, Advertise & Bid Site Subcontract	45	27-Jul-18	28-Sep-18
A6690	Develop, Advertise & Bid Plant Construction Subcontract	45	27-Jul-18	28-Sep-18
A6700	Develop, Advertise & Bid Misc Metals Subcontract	45	27-Jul-18	28-Sep-18
A6710	Develop, Advertise & Bid Electrical Subcontractor	45	27-Jul-18	28-Sep-18
A6670	Develop, Advertise & Bid I&C Subcontract	45	01-Oct-18	04-Dec-18
PKG 2B Obtain City Approval & Award		**60**	**01-Oct-18**	**26-Dec-18**
A7280	Obtain City Approval & Award Plant Construction Subcontract	15	01-Oct-18	19-Oct-18
A7260	Obtain City Approval & Award Mechanical Slide/Weir Gates	15	01-Oct-18	19-Oct-18
A6680	Obtain City Approval & Award Concrete Subcontractor	15	01-Oct-18	19-Oct-18
A7230	Obtain City Approval & Award Misc Metals Subcontractor	15	01-Oct-18	19-Oct-18
A6650	Obtain City Approval & Award Yard Piping Subcontractor	15	01-Oct-18	19-Oct-18
A6960	Obtain City Approval & Award Electrical Gear & Transformers	15	01-Oct-18	19-Oct-18
A6570	Obtain City Approval & Award Biological Process Aeration System	15	01-Oct-18	19-Oct-18
A6600	Obtain City Approval & Award Site Subcontract	15	01-Oct-18	19-Oct-18
A6630	Obtain City Approval & Award Electrical Subcontractor	15	01-Oct-18	19-Oct-18
A6610	Obtain City Approval & Award I&C Subcontract	15	05-Dec-18	26-Dec-18
Submittals		**74**	**22-Oct-18**	**08-Feb-19**
A7810	Submit/Review/Approve Site Work	40	22-Oct-18	19-Dec-18
A7290	Submit/Review/Approve Plant Construction Subcontract	40	22-Oct-18	18-Dec-18
A6620	Submit/Review/Approve Mechanical Slide/Weir Gates	40	22-Oct-18	18-Dec-18
A6590	Submit/Review/Approve Concrete	5	22-Oct-18	26-Oct-18
A6580	Submit/Review/Approve Site Work	20	22-Oct-18	16-Nov-18
A7220	Submit/Review/Approve Misc. Metals	40	22-Oct-18	18-Dec-18
A7080	Submit/Review/Approve Yard Piping	30	22-Oct-18	04-Dec-18
A7000	Submit/Review/Approve Electrical Material	40	22-Oct-18	18-Dec-18
A6970	Submit/Review/Approve Electrical Gear, Transformers, Power House (IPA#3)	30	22-Oct-18	04-Dec-18
A6560	Submit/Review/Approve Biological Process Aeration System	30	22-Oct-18	04-Dec-18
A7010	Submit/Review/Review Instrumentation	30	27-Dec-18	08-Feb-19
Fabrication & Delivery		**160**	**05-Dec-18**	**24-Jul-19**
A7300	Fab/Deliver DI Air Pipe	50	05-Dec-18	15-Feb-19
A7100	Fab/Deliver - DI Return Sludge Piping	60	05-Dec-18	04-Mar-19
A7090	Fab/Deliver - 24" DI Pipe	40	05-Dec-18	01-Feb-19
A6990	Fab/Deliver Transformer	100	05-Dec-18	29-Apr-19
A6980	Fab/Deliver Powerhouse	160	05-Dec-18	24-Jul-19
A6550	Fab/Deliver Biological Process Aeration System (Fine Bubbler Diffuser)	110	05-Dec-18	13-May-19
A7270	Fab/Deliver - Mechanical Slide/Weir Gates	75	19-Dec-18	08-Apr-19
A7210	Fab/Delivery Misc. Metals	40	19-Dec-18	15-Feb-19
A7030	Fab/Deliver Electrical Material	40	19-Dec-18	15-Feb-19
A7020	Fab/Del Instrumentation	60	11-Feb-19	06-May-19
CONSTRUCTION		**378**	**01-Jul-19**	**05-Jan-21**
Coordination Milestones		**45**	**21-Oct-20**	**29-Dec-20**



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Critical R...
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Preliminary Schedule
PKG#2A2B Detail Schedule by WBS

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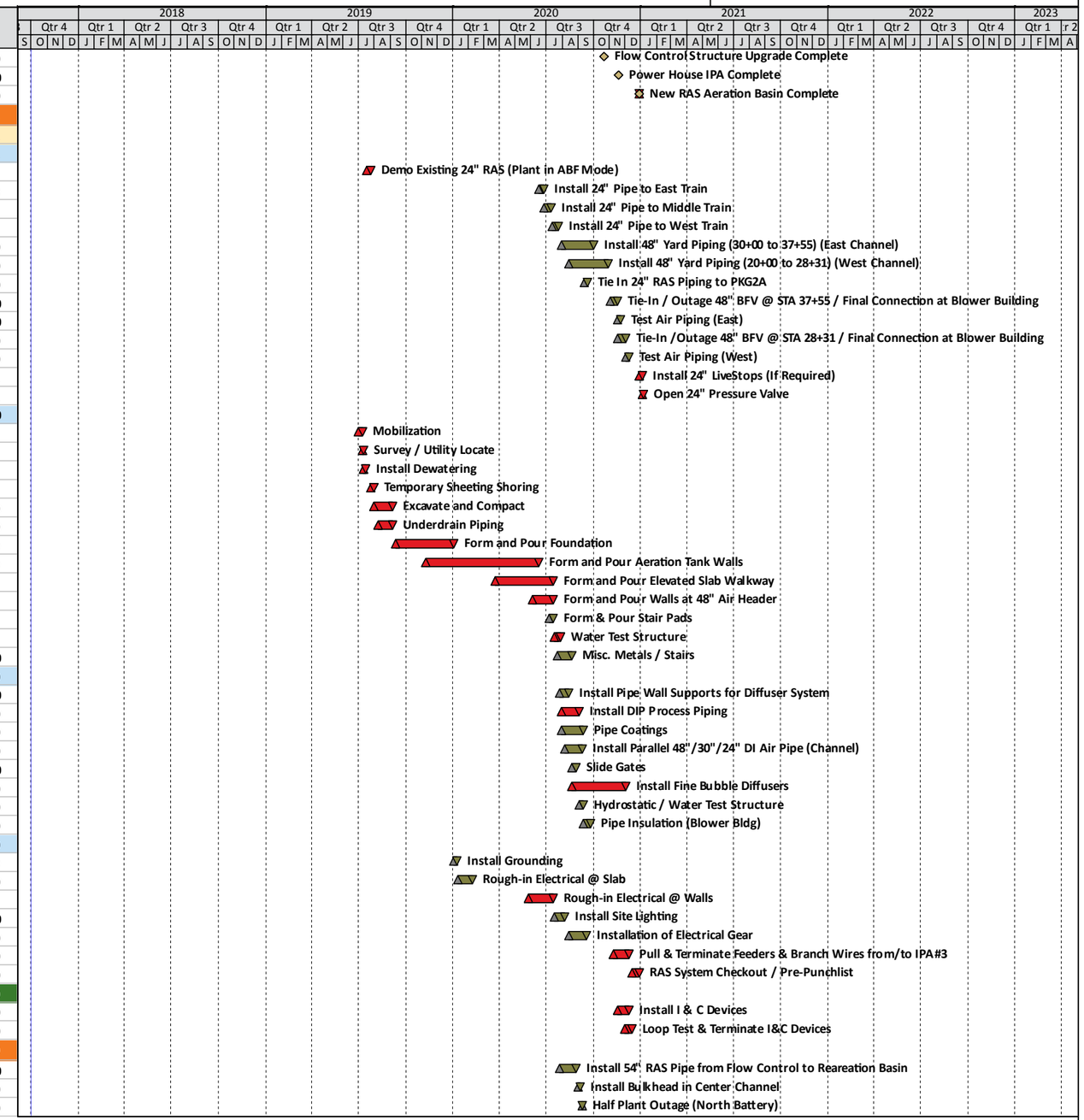
The City of Memphis

T.E. Maxson Wastewater Treatment Facility

DATE: 11-Oct-17 Time: 11:25

Activity ID	Activity Name	Dur	Start	Finish
MScn_110	Flow Control Structure Upgrade Complete	0		21-Oct-20
MScn_120	Power House IPA Complete	0		19-Nov-20
MScn_100	New RAS Aeration Basin Complete	0		29-Dec-20
SECONDARY PROCESS - RAS AERATION BASIN & NEW ELECTRICAL BUILDING		378	01-Jul-19	05-Jan-21
27 NEW RAS AERATION BASIN		378	01-Jul-19	05-Jan-21
Yard Piping		368	16-Jul-19	05-Jan-21
MX2400	Demo Existing 24" RAS (Plant in ABF Mode)	7	16-Jul-19	24-Jul-19
MX2425	Install 24" Pipe to East Train	7	17-Jun-20	25-Jun-20
MX2435	Install 24" Pipe to Middle Train	10	26-Jun-20	10-Jul-20
MX2455	Install 24" Pipe to West Train	10	13-Jul-20	24-Jul-20
MX2505	Install 48" Yard Piping (30+00 to 37+55) (East Channel)	45	30-Jul-20	01-Oct-20
MX2485	Install 48" Yard Piping (20+00 to 28+31) (West Channel)	55	13-Aug-20	30-Oct-20
MX2545	Tie In 24" RAS Piping to PKG2A	5	14-Sep-20	18-Sep-20
MX2515	Tie-In / Outage 48" BFV @ STA 37+55 / Final Connection at Blower Building	10	02-Nov-20	16-Nov-20
MX2525	Test Air Piping (East)	5	17-Nov-20	23-Nov-20
MX2495	Tie-In /Outage 48" BFV @ STA 28+31 / Final Connection at Blower Building	10	17-Nov-20	02-Dec-20
MX2535	Test Air Piping (West)	5	03-Dec-20	09-Dec-20
MX2465	Install 24" LiveStops (If Required)	3	30-Dec-20	04-Jan-21
MX2475	Open 24" Pressure Valve	1	05-Jan-21	05-Jan-21
Structure		286	01-Jul-19	19-Aug-20
MX1120	Mobilization	5	01-Jul-19	08-Jul-19
MX1125	Survey / Utility Locate	2	09-Jul-19	10-Jul-19
MX1130	Install Dewatering	3	11-Jul-19*	15-Jul-19
MX1170	Temporary Sheeting Shoring	4	25-Jul-19	30-Jul-19
MX1240	Excavate and Compact	25	31-Jul-19	04-Sep-19
MX1360	Underdrain Piping	20	07-Aug-19	04-Sep-19
MX1490	Form and Pour Foundation	75	12-Sep-19	02-Jan-20
MX1870	Form and Pour Aeration Tank Walls	150	08-Nov-19	16-Jun-20
MX2130	Form and Pour Elevated Slab Walkway	80	24-Mar-20	15-Jul-20
MX2260	Form and Pour Walls at 48" Air Header	30	03-Jun-20	15-Jul-20
MX2270	Form & Pour Stair Pads	7	07-Jul-20	15-Jul-20
MX2280	Water Test Structure	10	16-Jul-20	29-Jul-20
MX2370	Misc. Metals / Stairs	20	23-Jul-20	19-Aug-20
Mechanical		88	27-Jul-20	02-Dec-20
MX2410	Install Pipe Wall Supports for Diffuser System	15	27-Jul-20	14-Aug-20
MX2300	Install DIP Process Piping	25	30-Jul-20	02-Sep-20
MX2320	Pipe Coatings	30	30-Jul-20	10-Sep-20
MX2420	Install Parallel 48"/30"/24" DI Air Pipe (Channel)	24	06-Aug-20	09-Sep-20
MX2310	Slide Gates	7	20-Aug-20	28-Aug-20
MX2330	Install Fine Bubble Diffusers	70	20-Aug-20	02-Dec-20
A6100	Hydrostatic / Water Test Structure	5	03-Sep-20	10-Sep-20
MX2380	Pipe Insulation (Blower Bldg)	10	11-Sep-20	24-Sep-20
Electrical		248	03-Jan-20	29-Dec-20
A5880	Install Grounding	5	03-Jan-20	09-Jan-20
MX1930	Rough-in Electrical @ Slab	20	10-Jan-20	07-Feb-20
MX2110	Rough-in Electrical @ Walls	35	27-May-20	15-Jul-20
A5890	Install Site Lighting	15	16-Jul-20	05-Aug-20
MX2580	Installation of Electrical Gear	25	13-Aug-20	17-Sep-20
MX2780	Pull & Terminate Feeders & Branch Wires from/to IPA#3	20	09-Nov-20	09-Dec-20
MX2790	RAS System Checkout / Pre-Punchlist	10	15-Dec-20	29-Dec-20
Instrumentation		18	17-Nov-20	14-Dec-20
MX2830	Install I & C Devices	15	17-Nov-20	09-Dec-20
MX2880	Loop Test & Terminate I&C Devices	10	01-Dec-20	14-Dec-20
FLOW CONTROL STRUCTURE UPGRADES		61	27-Jul-20	21-Oct-20
FC0001	Install 54" RAS Pipe from Flow Control to Reareation Basin	25	27-Jul-20	28-Aug-20
FC0020	Install Bulkhead in Center Channel	5	31-Aug-20	04-Sep-20
FC0030	Half Plant Outage (North Battery)	1	08-Sep-20	08-Sep-20



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Preliminary Schedule
PKG#2A2B Detail Schedule by WBS

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Attachment 3- Alternative Analysis

- November 27, 2013 *Process Alternatives Evaluation TM*
- *Maxson Disinfection Alternative Evaluation Report* February 2017
- *Lagoon 5 Improvements Design Memorandum* dated March 23, 2015 from Black & Veatch
- *T.E. Maxson WWTF Process Upgrades Conceptual Design Report dated June 2016 – Appendices are not included due to space limitations. The full file is available upon request.*
- *1996 Preliminary Review of Alternatives*

Technical Memorandum

To: *Paul Patterson*
Scott Morgan, PE
Mike Brower

From: *CDM Smith Inc.*

Date: *November 27, 2013*

Subject: *T.E. Maxson WWTP Process Alternatives Evaluation*

1.0 Introduction

The T.E. Maxson WWTP (Maxson WWTP) is located in the southwest portion of Memphis, Tennessee at 2685 Steam Plant Road. The WWTP currently treats an average of 70 million gallons per day (mgd) of wastewater, serving the City of Memphis (City) since its commissioning in 1975. With upgrades over the years, the current liquid treatment process consists of coarse bar screens, grit removal, recently installed fine bar screens, primary clarification, high-rate biotowers, activated sludge and secondary clarification.

The City is currently planning an upgrade to provide disinfection as the final treatment process to meet requirements in the current draft National Pollution Discharge Elimination System (NPDES) permit. The process that will ultimately be selected to provide disinfection is directly impacted by the secondary effluent quality. In addition to the need to address effluent quality to minimize the costs of the new disinfection process, the facility is experiencing an increase in wastewater flows and loads, which has prompted the City to evaluate the existing plant and operations to determine what would be required to meet the original design flow of 90 mgd. As a result, the City has requested that CDM Smith conduct a holistic evaluation of the liquid processes at the Maxson WWTP to address the following objectives:

- Solids loading and clarifier performance to ensure disinfection optimization;
- Discuss concerns with odor control at the plant, particularly at the existing biotowers; and
- Potential future capacity issues at the plant.

This technical memorandum provides a summary of the process evaluation and includes an analysis of the biological treatment processes, consideration of solids loading, clarifier performance, biotower process performance, and capacity related issues. Additional evaluation of

biosolids handling, which was not identified in this scope of work, may be necessary depending upon the improvements selected for further consideration.

2.0 Evaluation Approach

Historical plant data were obtained from the City and analyzed to develop a basis of evaluation of the plant. Peaking factors for the average-day (AD), average-day maximum-month (ADMM) and maximum-day (MD) loading conditions were determined based on this analysis. These peaking factors were applied to the plant's permitted average day flow of 90 mgd as a basis for evaluating the liquid treatment processes; the design flows and loads are summarized in **Table 2-1**.

Table 2-1 Influent Design Conditions

Influent Parameters	AD	ADMM	MD
Flow (mgd)	90	126	153
BOD5 (ppd)	515,700	562,100	727,100
TSS (ppd)	426,300	550,000	703,500
TKN (ppd)	75,100	90,100	112,600
TP (ppd)	15,000	18,000	22,500
Minimum monthly Water Temp (deg C)	14	14	14

Table 2-2 provides a summary of the current draft NPDES requirements at the permitted average design flow of 90 mgd. In addition to permit compliance, this evaluation also considers the need to consistently achieve effluent total suspended solids (TSS) of less than30 milligrams per liter (mg/L). This is lower than the concentration required for discharge, according to the NPDES permit, but is a requirement for ultraviolet (UV) disinfection to be a feasible disinfection alternative. There are potential impacts on the solids handling processes as a result of the lower TSS objective, which will require further evaluation, based on the modifications selected for the liquid process.

Table 2-2 Effluent NPDES Requirements

Effluent Parameter	Maximum Daily	Average Monthly
BOD5 (mg/L)	84 (40% removal)	42 (85% removal)
TSS (mg/L)	96 (40% removal)	48 (85% removal)

There is currently no ammonia-nitrogen limit in the NPDES permit, and a total nitrogen limit is not anticipated in the foreseeable future; therefore, nitrification has not been included in the liquid treatment process evaluation. However, the alternatives have been developed such that, if

nitrification is required in a future effluent limit, the process improvements could be incorporated into any potential upgrades that would be required to achieve nitrification. While any of the alternatives developed could be later upgraded to achieve nitrification, each alternative has a different site footprint. Generally to achieve nitrification, the biomass maintained under aerobic conditions would need to be increased by approximately four times over that identified in this evaluation, which results in the need for additional aeration tankage and/or clarifiers.

While the current permit does not include nitrification or nutrient removal as requirements, there is the potential that nutrient limits will be implemented in some future permit cycle. The driver is implementation of State-developed nutrient reduction strategies, which are a major focus of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Task Force) responsible for the national strategy to reduce, mitigate, and control hypoxia in the Northern Gulf of Mexico and improve water quality in the Mississippi River Basin. The Task Force was established in 1997 and consists of 5 federal agencies and 10 state agencies.

The Task Force objectives include having each state develop and implement its own nutrient reduction strategy, which provides flexibility for tailoring the strategy's approach and components. At the same time, the Task Force recognizes that all state strategies need to include certain essential components to achieve overall goals. The participating states include Arkansas, Indiana, Illinois, Iowa, Louisiana, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Tennessee and Wisconsin. Most of these states have already completed their strategies, while Arkansas, Kentucky and Tennessee continue to work on completing the final documents.

While Tennessee has yet to publish this guidance, several other discharge permits in the state reference the approach to how the state will implement its nutrient strategy. The Tennessee Department of Environment and Conservation (TDEC) has been developing its strategy to reflect the goals of EPA's March 16, 2011, *Memorandum: Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions*. The Tennessee approach uses regional USGS SPARROW models to determine the required performance level from WWTPs within hydrologic unit code 10 (HUC 10) watersheds.

TDEC is utilizing the "SPARROW" model (SPARROW refers to SPAtially Referenced Regressions on Watershed attributes), which relates in-stream water-quality data to spatially referenced watershed characteristics, including contaminant sources and transport factors to support its strategy. Tennessee has aggregated the South Atlantic Gulf and Tennessee (SAGT) region model output for nitrogen and phosphorus for HUC-10 watersheds within Tennessee's borders. Thus, for West Tennessee, output from the Lower Mississippi, Arkansas-White-Red, and Texas Gulf River Basin Model (MRB5) will be applied with the focus being on agricultural reductions. However, this does not eliminate the possibility of nutrient limits in WWTP permits in future permit cycles. It is anticipated that if limits are imposed in the future, TDEC would first implement seasonal nitrification requirements (i.e., summer ammonia limits). If additional actions are deemed

necessary as the strategy is implemented, then it is anticipated that TDEC would provide these more restrictive limits (total nitrogen or total phosphorus limits) in a phased approach.

2.1 Existing Capacity Evaluation

The current average flow at the plant is approximately 70 mgd, and given the influent wastewater strength, the plant is currently at or above its original design influent biochemical oxygen demand (BOD) load. With an increase to 90 mgd (design flow), the treatment objectives cannot be met with the existing plant infrastructure. Facility improvements will be required to accommodate the increased flow and load in order to meet permit requirements, as well as to provide adequate effluent quality for implementing UV disinfection, if selected as the preferred disinfection alternative.

The activated sludge process is currently operated with a low solids retention time (SRT), approximately one day, to avoid overloading the secondary clarifiers. While the plant is generally able to achieve permit requirements using this approach, this mode of operation is unstable and does result in episodic permit excursions with respect to TSS. However, based on current biotower performance with respect to soluble BOD removal, it is not possible to increase the SRT with the existing volume in the aeration tanks (even including the volume that was originally designed as aerobic digesters), which are undersized to handle the design flow from the biotowers at the current loading rate, without overloading the secondary clarifiers.

On August 27th, 2013 CDM Smith facilitated a workshop with City staff to discuss current plant operations and potential technologies appropriate for application at the facility to meet treatment requirements. Several process alternatives were discussed and the alternatives were narrowed to the most feasible options. **Figure 2-1** provides a summary of the processes to be evaluated; because each unit process option impacts the next downstream process, alternatives are presented as a decision tree. For example, if the existing biotowers process would remain, then a decision would need to be made whether it is more cost effective to add intermediate clarifiers or additional aeration basin volume. In summary, three comprehensive process alternatives have been evaluated and the results of that analysis are provided in this memorandum.

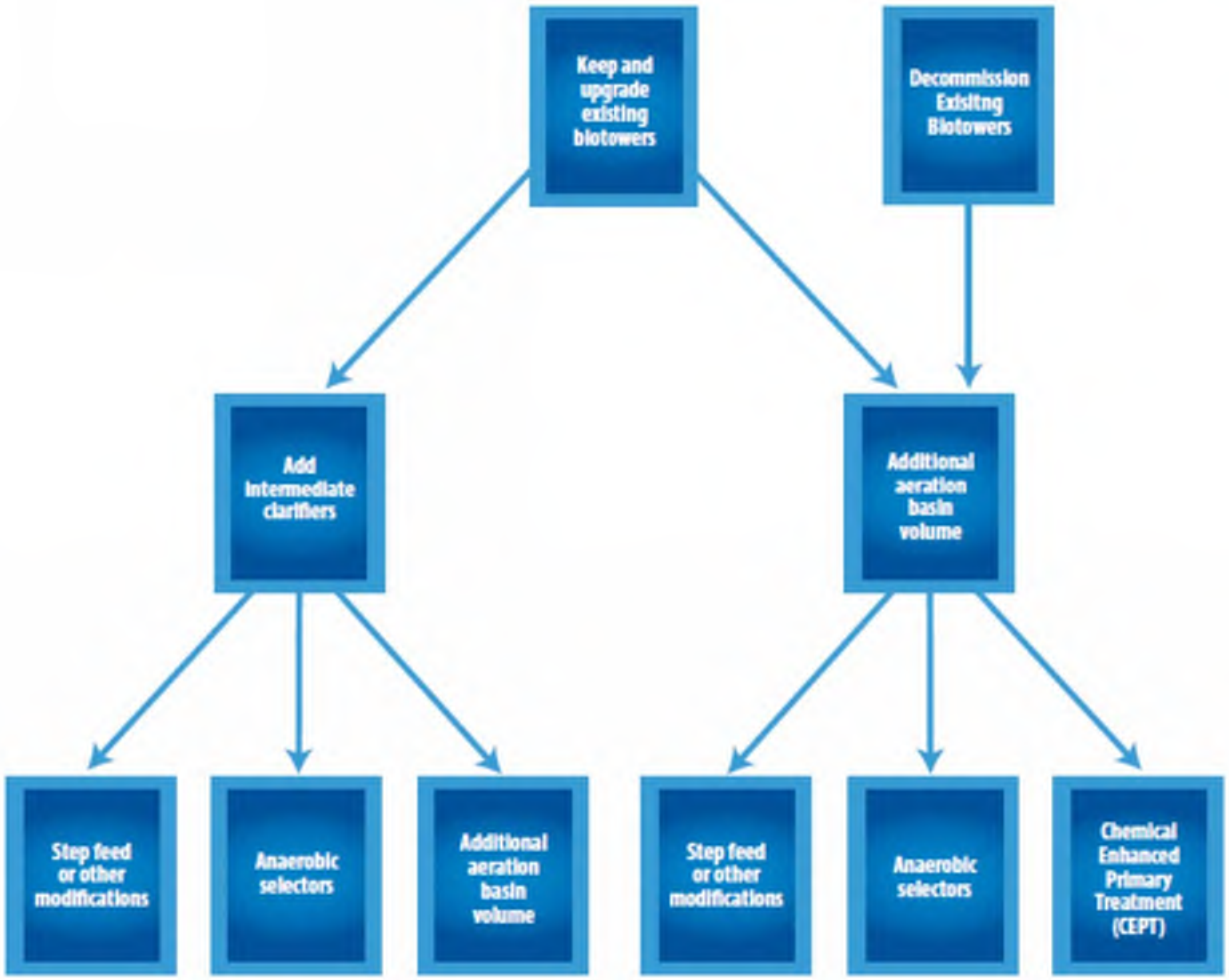

Figure 2-1 Alternatives Evaluation Decision Tree

2.2 Biotower Evaluation

With respect to the decision to keep or eliminate the existing biotowers, CDM Smith evaluated the performance of the original biotower media and compared performance to that reported for new plastic media, based on the projected loading to the process. Four biotowers were constructed in 1984 with redwood media; two additional biotowers were installed in 1997 with western cedar media. The media is past its anticipated service life and the possibility of structural failure and collapse of the media support structure presents an ongoing risk.

The performance of the biotowers could be improved by replacing the original media with new media. New media provides a significant increase in the surface area for biofilm growth, resulting in more efficient soluble BOD removal. A comparison of the soluble BOD removal by the existing original media and the anticipated removal by new media is shown in **Figure 2-2**. The performance of new media is based on modeling runs completed by Brentwood Industries using their Cross-

Flow Plastic Media. To meet the treatment objectives at the design flows and loads using the existing biotowers (if they remain) it will be necessary to replace the media. The impact of the biotowers on the aeration basin loading and resulting improvements are evaluated and discussed in Section 3.0.

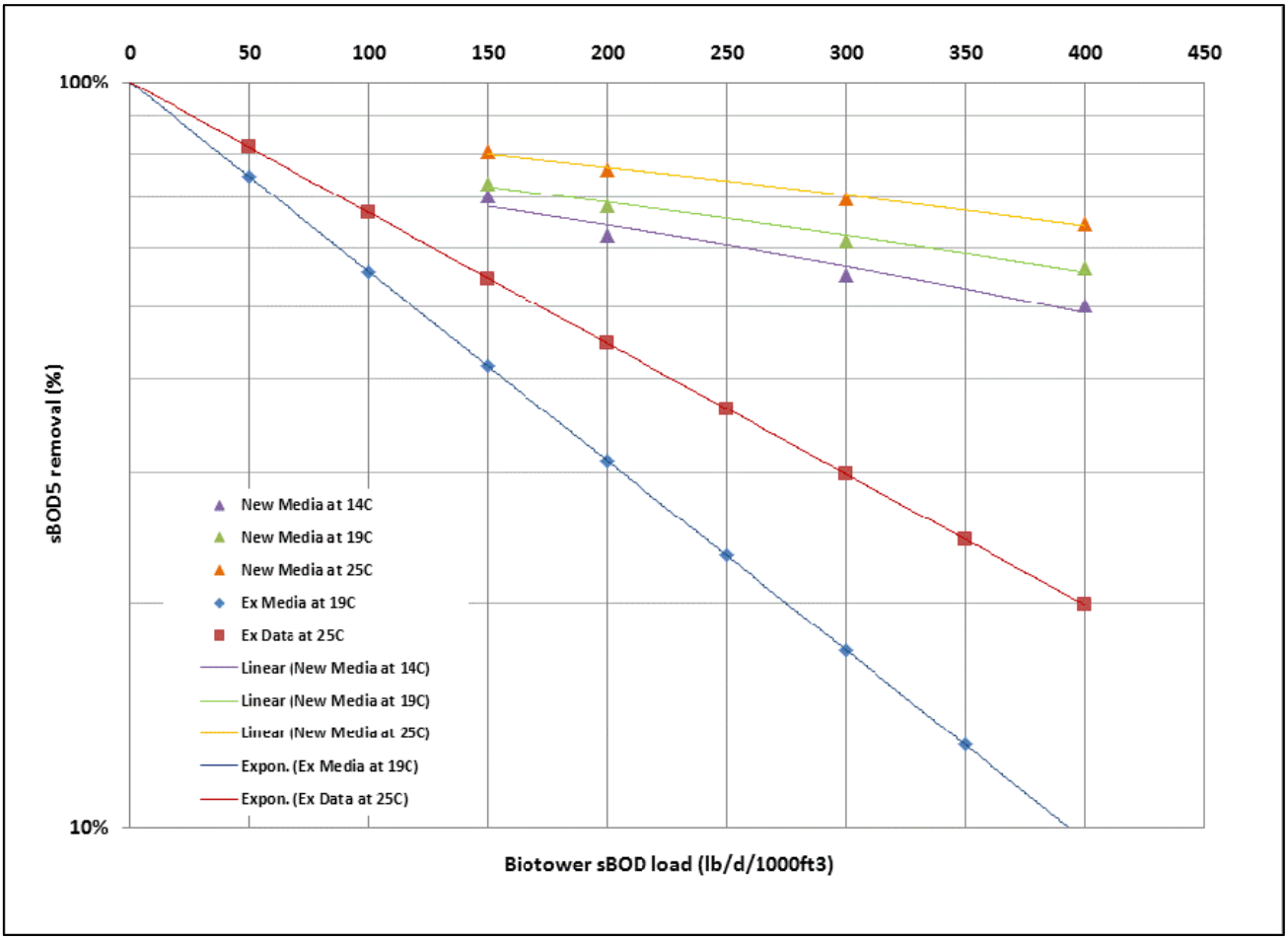

Figure 2-2 New and Existing Media Biotower Performance (% sBOD removal versus sBOD load)

3.0 Treatment Alternatives

Three treatment alternatives have been identified for detailed evaluation based on the decision tree presented in Figure 1. The requirements of each alternative are described in this section. The evaluation of each alternative includes a description of the required modifications to the liquid process train to meet the current draft NPDES permit requirements over the range of flows and loads associated with an average design flow of 90 mgd (no nitrification), and meet the TSS requirement of less than 30 mg/L on a consistent basis, for UV disinfection. In order to provide a stable activated sludge process, a minimum SRT of 2 days was selected as the basis of design. The implications with respect to the solids handling process are noted under each alternative, but

upgrades to accommodate the additional sludge handling has not been included in this evaluation. It is recommended that the City review the solids handling processes if process improvements are advanced beyond the conceptual stage.

3.1 Alternative 1: Abandon Existing Biotowers and Expand Activated Sludge Process

Alternative 1 includes abandoning the biotowers in place and expanding the activated sludge process to meet treatment requirements. CDM Smith developed a desktop tool that was utilized to determine the loading to the activated sludge process without the soluble BOD removal provided by the biotowers, so that process modifications could be identified to address future flows and loads associated with a design capacity of 90 mgd.

The average daily design flow, including sidestream recycle, to the activated sludge process is 95.8 mgd with an ADMM BOD load of 485,000 pounds per day (ppd) and a TSS load of 297,000 ppd. With an aerobic SRT of 2 days and a mixed liquor suspended solids (MLSS) of 3,400 mg/L, 29.7 million gallons (MG) of aerobic tank volume is required. The existing aeration basins provide 18.5 MG of aerobic tank volume, requiring an additional 11.2 MG to be constructed. New aeration basins would operate similarly to the existing system, i.e., in two-pass plug flow mode. As an alternative to this bioreactor configuration, the existing and new tankage could be modified to operate in step-feed mode, which would require less aerobic volume; however, step-feed would require modification of the tanks to accommodate multiple feed points. The total aeration tank volume required for step-feed operation is 24 MG (versus 29.7 MG in conventional mode), which would require an additional 5.5 MG of tankage to the existing system to be constructed (footprint 50,000 square foot (SF)) instead of the 11.2 MG required for the conventional mode.

To provide adequate clarification with one unit out of service, 12 secondary clarifiers are required, assuming a sludge volume index (SVI) of 150 milliliters per gram (mL/g). This SVI is characteristic of a well-settling biomass and in order to consistently achieve this level of performance, an anaerobic selector should also be anticipated as part of this alternative. Selectors have established proven performance at many operating plants. The preliminary sizing of an anaerobic selector, based on a hydraulic retention time (HRT) of 1 hour (forward flow only) is 3.8 MG; the selector would be included between the primary clarifiers and aeration tanks.

The return activated sludge (RAS) capacity recommended for this scenario is 100% of the average flow (or 90 mgd). The existing RAS pumping system has a capacity of 104 mgd with all pumps in service; however, due to the proposed location of the new clarifiers it is recommended that a new RAS pump station be constructed and dedicated to these clarifiers. The total solids from primary sludge, combined with the waste activated sludge (WAS), are approximately 641,000 ppd, or 3.6 dry tons per mgd, on an ADMM basis. The increase in WAS can be accommodated using an additional pump with disposal to the existing lagoons. The increase in primary sludge may require longer operation of the solids handling process with the existing belt filter presses (BFP), or require additional units to be installed.

Expanding the existing activated sludge process to accommodate these loads would require construction of additional aeration tanks, a new blower building, an anaerobic selector, secondary clarifiers, and RAS and WAS pumps housed in a new pump station. This alternative would also include removal and disposal of the media in the biotowers, though the structures would not be demolished, but instead abandoned in place. It is recommended that the biotower structures not be demolished as the space is not required for other needs at this time and they could be used in the future if required to meet increased loading or future ammonia limits requiring nitrification be added to the process. **Table 3-1** provides a summary of process upgrades to implement this alternative. The analysis conducted for Alternative 1 assumes that additional blowers, clarifiers and pumps would be provided in a configuration similar to conventional plug-flow treatment.

Table 3-1 Expand Activated Sludge Process, No Biotowers

Process Upgrades	Future Required	Existing	New Construction
Aeration			
Aeration Tank Volume (MG)	29.7	18.5	11.2
Anaerobic Selector Tank Volume (MG)	3.8	0	3.8
Aeration Tank Footprint (SF)	265,000	165,000	100,000
Air Requirement (SCFM)	335,000	240,000	95,000
Total Blower HP	19,000	9000	10,000
Total Number of Blowers	10 total 9 duty	6	4
Clarification			
Secondary Clarifier Units (135 FT Diameter)	12	8	4
Solids			
WAS Pumping Capacity (MGD)	13.5 total 9.0 duty	9.0	4.5
Total Number of WAS Pumps	3	2	1
RAS Pumping Capacity (MGD)	125 total 90 duty	104	21
Total Number of RAS Pumps	8 total 6 duty	6	2
Total Solids Production (ADMM PPD)	641,000	NA	NA
Total Solids Production (DT/MGD)	3.6	NA	NA

3.2 Alternative 2: Upgrade Biotowers and Add Intermediate Clarifiers

Upgrading the existing biotowers with new media would significantly increase their performance as noted earlier. The biotowers could remove more soluble BOD; however, increased solids concentrations in the biotower effluent would occur because of increased biomass production and resultant sloughing. These solids, if not removed, would increase the solids loading to the aeration tanks and significantly impact the activated sludge process capacity. To avoid construction of additional aeration tankage and upgrades to the ancillary systems to accommodate these solids, intermediate clarifiers could be added downstream of the biotowers.

Conceptually, six (6)164-ft diameter intermediate clarifiers would provide a surface overflow rate (SOR) of 706 gallons per day per square foot (gpd/sf) at average daily flow (ADF) and would remove an estimated 330,000 ppd day of solids. The resultant ADMM load to the downstream activated sludge process would be 166,000 ppd BOD and 26,000 ppd TSS. With an aerobic SRT of 2 days the existing aeration tank volume is adequate for treatment operating at a MLSS concentration of 1,600 mg/L, requiring no upgrade to the tank volume or the air supply system. The aeration tank volume required for this scenario at a MLSS of 1,600 mg/L is 18.5 MG. In addition, there is sufficient spare volume within the existing aeration tanks to insert an anaerobic selector, sized at 3.8 MG, negating the need to build a new structure for the selector. Incorporating an anaerobic selector into the existing tankage would result in remaining aerobic volume of 14.7 MG and a resulting MLSS concentration of 1,900 mg/L. In addition, due to the lower required MLSS concentration and the reduced solids load to the clarification process, the existing 8 secondary clarifiers and sludge pumping capacity are adequate. The existing clarifiers, with one unit out of service, with a SVI of 150 mL/g, provide a SOR of 900 gpd/sf and a solids loading rate (SLR) of 24 ppd/sf at ADF without the selector and 29 ppd/sf at ADF with the selector . The total solids produced, including primary sludge, intermediate sludge and WAS is approximately 816,000 ppd, or 4.5 dry tons per mgd on an ADMM basis.

This alternative would require media replacement in all six biotowers, biotower odor control, six 164-ft new intermediate clarifiers and an intermediate sludge pump station. The overall depth of the media in the biotowers would be reduced from 21 feet to approximately 18 feet and the floor of the biotowers could be raised to avoid construction of an intermediate pumping station to pump flow to the aeration tanks.

Table 3-2 presents a summary of process upgrade requirements to implement Alternative 2.

Table 3-2 Upgrade Biotowers and Add Intermediate Clarifiers

Process Upgrades	Future Required	Existing	New Construction
Biotowers			
No. Units (135 FT Diameter)	6	6	0
Media Depth (FT)	18	21	18
Odor Control			
Air Requirement (SCFM)	180,000	0	180,000
Total Fan HP	600	0	600
Intermediate Clarification			
Intermediate Clarifier Units (164 FT Diameter)	6	0	6
Anaerobic Selector			
Tank Volume carved out of existing aeration tank (MG)	3.8	0	3.8 (modified existing)
Solids			
Intermediate Sludge Pumping Capacity (MGD)	2.3 total 2.0 duty	0	2.3
Total Number of Pumps	7 total 6 duty	0	7
Total Solids Production (PPD)	816,000	NA	NA
Total Solids Production (DT/MGD)	4.5	NA	NA

Notes:
1. Odor Control requirements based on V&A Report.

Alternative approaches to providing odor control for the biotowers have not been evaluated in this memorandum; odor control was the subject of a separate evaluation recently conducted by V&A. However, should Alternative 2 be selected and advanced to the conceptual design stage, it is suggested that alternative odor control approaches be carefully considered. One option that has been considered for similar applications includes capture of odorous air, and diffusing it into the activated sludge system. This accomplishes two goals: 1) treatment of odor in the aerobic biological process in the aeration tanks; and 2) use of the ventilated air stream as the source of process oxygen. While this odor control approach has merit, and has been successfully used at other facilities, there are several aspects of the approach that are disadvantages and need to be carefully considered. These include:

- The condition/characteristics of the odorous air and the impact of contaminants in the air stream on the process, including condensate handling.
- The material specifications (and cost) that may be required to provide process blowers that can suitably compress the odorous air to the required pressure.

- The potential constraints this approach may place on the ability to adequately control dissolved oxygen in the process tanks, due to the inability to turn down the ventilation rate of the odor control system.

3.3 Alternative 3: Utilize CEPT, Upgrade Biotowers and Expand Activated Sludge Process

Alternative 3 includes addition of chemical enhanced primary treatment (CEPT), upgrade of the biotowers with new media, and expansion of the activated sludge process. In this alternative, additional solids would be removed in primary treatment, reducing the load on the biotowers and the downstream activated sludge process. Additional aeration tank volume would be required, but at a lower volume than Alternative 1.

By adding CEPT, the solids and organic loading to the biotowers could be reduced. The biotowers would be upgraded with new media to further reduce soluble BOD loading to the activated sludge process. As a result, the load to the activated sludge process would be 335,000 ppd BOD and 336,000 ppd TSS under ADMM loading conditions. With an aerobic SRT of 2 days and a MLSS of 3,100 mg/L, the total aeration tank volume required is approximately 24 MG. The existing aeration basins provide 18.5 MG of aerobic tank volume, requiring an additional 5.7 MG to be constructed. Similar to Alternative 1, 12 secondary clarifiers would be required to provide adequate clarification and a new 3.8 MG tank is required for the anaerobic selector. Also similar to Alternative 1, step-feed could be implemented and would require slightly less aerobic volume than plug-flow tanks. Modifications to the existing aeration tanks would be required to accommodate multiple feed points. Additional blowers, clarifiers, and pumps would be the same as for conventional treatment. The total aeration tank volume required for step-feed is 19.6 MG (vs. 24.2 MG for conventional), which would require an additional 1.1 MG of tankage be constructed (footprint of 10,000 SF) instead of the 5.7MG required for the conventional mode.

The required RAS rate for this scenario is 82% of the average flow or 74 mgd. The existing RAS pumping system has a capacity of 104 mgd with all pumps in service; however, due to the proposed location of the new clarifiers it is recommended that a new RAS pump station be constructed and dedicated to these clarifiers. The total solids produced, including primary sludge and WAS, is approximately 726,000 ppd or 4.0 dry tons per mgd on an ADMM basis. The increase in WAS can be accommodated using an additional pump with disposal of biosolids to the existing lagoons. The increase in primary sludge may require longer operation of the solids handling process with the existing belt filter presses (BFP) or require additional units to be installed. The inert chemical solids from the CEPT process would not be biodegraded in the lagoons, and the impacts of the additional inert materials would have to be evaluated, particularly in light of the ongoing work on Lagoon #5. As a result, the chemical sludge from the primaries may require an alternate disposal method.

This alternative would require a chemical feed system and building, media replacement in all six biotowers, biotower odor control, additional aeration tanks and one new blower, secondary

clarifiers, and RAS and WAS pumps. **Table 3-3** presents a summary of process upgrade requirements to implement Alternative 3.

Table 3-3 CEPT, Biotower & Activated Sludge Upgrades

Process Upgrades	Future Required	Existing	New Construction
CEPT			
Chemical Feed System (ferric chloride) - Four 9,000-gal FRP storage tanks with pumps and controls	1	0	1
Chemical Feed System Building (SF)	2400	0	2400
Biotowers			
No. Units (135 FT Diameter)	6	6	0
Media Depth (FT)	21	21	21
Odor control			
Air Requirement (SCFM)	180,000	0	180,000
Total Fan HP	600	0	600
Aeration			
Aeration Tank Volume (MG)	24.2	18.5	5.7
Anaerobic Selector (MG)	3.8	0	3.8
Aeration Tank Footprint (SF)	215,000	165,000	50,000
Air Requirement (SCFM)	246,000	240,000	6,000
Total Blower HP	14,000	9,000	5,000
Total Number of Blowers	7 total 6 duty	6	1
Clarification			
Secondary Clarifier Units (135 FT Diameter)	12	8	4
Solids			
WAS Pumping Capacity (MGD)	13.5 total 9 duty	9	4.5
Total Number of WAS Pumps	3	2	1
RAS Pumping Capacity (MGD)	125 total 90 duty	104 total	21
Total Number of RAS Pumps	8 total 6 duty	6	2
Total Solids Production (PPD)	726,000	NA	NA
Total Solids Production (DT/MGD)	4.1	NA	NA

4.0 Conceptual Layouts of Alternatives

This section presents conceptual level layouts for each alternative. In addition to addressing process modifications for each alternative, the layouts identify a location for the effluent pump station wet well and disinfection facilities, which have been evaluated separately as part of the disinfection study and would be incorporated into the upgrade alternatives.

4.1 Alternative 1: Abandon Existing Biotowers and Expand Activated Sludge Process

Figure 4-1 shows a conceptual layout for Alternative 1 – abandoning the existing biotowers and expanding the activated sludge process as described in Section 3.1. The existing biotower media would be removed and disposed of at a landfill. In order to provide a 3.8 MG anaerobic selector, an approximate footprint of 256 ft x 128 ft would be required for a new basin with a sidewater depth of 15 ft. An additional 11.2 MG, or 100,000 square feet of aeration tank volume (operated in conventional mode), would be required for this alternative and has been preliminary shown west of the biotowers. The two retrofitted clarifiers (Nos. 5N and 5S) would not be used due to hydraulic issues and the space could be repurposed as wet wells for the effluent pump station. Four additional new clarifiers are required and could be located adjacent to the new aeration tanks. The existing blower and RAS buildings do not have adequate space to accommodate additional equipment and a new building is required; the blower and RAS building has been shown adjacent to the new aeration tanks and clarifiers. The disinfection facility would be located between the two sets of secondary clarifiers as a central point for the secondary effluent to combine and be treated.

4.2 Alternative 2: Upgrade Biotowers and Add Intermediate Clarifiers

Figure 4-2 shows a conceptual layout for implementing Alternative 2 – upgrading the biotowers and adding intermediate clarifiers. The existing biotowers would remain and the media would be replaced with "cross flow" type high-surface area media, as manufactured by Brentwood Industries or equivalent. An odor control system would be provided to treat air from the biotowers and this system would be located adjacent to the biotowers. Six intermediate clarifiers would be required to remove solids prior to the activated sludge process and could be located to the east of the existing biotowers. To avoid the need to pump wastewater from the intermediate clarifiers to the aeration tanks, the biotower filter depth would be reduced from the current depth of 21-ft to 18-ft and the floor of the existing structures would be raised. A sludge pump station to convey the settled solids from the clarifiers to the solids handling process would need to be constructed adjacent to the intermediate clarifiers. No new aeration tank volume would be necessary, and there would be sufficient volume in the existing aeration tankage to convert 3.8 MG into an anaerobic selector. The two retrofitted clarifiers (Nos. 5N and 5S) would not be reused and the space could be repurposed for wet wells to the effluent pump station. The disinfection facility would be located west of the secondary clarifiers at the end of the treatment process.

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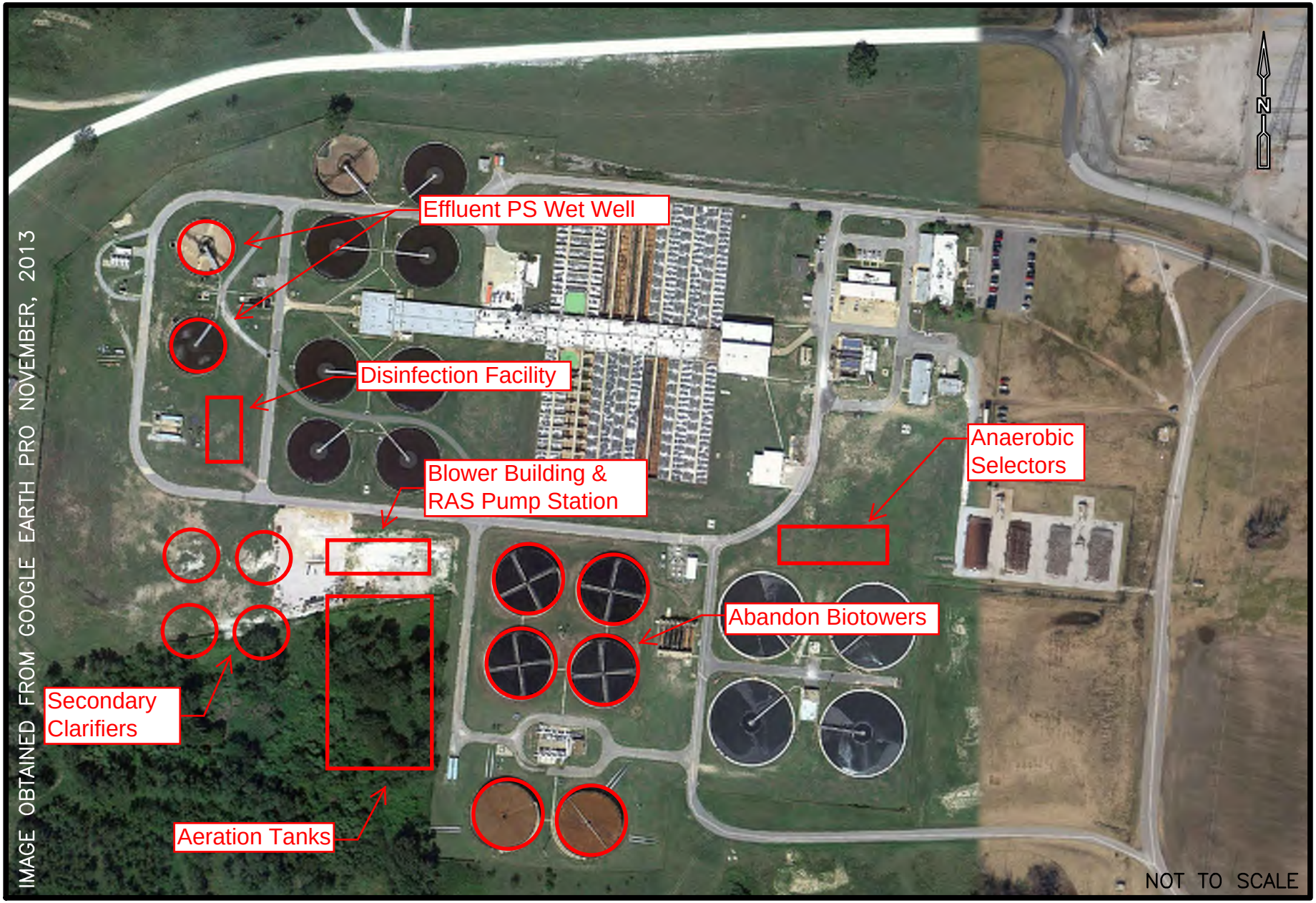

IMAGE OBTAINED FROM GOOGLE EARTH PRO NOVEMBER, 2013

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Figure No. 4-1
Alternative No. 1
NOVEMBER 2013

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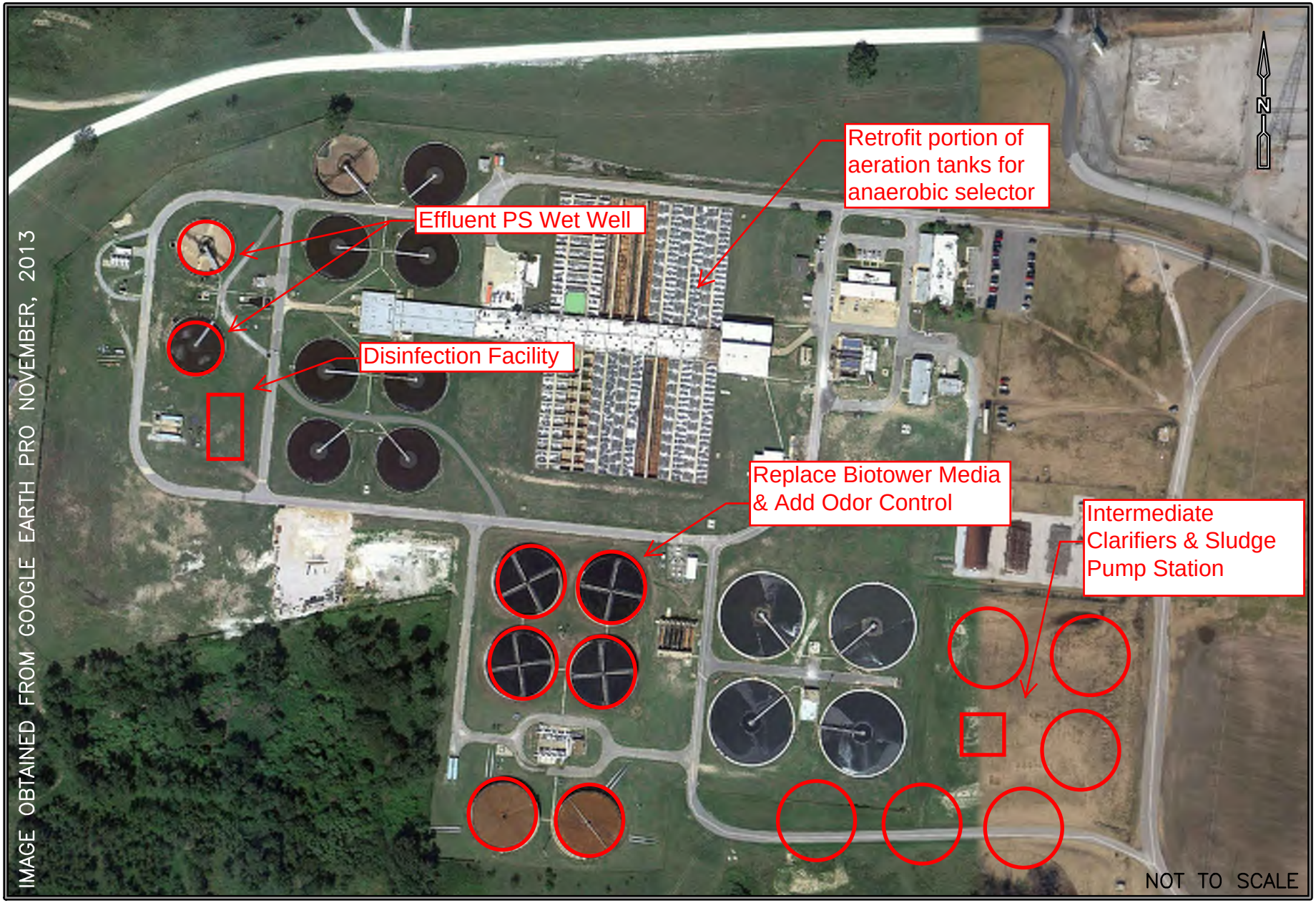

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Figure No. 4-2
Alternative No. 2
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4.3 Alternative 3: Utilize CEPT, Upgrade Biotowers and Expand Activated Sludge Process

Figure 4-3 shows a conceptual layout for Alternative 3 – utilizing CEPT with upgrades to the biotowers and the activated sludge process. To implement the CEPT process, a chemical feed system would be required in a new building located just to the east of the primary clarifiers. The building would be located adjacent to a plant driveway to facilitate chemical deliveries (assumed to be ferric chloride for this analysis). The CEPT building would house chemical storage tanks, pumps and ancillary mechanical, electrical and instrumentation equipment. The existing biotowers would remain and the media would be replaced with new high-surface area media (as noted in Alternative 2). The biotower depth would remain at 21-ft deep. An odor control system would be provided to treat air from the biotowers; the odor control facility would be located adjacent to the biotowers. A 3.8 MG anaerobic selector, approximate footprint of 256 ft x 128 ft, would be required. An additional 5.7 MG of aerobic volume is required for the activated sludge process and could be located adjacent to the existing tanks. The two retrofitted clarifiers (Nos. 5N and 5S) would not be reused and the space could be repurposed as wet wells for the effluent pump station. Four additional clarifiers are required and could be located adjacent to the biotowers. Due to hydraulic constraints and lack of space in the existing RAS building, a new pump station would be located central to the new clarifiers. The disinfection facility would be located west of the secondary clarifiers at the end of the treatment process.

5.0 Engineer's Opinions of Probable Costs

5.1 Basic Assumptions

For this study, probable capital (construction) costs were estimated based on vendor quotes, estimation of construction quantities and building spaces, cost information from recently completed projects and other relevant sources. Specific capital cost estimating factors include indirect costs, contractor's general conditions, contractor's overhead and profit, contingencies, and engineering and implementation. Indirect costs include costs associated with permits, sales tax, insurance and bonds. Adjustments and changes made during subsequent stages of design would affect the estimates, as would future escalation in the cost of materials, labor, and equipment. Specific capital cost factors used in this memorandum to calculate the probable costs include:

Construction Contingency	30 percent
Contractor GC Field General Conditions	10 percent
Contractor GC Indirects, Overhead & Profit	10 percent
Contractor Bonds and Insurance	3.65 percent
Planning, Design and Construction Services	10 percent
Utility Administration, Legal, bonds & Insurance	3 percent

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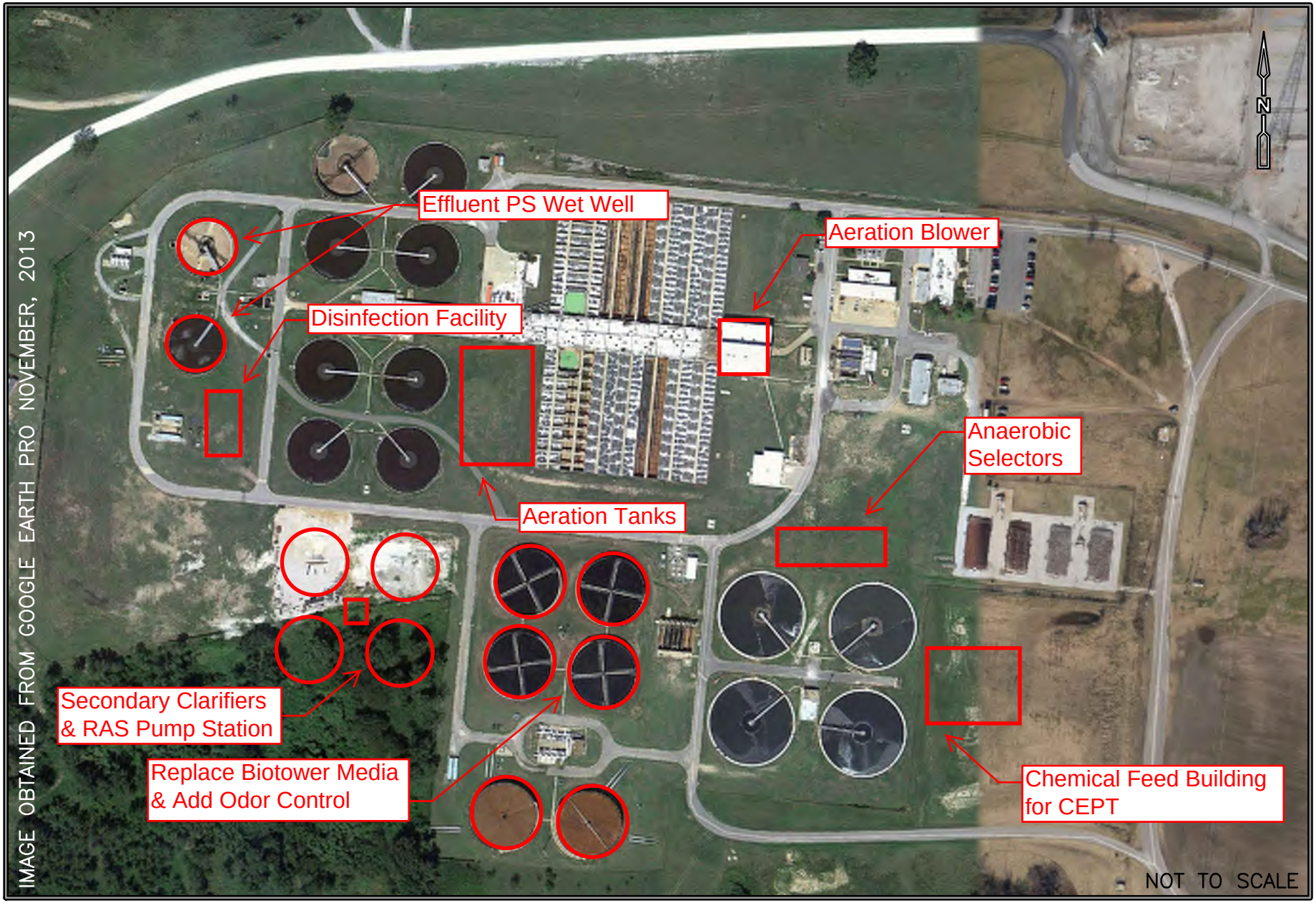

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Figure No. 4-3
Alternative No. 3
NOVEMBER 2013

5.2 Opinion of Probable Project Costs

The capital construction costs for each alternative include the process modifications as described in the previous sections. In addition to the process modifications, estimated costs for potential electrical modifications required to support the process modifications and to retrofit the effluent pump station and wet well were included; however, no actual electrical evaluation or recommendations were completed. The electrical costs included are estimated based on past relevant projects. For planning level purposes, the electrical upgrades have been estimated at 10 percent of the direct construction cost. For each alternative placeholders of $1 million and $3 million, respectively, have been allocated to account for the provision of a new or modified effluent pump station wet well (as an actual design concept was not completed as part of this study) as well as the addition of an anaerobic selector for biological treatment as part of each of the alternatives as discussed above. **Table 5-1** provides a summary of the Opinion of Probable Project Cost (OPPC) for each alternative.

Table 5-1 Opinion of Probable Project Cost

Alternative	Description	Individual OPPC
1	No Biotowers Expand Activated Sludge Process	$78,000,000 Conventional ($68,000,000 Step Feed)
2	Upgrade Biotowers & Activated Sludge Process	$82,000,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$104,000,000

For Alternative 1, which does not utilize the existing biotowers, it was assumed that the biotower media would be removed and disposed of at a landfill and the towers would be abandoned in place. No cost was added for demolition of the tower structures; it is recommended that the structures be abandoned in place as the space is not needed at this time for other purposes. Also, it allows for the biotowers to be put back in operation in the future if the loading conditions change. In addition, the capital cost for the odor control system identified in the August 14, 2013 V&A technical memorandum is included in both Alternatives 2 and 3 at the previously identified cost of $7.2 million. CDM Smith has not independently verified the sizing of this facility or the line item cost.

5.3 Comparative Operational Costs

To compare the approximate differences in operational costs among alternatives, chemical, power, and labor costs associated with each alternative have been developed and are presented in **Table 5-2**. Cost assumptions used in this evaluation include:

Power $0.076 per kilowatt-hour (kWh)

Labor Rate $40/hr.

Ferric chloride ($FeCl_3$) $1.06/gal (obtained verbally from Kemira for 36% solution)

Table 5-2 Comparative Annual Operating Costs

Alternative	Description	Labor Cost	Power Cost	$FeCl_3$ Cost	Comparative Cost
1	No Biotowers Expand Activated Sludge Process	$0	$5,400,000	$0	$5,400,000
2	Upgrade Biotowers & Activated Sludge Process	$17,000	$4,200,000	$0	$4,217,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$250,000	$5,700,000	$2,100,000	$8,050,000

Notes:
1. Operational costs are for alternative comparison only and do not reflect total plant operating cost.

Power costs are differential costs, based on major motor loads that are included in one or more alternatives. The power costs do not include those that apply equally to all alternatives. The process equipment considered for the comparative power consumption includes:

CEPT chemical feed system

Intermediate pump station (from primary clarifiers to biotowers)

Biotower recirculation pumps

Biotower odor control fans

Intermediate clarifiers

Intermediate sludge pumps

Aeration tank blowers

Secondary clarifiers

RAS and WAS pumps

For aeration blower power estimates, horsepower requirements were estimated based on average day demand (at 90 mgd), assuming six months per season based on winter and summer air requirements. The biotower odor control fans were based on a ventilation rate of 30,000 cubic feet per minute (cfm) per biotower, as determined by V&A Consultants in a technical memorandum dated August 14, 2013. The horsepower requirements for the odor control fans were not included in the V&A evaluation; CDM Smith estimated power based on the air requirement determined by V&A to be 100 horsepower (hp). If odor control is to be implemented, the horsepower requirement would be confirmed during subsequent stages of more detailed engineering. The cost of odor control media replacement for the odor control biofilters has not been included in this evaluation. The V&A report indicates that the City may own a low- or no-cost source of media, but it should be noted that the media may need to be replaced every 3-6 years depending on loading to the process. As previously discussed, solids handling has not been included in this evaluation and the associated impacts to operations has not been included in these costs.

5.4 Summary of Life Cycle Costs

The approximate difference in life cycle costs associated with each alternative has been developed and is presented in **Table 5-3**. The lifecycle cost includes the OPCC for construction and the annual operating costs summarized in Table 5-2. Assumptions used in this evaluation include:

Planning period	20 years
Discount rate	4.13 percent
Inflation rate	3.00 percent
Power escalation rate	2.00 percent

Table 5-3 provides a summary of the lifecycle costs of the three alternatives and indicates that Alternative 1 has the lowest capital cost and the 20-year present worth of this alternative with higher operations costs makes Alternative 2 a viable option as well. The power requirement for aeration is the significant operating cost for Alterative 1. Utilizing CEPT (Alternative 3) has both a high capital cost and a high operations cost, primarily due to the need to implement capital improvements in primary treatment, biotowers upgrades and the activated sludge process. Additional chemical requirements also significantly impact the operations costs of Alternative 3.

Table 5-3 Total 20-Year Life Cycle Comparison of Alternatives

Alternative	Description	Capital Cost (OPPC)	20 Year Operations Present Worth	20 Year Total Present Worth
1	No Biotowers Expand Activated Sludge Process	$78,000,000 Conventional ($68,000,000 Step Feed)	$118,000,000	$196,000,000 Conventional ($186,000,000 Step Feed)
2	Upgrade Biotowers & Activated Sludge Process	$82,000,000	$92,000,000	$174,000,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$104,000,000 ($94,000,000 Step Feed)	$167,000,000	$271,000,000 ($261,000,000 Step Feed)

5.5 Recommendations

Although a solids handling evaluation was not completed, impacts to the solids handling operations should be considered and fully understood in determining a recommended approach for expanding the WWTP. The operation for solids handling for Alternative 1 and 2 would remain essentially the same as the current operation, with biological solids pumped directly to the lagoons and primary sludge dewatered and discharged to the lagoons. The existing belt filter presses may be adequate for dewatering the increased solids by extending the hours of operation or installing additional units. Alternative 3, CEPT with activated sludge process, produces two types of sludge; an additional chemical sludge is produced from the CEPT process and will require that the sludge be disposed of separately from the biological sludge.

Due to the high capital and operations costs of Alternative 3 coupled with the potential complexities associated with handling inert solids from the CEPT process, this option is not considered a viable alternative and can be eliminated from further evaluation. Alternative 1 and 2 are both feasible options that provide their own benefits to the WWTP. A summary of the advantages and challenges of each of these two alternatives are summarized in **Table 5-4**.

Table 5-4 Non-Cost Comparison of Alternatives 1 and 2

	Alternative 1	Alternative 2
Description	Abandon biotowers and expand activated sludge process.	Upgrade biotowers and add intermediate clarifiers.
Impacts to Process Configuration for Potential Future Ammonia Limit	Aerobic SRT would have to be quadrupled (to 8 days) to nitrify year-round. This would require a 4x increase in aeration basin volume to keep the same MLSS concentration of 3,400 mg/L (this assumes no additional secondary clarifiers). Final configuration with step-feed would have 96 MG of aerobic tankage and 12 secondary clarifiers. Fitting the necessary aeration tank volume on the site may be marginally feasible.	Aerobic SRT would have to be quadrupled (to 8 days) to nitrify year-round. This would require a 2.25x increase in aeration basin volume and four additional secondary clarifiers. Final configuration without step-feed and the selector inside the existing aeration tankage would have 33 MG of aerobic tankage and 12 secondary clarifiers, while increasing the MLSS from 1,900 mg/L to 3,400 mg/L. The additional requirements are less than Alternative 1 because the MLSS concentration for Alternative No. 2 can be raised to equal Alternative No. 1 to offset additional aerobic tankage.
Impacts to Process Configuration for Potential Future TN Requirements	Sufficient soluble BOD for process to be expanded would be available. Anoxic process volume would need to be added; the anaerobic selector volume could be converted to provide at least a portion of the required anoxic volume.	Biotowers would need to be removed, or at least the ability to bypass all or a portion of the flow around the biotowers would be necessary to provide sufficient soluble BOD to the activated sludge process. Anoxic process volume would need to be added; the anaerobic selector volume could be converted to provide at least a portion of the required anoxic volume.
Odor Control	Biotowers and Intermediate Pump Station not required, eliminating this specific source of odor and need for control.	Biotowers and Intermediate Pump Station remain and odor control system will be required.
Additional Capacity/ Process Flexibility	No ability to increase MLSS (3,500 mg/L) in existing tankage, 20 mg/L estimated effluent TSS. No additional process capacity available.	Lower MLSS (1,600 mg/L) requires 13.5 MG of aeration volume of the 18.5 MG available; process flexibility available to allow increase of MLSS in existing tankage; 10 mg/L estimated effluent TSS.
Maintenance of operations during construction	Existing processes can operate largely without impact during construction.	Only one biotower can be out of service at a time for media replacement.

Tables 5-1, 5-2 and 5-3 show that on an economic basis, Alternatives 1 and 2 are in the same range. Alternative 1 is more economical on a capital-cost basis, and Alternative 2 is more economical on an annual operating cost basis, and has a lower 20-year life cycle cost. Because the economics are "close", the right alternative for the plant to implement therefore must result from a considered weighing of the non-economic factors presented by each option.

The most critical non-economic consideration in deciding between Alternative 1 and Alternative 2 is the potential requirement for the plant to achieve nitrification (either year-round or seasonal) or total nitrogen removal in the future. As indicated by review of Table 5-4, if the plant is required to remove ammonia (to nitrify) in the future, then Alternative 2 would be the preferred option; however, if the plant is required to remove total nitrogen (to denitrify) in the future, then Alternative 1 would be preferred. At this time, it is unknown which, if either, of these performance requirements will become part of the plant's discharge permit.

However, it is possible to proceed with needed process upgrades now while keeping options open for meeting future permit possibilities. By selecting Alternative 1 now, the plant would implement the lowest capital cost option now, and if implemented correctly, could maintain the flexibility to best address future permit requirements for either ammonia or total nitrogen. The expansion of the activated sludge process described to implement Alternative 1, consisting primarily of new aeration tankage, clarifiers and supporting systems, would be sited and built to accommodate further expansion to meet potential future permit requirements. The biotower structures would be abandoned in place but not demolished; therefore, it would be possible to put back into operation in the future if ammonia removal is required. In addition, the siting of the Alternative 1 facilities would allow for site footprint to be allocated for intermediate clarifiers in the future (east of the biotowers as shown in Alternative 2), if total nitrogen removal is required in the future. In the event that a future nitrogen limit is required, the biotowers could then be demolished and additional aeration tankage could be constructed in this space.

Because of its flexibility to be designed and arranged to be suitable for future adaptation to either ammonia or total nitrogen limits, Alternative 1 is recommended for implementation at this time.

FINAL

REPORT

Maxson Disinfection Alternative Evaluation Report

City of Memphis, TN

February 2017

CDM Smith

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Section ES

Executive Summary

This report describes results of pilot and bench-scale testing conducted at the T.E. Maxson wastewater treatment plant (Maxson WWTP) in 2013 and 2015 as part of the City of Memphis Disinfection Study Project. Pilot scale testing in 2013 was conducted for sodium hypochlorite, peracetic acid (PAA), and ultraviolet (UV) disinfection to compare and determine disinfection efficacy. During the 2013 testing a portion of the plant's treatment processes were being bypassed, potentially impacting the effluent water quality, and a significant industrial user came off line after the 2013 pilot testing. Supplemental pilot and bench-scale testing performed in 2015 was conducted for PAA, UV, and UV/PAA in combination to determine if there was an improvement in effluent water quality, and thus disinfectant performance, after these changes. The City of Memphis (City) has contracted with CDM Smith to evaluate potential process improvements that could improve effluent quality and process control. Using information from the process analysis for the Maxson WWTP and the design doses developed based on pilot and bench testing, CDM Smith prepared planning level capital, operations and maintenance cost estimates for each disinfection alternative.

The original pilot scale testing began in March 2013. Pipe reactors were constructed on location in which plant effluent was treated with either sodium hypochlorite or peracetic acid. UV testing was also performed in a trailer mounted UV disinfection pilot from Trojan Technologies. Control samples were analyzed for color, UV transmittance (UVT) total suspended solids (TSS) *Escherichia coli (E. coli)*, and disinfection by-products (DBPs). Treated samples were analyzed for *E. coli* and disinfection by-products. Testing results with respect to recommended design doses are presented in this report, which is divided into five major sections. Testing objectives, background and permit requirements are described in Section 1, procedures are outlined in Section 2, results and recommendations for design doses are presented in Section 3, and conceptual cost estimates are summarized in Section 4.

The results of the pilot scale testing showed that sodium hypochlorite and PAA could be effective for achieving bacterial inactivation to meet permit compliance for *E. coli*, which includes a monthly geometric mean of 126 colony forming units (cfu)/100 mL, with a daily single grab maximum of 487 cfu/100 mL under current plant operating conditions. In addition to *E. coli* inactivation, DBP formation potential was evaluated for sodium hypochlorite and peracetic acid. Dioxin congeners were detected in the undisinfected effluent and sometimes persisted into the disinfected water. Disinfection did not increase the occurrence or concentration of dioxin congeners. Sodium hypochlorite was also found to form low concentrations of trihalomethanes (THMs) at the doses that were effective for disinfection. NDMA was not detected in any sample.

Prior to proceeding with the disinfection design phase, the City and CDM Smith agreed that supplemental pilot and bench testing was necessary to determine the impacts the two changes at the Maxson WWTP had on disinfection efficacy. The supplemental pilot-scale testing began in early May 2015 and concluded in early June 2015, while the UV/PAA bench-scale testing was conducted over a week in late September 2015. The supplemental testing had the following objectives:

- Refine the design criteria for PAA disinfection to meet disinfection limits

  - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times
  - Determine the design dose for average conditions to support calculation of associated operating costs
- Confirm the UV disinfection design dose to support estimates of capital and operating costs
- Quantify and compare disinfection kinetics among several UV and PAA combinations including:
  - PAA alone, UV alone, UV followed by PAA, PAA followed by UV, simultaneous disinfection with UV and PAA.
- Propose a mechanistic model to describe the efficacy of the combined disinfectant

The supplemental PAA pilot testing allowed for the development of a kinetic model to predict PAA disinfection efficacy across a range of doses and contact times. During the analysis of the dataset it was determined that a double exponential decay model provided the best correlation with the dataset, and it was shown to have a reduced spread between the data and the model, when compared to Hom's Model or the standard CT model. Therefore, the double exponential decay model was utilized to determine the necessary CT values at the minimum, average and maximum design conditions. **Table ES-1** summarizes the design criteria for the PAA system.

Table ES-1: Required PAA CTs and Design Points

Flow Conditions	Flow (MGD)	Required Log Inactivation	CT*
Permitted Average	90	µ.92	87.1
Peak Hour	170	µ.82	74.1
Daily Minimum	50	2.81	22.4

*CT results include a 1.µx safety factor for scaling up to full scale

The results from the recent collimated beam analysis were compared against the historical collimated beam data. It was found that there is no significant difference between the two datasets. Therefore, the water quality at the time of the 2013 sampling and the 2015 sampling yielded nearly identical collimated beam results. The supplemental pilot and bench testing data showed that a design UVT of 20% would be more reasonable than the UVT value of 35%, which was utilized previously.

The data from the bench testing of a combined UV/PAA disinfectant indicated that the most consistent and positive results occurred with UV followed by PAA. Although the results are promising, further research is required to accurately describe the effect of combined disinfection, and the economic analysis that was performed based on the results did not indicate significant economic savings through application of a combined disinfection system.

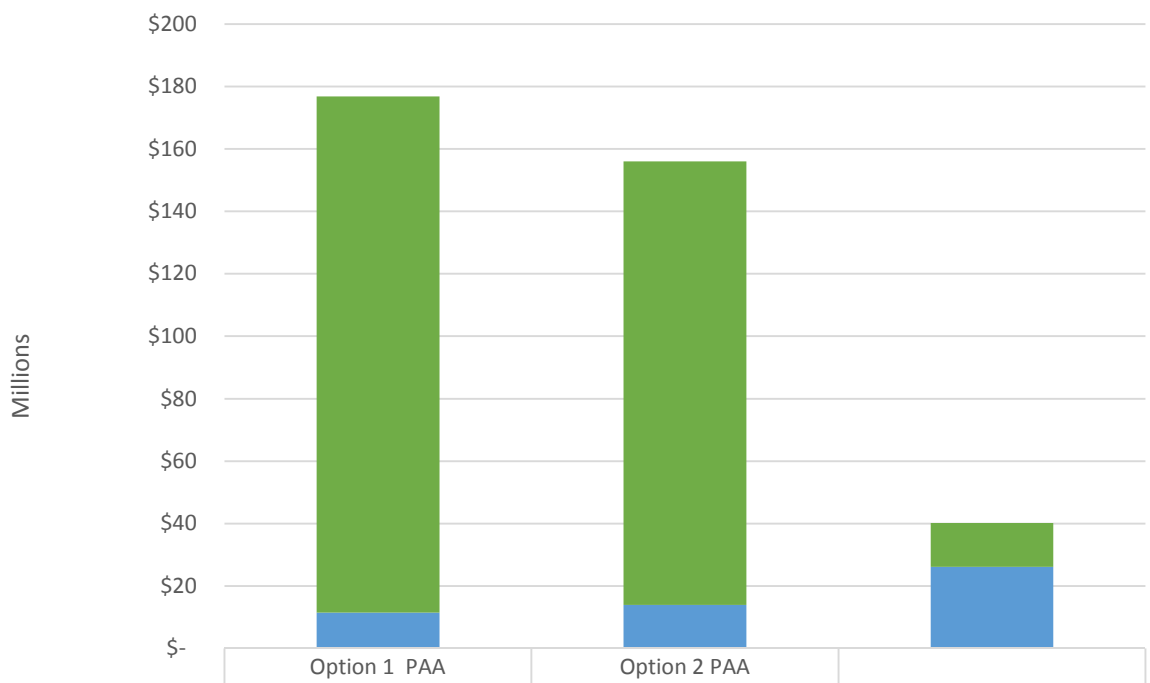
Further discussions regarding the use of chlorine disinfection were had between CDM Smith and the City. Use of chlorine disinfection has lower lifecycle costs and similar capital costs to PAA disinfection, however the use of a chlorination disinfection system has additional permitting requirements that include additional testing under Section 3.6.1 of the permit, as follows, making the technology more challenging to implement:

"3.6.1 Additional Permittee Submittals (If Chlorination Disinfection System Selected)

Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly generated byproducts are related to TRC according to the compliance schedule…"

As a result of the additional testing required in the permit, it was determined that chlorine disinfection would no longer be considered.

Based upon the supplemental testing performed in 2015, the conceptual costs for UV and PAA were revised. Comparative 20 year lifecycle costs for three alternative disinfection systems are illustrated in **Figure ES-1**. The first alternative is a PAA system with a contact tank providing 31 minutes of contact time at average flow, the second is a PAA system providing 31 minutes of contact team at peak flow, and the third is a UV system designed to treat effluent with a 20% UVT.



	Option 1 PAA 25µ,000 cubic ft	Option 2 PAA 489,000 cubic ft	20% UVT Design UV System
Total Annual Cost	$165,µ00,000	$142,000,000	$14,000,000
Total Capital Cost	$11,500,000	$14,000,000	$26,200,000
Lifecycle Costs	$177,000,000	$156,000,000	$40,000,000

Figure ES-1 20 Year Lifecycle Analysis of Three Disinfection Options

Providing more contact time at average flow for the PAA system eliminated the need for quenching with sodium bisulfite, although the capital costs for a small sodium bisulfite was included for emergency use. Although the lifecycle costs of the UV alternative is lower than that of the two PAA alternatives, the City of Memphis and CDM Smith discussed the impacts caused by the variability of the low UV transmittance seen in the Maxson WWTP effluent. The variability likely stems from the change in processes and raw materials utilized by industrial users within the City's collection system. In addition, the capital cost required to increase the UVT of the effluent via another treatment process, such as ozone, to make UV disinfection a viable option, is cost prohibitive for the City. Based upon

these discussions it was decided to eliminate UV from the list of disinfection alternatives. Therefore PAA disinfection is the recommended disinfection alternative to be utilized at the Maxson WWTP. Further analysis was performed to find the optimal combination of contact tank size and PAA dose to reduce the lifecycle costs. Results from the detailed cost analysis and the supplemental pilot data indicate that the most cost effective contact tank size to reduce overall lifecycle cost is 489, 235 cubic ft. As a result, the most cost effective disinfection alternative is PAA - Option 2.

If the City opts to implement PAA disinfection and the associated secondary treatment upgrades to address chemical oxidant demands in the effluent, there are significant ancillary benefits to this decision. While PAA disinfection has the highest lifecycle cost, the low capital cost of the PAA disinfection system combined with the avoidance of additional permitting requirements as described above, has resulted in PAA disinfection being the selected disinfection alternative for the Maxson WWTP. Additionally, proceeding in this direction may enable the City to address other major concerns regarding odor control and future capacity issues at the Maxson WWTP.

Section 1

Introduction

1.1 Facility Background

Raw wastewater influent to the Maxson WWTP flows through coarse bar screens and aerated grit tanks for removal of large organic and inorganic constituents in the raw wastewater. From the grit tanks, flow passes through new fine bar screens before it passes to the primary clarifiers. Primary clarifier effluent is pumped to the activated biological filter towers which provide gross removal of wastewater organic constituents, followed by biological treatment in aeration tanks and secondary clarifiers before discharge into the Mississippi River. A process flow diagram for the Maxson WWTP is provided in **Figure 1-1**.

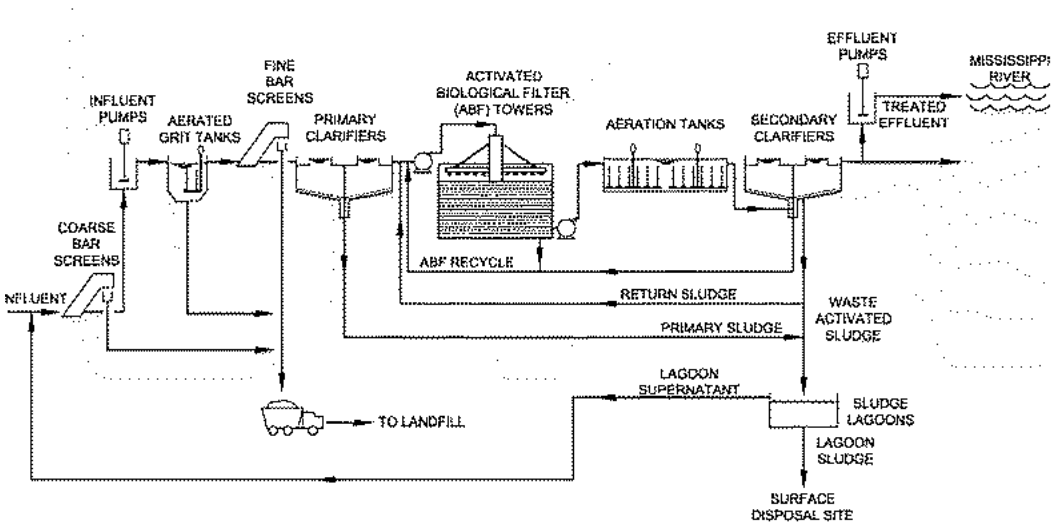


Figure 1-1 Process flow diagram of Maxson WWTP

A summary of historical effluent wastewater characteristics that are important in selection of a disinfection technology is provided in **Table 1-1**. The NPDES permit limits are included in the table for reference.

1.2 NPDES Permit Requirements

The current NPDES permit, number TN0020729, issued by Tennessee Department of Environment and Conservation (TDEC) authorizes the Maxson WWTP to discharge treated effluent from Outfall 001 to the Mississippi River at Mile 725.0, pursuant to the permit limits and monitoring requirements specified in the permit. The facility, as noted in the permit, has a treatment design capacity of 90 million gallons per day (MGD) with a peak hour hydraulic capacity of 170 MGD. The effluent limits for parameters relevant to the evaluation of disinfection processes are summarized in **Table 1-2**.

Table 1-1 Effluent water quality characteristics at the Maxson WWTP

Parameter	Daily Performance Data			NPDES Limit		
	Minimum observed	Average or mean[1]	Maximum observed	Daily (minimum and) maximum	Weekly maximum	Monthly maximum
Daily Flow (MGD)[2]	18	78	170	90[12]	-	-
BOD_5 (mg/L)[µ]	4	29	177	84	6µ	42
TSS (mg/L)[4]	4	µ0	201	96	72	48
pH[4]	6.2	7.µ	8.5	(6.0) - 9.0	-	-
E. coli (cfu/100mL)[5]	1.µ x 10^4	7.4 x 10^5 (5.2 x 10^5 as geomean)	5.7 x 10^6 (2.0 x 10^6 is 99-percentile)	487	-	126 as a geomean
Apparent Color (PtCo units)[6]	28	401	1152	-	-	-
True Color (PtCo units)[7]	8	109	496	-	-	-
Apparent UVT (%)[8]	2 (1µ)[9]	25	50	-	-	-
Filtered UVT (%)[10]	11 (µ1)[11]	41	58	-	-	-

[1]Arithmetic means were reported for all values except *E. coli* which is also reported as a geometric mean.
[2]Average daily influent flow values; period of record = 1/1/08-5/µ1/201µ.
[µ]Daily values taken from composite effluent samples; period of record = 1/1/08-5/µ1/201µ.
[4]Daily values taken from period of record = 1/1/08-5/µ1/201µ.
[5]Daily values taken from effluent grab samples; period of record = 9/14/2010-7/11/201µ.
[6]Daily values taken from composite effluent samples; period of record = 6/28/2011-12/2/2012.
[7]Daily values taken from composite effluent samples; period of record = 6/28/2011-12/2/2012.
[8]Daily values taken from composite effluent samples; period of record = 8/11/2011-12/27/2011.
[9]In parentheses: lowest 10th percentile of apparent UVT data on record.
[10]Daily values taken from composite effluent samples; period of record = 8/11/2011-12/27/2011.
[11]In parentheses: lowest 10th percentile of filtered UVT data on record.
[12]The NPDES Permit value for flow is shown as a "permitted average capacity" and not as a limit.

Table 1-2 Select NPDES permit effluent limits for the Maxson WWTP

Effluent Characteristics	Monthly	Weekly	Daily	
	Maximum (Average)	Maximum (Average)	Maximum	Minimum
BOD_5 (mg/L)	42	6µ	84	-
BOD_5 (lb/day)[1]	µ1,525	47,288	-	-
TSS (mg/L)	48	72	96	-
TSS (lb/day)[1]	µ6,029	54,04µ	-	-
E. coli (cfu/100 mL)[2,µ]	126	-	487	-
Total Residual Chlorine (TRC) or Total Residual Oxidant (TRO) (mg/L)[1]	-	-	2.0	-
pH (standard units)	-	-	9.0	6.0
Total Dioxin (µg/L)	0.000001	-	0.000001	-

[1]These permit limits are subject to the pending NPDES permit appeal.
[2]The concentration of the *E. coli* group after disinfection shall not exceed 126 cfu per 100 mL as the geometric mean calculated on the actual number of samples for *E. coli* within the required reporting period. The permittee may collect more samples than specified as the monitoring frequency but, not at intervals of less than 12 hours. For the purpose of determining the geometric mean, individual samples having an *E. coli* group concentration of less than one (1) cfu per 100 mL shall be considered as having a concentration of one (1) cfu per 100 mL.
[µ]The compliance schedule pertaining to *E. coli* permit limits is subject to the pending NPDES permit appeal.

1.µ Pilot Study Objectives

In order to meet the new permit requirements, a new disinfection system will be required at the existing facility. While a desktop evaluation can provide planning level costs, the complex nature of the effluent, considering the significant industrial contributions to the WWTP influent, necessitates site-specific data to identify engineering design criteria for the facility as well as the operational parameters that would allow the Maxson WWTP to meet both bacterial standards and limits for disinfection by-products (DBPs). In support of developing this information, a pilot study was conducted to evaluate three disinfection technologies that were previously identified as feasible options to meet NPDES permit requirements. Specific goals of the pilot project were to:

- Determine the required disinfection dose, residual, and contact time to achieve compliance with *Escherichia coli (E. coli)* permit limits using sodium hypochlorite, UV, and PAA.
- Identify how total suspended solids (TSS), ultraviolet transmission at 254nm (UVT) and color impact disinfection performance.
- Characterize the potential formation of regulated DBPs for chlorination using sodium hypochlorite.
- Evaluate process control options for disinfection using total residual chlorine or peracetic acid residual.
- Develop comparative capital and operating cost estimates for each technology to support recommendations for selection and implementation of the disinfection method that most cost-effectively meets the new permit requirements.

1.4 Pilot Study Evaluation Criteria

To meet the objectives of the pilot study, specific criteria for determining whether a disinfection alternative could meet the permit requirements were developed. The following sections include a description of the development of criteria for evaluation of bacteria inactivation and DBP formation.

1.4.1 Bacteria Inactivation

Considering the new permit limits that have been added for *Escherichia coli* (*E. coli*), it is important to evaluate the target removal that is required to provide discharge compliance. For the Maxson WWTP, treated effluent (which would be influent to the proposed new disinfection system) had an average, historical *E. coli* concentration of 7.4 x 10^5 cfu/100mL for the period of 9/14/2010 through 7/11/13. The maximum recorded *E. coli* concentration during this same period was 5.7 x 10^6 cfu/100mL. The permitted effluent *E. coli* limit includes a monthly geometric mean of 126 cfu/100mL and a daily maximum of 487 cfu/100mL, therefore the inactivation rates required to consistently meet the NPDES permit requirements were calculated as follows:

Average Monthly Inactivation Rate Required[1]*:* $\log(7.4 \times 10^5) - \log(1.26 \times 10^2) = \mu.8$

Maximum Daily Inactivation Rate Required[2]*:* $\log(5.7 \times 10^6) - \log(4.87 \times 10^2) = 4.1$

[1]Based on average of all observed data which slightly more conservative than using the geometric mean.

[2]Based on maximum of historic observed values.

It is of interest to note that because the maximum effluent *E. coli* concentration is not substantially greater than the average value (i.e., there is not a high level of variability in the effluent bacterial

concentrations), the maximum inactivation rate is nearly the same as what is required for the average inactivation rate. Thus, considering that plant operations staff would not likely run the process on the edge of the compliance limit, it is recommended to use one half of the monthly geometric mean value (63 cfu/100 mL) in new permit to establish the baseline condition for operations. Thus, target operating limits that have been added for *E. coli* as follows in order to develop average operational doses for chlorine, PAA and UV disinfection:

Average Operating Inactivation Rate Required[1]*:* $\log(7.4 \times 10^5) - \log(6.\mu \times 10^1) = 4.1$

[1]Based on average of all observed data which slightly more conservative than using the geometric mean.

1.4.2 Disinfection Byproduct Formation

In addition to discharge limits, TDEC may require additional investigations to characterize and control chlorinated DBPs, if chlorination is chosen as the preferred disinfection method. In the permit for the Maxson WWTP, Section 3.6.1., ***Additional Permittee Submittals (If Chlorination Disinfection System Selected)***, indicates that the Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly generated byproducts are related to TRC according to the compliance schedule provided in the permit.

Further, TDEC water quality criteria for the receiving reach of the Mississippi River include standards for DBPs. The designated uses of the receiving reach of the Mississippi River in Tennessee are: Industrial Water Supply, Fish and Aquatic Life, Recreation, Livestock Watering and Wildlife, Irrigation and Navigation. The general water quality criteria for these designated uses are provided in the Rules of the TDEC Tennessee Water Quality Control Board Division of Water Pollution Control, Tennessee Code Annotated (TCA) Chapter 1200-04-03.

The Fish and Aquatic Life and Recreation use in-stream water quality criteria contain parameters that are relevant to chlorine disinfection as summarized in **Tables 1-3** and **1-4**. These parameters provide the basis of the analytical testing of DBP formation. Criteria for Industrial Water Supply, Livestock Watering and Wildlife, Irrigation, and Navigation designated uses are narrative and do not contain additional specific chemical constituents of concern to disinfection.

Table 1-µ Analytical parameters based on TDEC Numeric Criteria for Fish and Aquatic Life

Compound	Criterion Maximum Concentration (CMC) (µg/L)	Criterion Continuous Concentration (CCC) (µg/L)
Total Residual Chlorine (TRC)	19	11

Table 1-4 Analytical parameters based on TDEC Numeric Criteria for Recreation

Compound		Organisms Only Criteria[1] (µg/L)
Dioxin[2]		0.000001
Trihalomethanes (THMs)	Bromoform	1400
	Chlorodibromomethane	1µ0
	Chloroform	4700
	Dichlorobromomethane	170
N-Nitrosodimethylamine (NDMA)		µµ

[1] "Organisms Only" Criteria for Recreation refers to the protection of public health due to the consumption of organisms. Different criteria exist where the water impacts both the consumption of water and organisms, i.e. where the water is designated for both recreation and domestic water supply.

[2] Total dioxin is the sum of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs).

1.4.µ Summary of Evaluation Criteria for Pilot Testing

Considering the NPDES permit and TDEC water quality requirements, a list of parameters were developed to aid in evaluating disinfection technologies (**Table 1-5**).

Table 1-5 Summary of criteria for evaluation of disinfection technologies

Parameter		Objective	Source of Requirement
E. coli (post-disinfection)		487 cfu/100 mL daily maximum; 126 cfu/100 mL monthly maximum	NPDES permit
E. coli Inactivation		4.1 log	Based on the NPDES permit limits and data on record regarding current effluent *E. coli* concentrations (see Section 2)
TRC or TRO		2.0 mg/L	NPDES permit; Also relevant to fish and aquatic life criteria
Total Dioxin		0.000001 µg/L	NPDES permit; TDEC Recreational use criteria for organisms
THMs	Bromoform	1400 µg/L	Recreation use criteria for organisms
	Chlorodibromomethane	1µ0 µg/L	Recreation use criteria for organisms
	Chloroform	4700 µg/L	Recreation use criteria for organisms
	Dichlorobromomethane	170 µg/L	Recreation use criteria for organisms
NDMA		µµ µg/L	Recreation use criteria for organisms

Section 2

Pilot Testing Procedure

Pilot tests were conducted at the Maxson WWTP between 3/5/2013 and 4/5/2013. Two chemical disinfection pilot reactors were constructed onsite using Schedule 40 PVC pipe and included flow control, flow metering, chemical injection points and in-line mixing. Sample ports were located along the length of the reactors that allowed sample collection at various time points. The flow rate through the PAA system was 100 gallons per minute (gpm), and flow rate through the hypochlorite system was 25 gpm. A photograph of the chemical disinfection reactors are shown in **Figure 2-1**. The reactors were fed from a common header (**Figure 2-2**) with plant effluent pumped from the Parshall flume (**Figure 2-3**). Chemical disinfectants were pumped via diaphragm pumps into static mixers at the head of the pipe reactors (**Figure 2-4**). Water samples were collected from sample taps (**Figure 2-5**) located along the reactor length and that correspond to specific contact times.

Figure 2-1 Pilot Reactor System

Figure 2-2 Common Feed Header System

Figure 2-µ Parshall flume and feed pumps

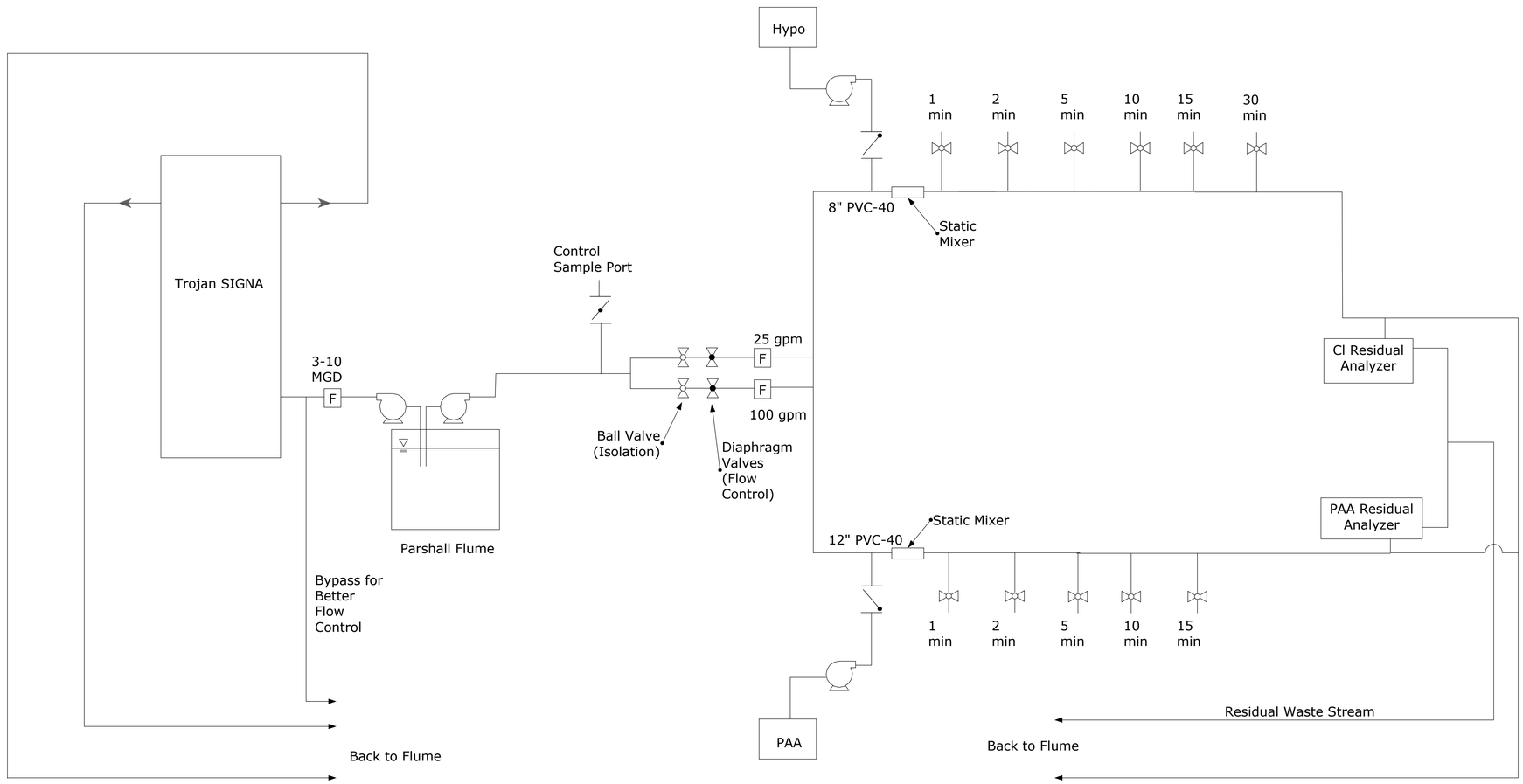
Figure 2-4 Chemical feed pump

Figure 2-5 Sample Tap

The UV disinfection pilot trailer was rented from Trojan Technologies. The system was housed in a semi-trailer near the Parshall flume. The TrojanSIGNA pilot was comprised of a stainless steel channel, a UV lamp bank containing eight Trojan solo lamps, an automatic lamp cleaning system, and an online UVT analyzer. The pilot unit is capable of treating up to 10 MGD when UVT values are at least 35%. Due to effluent UVT during the pilot period, flow was limited to about 7MGD. UV disinfected samples were collected using a dip sampler to grab samples directly from the channel, downstream of the UV lamps. The UV pilot system was fed from the inlet to the Parshall flume and discharged back into the effluent end of the Parshall flume structure. Flows ranged between 1MGD and 7MGD. A photograph of the TrojanSIGNA system is shown in **Figure 2-6**. A process flow diagram for the entire pilot system is shown in **Figure 2-7**.

Figure 2-6 TrojanSIGNA UV System

FIGURE 2-7
PROCESS FLOW DIAGRAM
PILOT SYSTEM AT MAXSON WWTP



REV. NO.	DATE	DRWN	CHKD	REMARKS

0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED BY: Kati Bell
DRAWN BY: Josh Goldman
SHEET CHK'D BY:
CROSS CHK'D BY:
APPROVED BY:
DATE:

CDM Smith
555 17th Street, Suite 1100
Denver, CO 80202
Tel: (303) 383-2300

CITY OF MEMPHIS
MAXSON DISINFECTION PILOT

FIGURE 2-7
PROCESS FLOW DIAGRAM
PILOT SYSTEM AT MAXSON WWTP

PROJECT NO. 6016-83104
FILE NAME: Stiles_PFD
SHEET NO.
1

The general procedures for disinfection tests were to set the PAA and hypochlorite feed pumps for specific feed rates to achieve targeted doses; the UV dose was set based on flow and UVT which was used to determine the lamp power setting for each experiment. After a stabilization period of approximately three average hydraulic retention times for the pilot system to reach steady state, control samples were analyzed for apparent color, UVT, TSS, *E. coli*, and DBPs in selected samples. Treated samples were analyzed for oxidant residual (for chemical oxidants), *E. coli* and DBPs in selected samples. The scope of the pilot was to characterize DBP formation potential for chlorine-based disinfection, but selected DBP samples were also run for PAA tests to confirm that DBP formation is not a concern. Color and UVT were not evaluated in the treated samples because the influence of disinfection method on the effluent color was not a stated objective of this study. Control aliquots were obtained from the control sample port prior to disinfection and disinfected samples were collected at either the 15 or 30 minute sample port for additional testing to establish the performance of the set chemical dose. The disinfected samples were tested in the field for chemical residual, pH and temperature. Approximately once per week, several samples were also collected for shipment to an external laboratory to test for DBPs; these samples were collected and shipped on ice to Test America. Samples were analyzed for dioxins, NDMA, and THMs.

The TrojanSIGNA UV pilot procedure was developed with the help of Trojan Technologies in order to verify applicability of the third-party validation that defines the reduction equivalent dose (RED) as a function of flow rate, lamp power, and UVT. For each experiment, UVT was measured and the system was set to a specific flow rate and lamp power. A RED was calculated based on difference between the concentration of *E. coli* in the disinfected sample and the control sample; the result was compared to the value predicted by the third party equation. A summary of the analytical methods used for testing is provided in **Table 2-1**.

Table 2-1 Analytical methods

Parameter	Responsible party	Method
pH	CDM Smith	pH probe
E. coli	CDM Smith	Standard Methods 922µ
TRC	CDM Smith	Hach DPD Kit
Total Residual PAA	CDM Smith	Chemetrics PAA Kit EPA Method µµ0.5
TSS	City of Memphis laboratory	Standard Methods 2540C
UVT, Apparent	CDM Smith	Single wavelength at 254nm using HACH DR5000
Color, Apparent	CDM Smith	Standard Methods 2420
Dioxins	CDM Smith (subcontract to specialty laboratory)	EPA Method 161µ
THMs	CDM Smith (subcontract to specialty laboratory)	EPA Method 524.1
NDMA	CDM Smith (subcontract to specialty laboratory)	EPA Method 8270
Particle size analysis	CDM Smith (subcontract to specialty laboratory)	Digital imaging using FlowCAM®

Figure 2-8 shows the preparation of an IDEXX tray for *E. coli* analysis, and **Figure 2-9** shows the IDEXX tray being sealed prior to incubation. After a 24-hour incubation period, IDEXX trays (**Figure 2-10**) are examined under a black light to determine which cells contain *E. coli*. A most probable number of *E. coli* is calculated based on the number of wells that fluoresce.

Figure 2-8 IDEXX tray preparation

Figure 2-9 IDEXX tray sealing

Figure 2-10 Incubated IDEXX trays

Section µ

Pilot Results

µ.1 Characterization of Maxson WWTP Effluent

The efficacy and efficiency of wastewater disinfection processes that could be implemented are integrally tied to effluent quality prior to disinfection. Applicability of chemical disinfection alternatives depends on oxidant demand, potential to form DBPs, and the presence of recalcitrant organic compounds that pass through the treatment process. The effluent water quality of the untreated (control) samples during the pilot testing period is summarized in **Table 3-1** along with the NPDES permit limits, TDEC water quality criteria, and historical performance, described in Section 2.

The strategy for implementation of the pilot study included consideration of timing to capture conditions when the lowest effluent quality could be tested. As a result, testing was targeted for late winter when temperatures are lowest and when plant staff has the most difficulty with plant operating conditions. Based on the effluent characterization data collected during the pilot and presented in Table 3-1, the effluent quality adequately reflected conditions that would provide information for developing engineering design criteria to meet permit compliance under the most difficult operating conditions.

In general the results for parameters tested for control samples during pilot testing showed the following:

- TSS during the pilot period were higher than historical averages for samples; while grab samples were not collected for BOD, the daily composites collected for permit compliance during this same period were also higher than reported in historical data. Specifically, the average BOD during the pilot period was 51 mg/L as compared to an average of 30 mg/L for the period between 1/1/2008 and 5/31/2013.
- *E. coli* concentrations measured in pilot samples were within the range of historical concentrations. During the pilot period, the average *E. coli* concentration was 2.6 x 10^5 cfu/100 mL compared to 7.3 x 10^5 cfu/100mL recorded between 9/14/2010 and 7/11/2013.
- Color and UVT, which are parameters that can be used as indicators of the characteristics of organic carbon in the effluent, were measured; color during the pilot study was higher than historical data and UVT measured during the study was substantially lower than data previously reported in Table 1-1.

DBPs including dioxins, trihalomethanes (THMs) and N-nitrosodimethylamine (NDMA) were measured; two dioxin congeners were detected at least once in the undisinfected effluent, and one OCDD, persisted into the disinfected water. Neither THMs nor NDMA were detected in any control sample.

Table µ-1 Secondary Effluent Water Quality during Pilot Testing

Parameter		Units	NPDES Permit Limits[1]		TDEC Water Quality Criteria	Average Value during Pilot Test Period	Historical daily average concentration[2,µ]
			Monthly	Daily		µ/1 -4/5	
E. coli		cfu/100mL	126 (geomean)	487	-	2.6×10^{5}	7.µ x 10^{5}
BOD		mg/L	42	84	-	51[5]	µ0
TSS		mg/L	48	96		42[5]	µ0.µ
Color, Apparent, Average		PtCo Units	-	-	-	562	401
UVT, Apparent, Average		% Transmittance	-	-	-	17	27
NDMA		µg/L	-	-	µµ	0	-
THMs	Bromoform	µg/L	-	-	1400	0	-
	Chlorodibromomethane	µg/L	-	-	1µ0	0	-
	Chloroform	µg/L	-	-	4700	0	-
	Dichlorobromomethane	µg/L	-	-	170	0	-
Dioxins, Total[4]		µg/L	0.000001	0.000001	0.000001	0	-

[1] Maximum average unless otherwise noted.
[2] *E. coli* period of record is 9/14/2010 – 7/11/201µ.
[µ] TSS period of record is 1/2008 – 5/201µ.
[µ] Color, UVT period of record is 1/2010 – 5/201µ.
[4] Total dioxins is the sum of all dioxin and dibenzofuran isomers after multiplication by Toxic Equivalent Factors (TEFs).
[5] Average value compiled from plant MOR data during piloting period.

µ.2 Sodium Hypochlorite Test Results

Chlorination, by bulk liquid hypochlorite is a widely used disinfection method and could be used at the Maxson WWTP with construction of a chlorine contact basin and chemical feed and storage facilities. New instrumentation and programming would be required for process control and integration into the existing plant control system. For piloting at the Maxson WWTP, a 12.5% sodium hypochlorite solution was obtained from Ideal Chemical and fed using a Pulsatron Series MP diaphragm pump through a static mixer into the pilot reactor. The applied doses tested ranged throughout the study from 9 mg/L to 36 mg/L as shown in **Figure 3-1.**

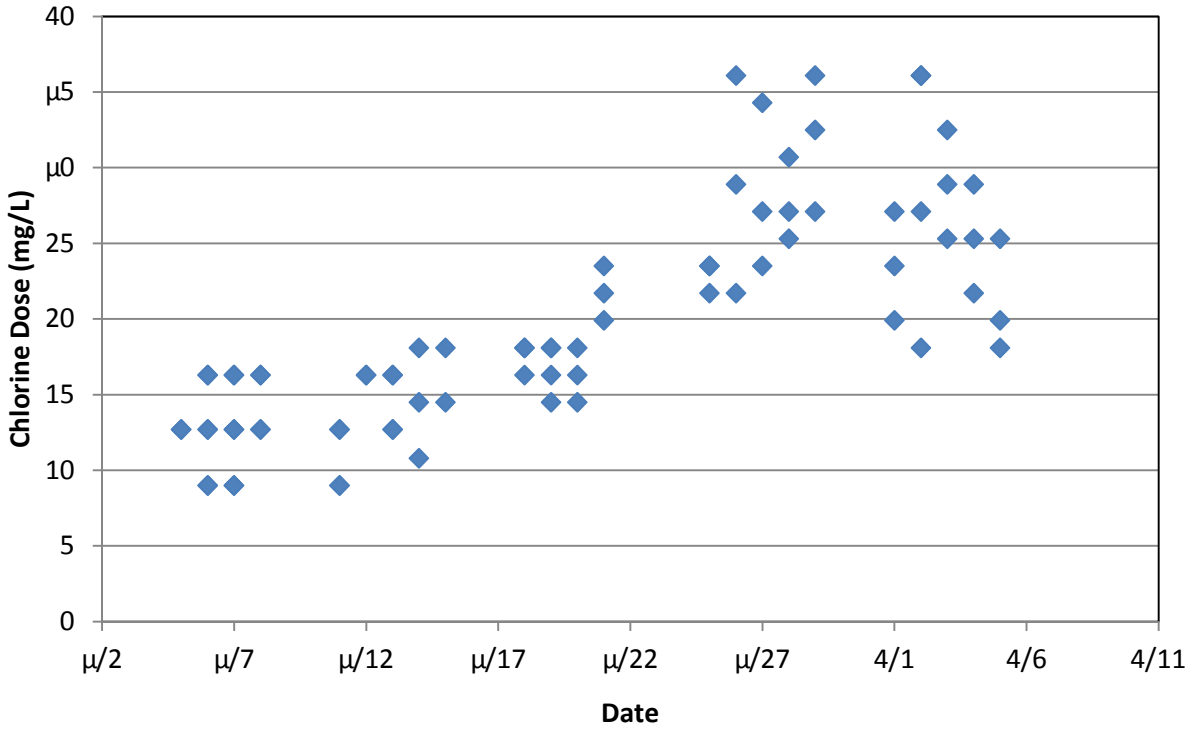


Figure µ-1 Chlorine dose range for pilot period

µ.2.1 Chlorine, Demand, Residual and *E. coli* Disinfection

There are a number of disinfection process control strategies that can be employed to manage a chlorine based (here, sodium hypochlorite) disinfection system. Because there is a lag time in obtaining bacterial inactivation results, there is no "on-line" method that provides direct process control for disinfection. One method that has been used to control chlorine disinfection processes is to use chlorine residual which can be linked to process performance by developing an understanding of the process through testing.

Inactivation kinetics of chlorine disinfection has been studied extensively, and has generally been described with expressions that combine process parameters such as disinfectant dose, contact time and microbial concentrations. The Chick–Watson formula is the oldest model that has been used and is based on the product of residual disinfectant concentration (C) and contact time (t).

$$log\left(\frac{N}{N_0}\right) = -L_S C^n t$$

In the Chick–Watson formula N_0 and N are the initial and final (i.e., after time t) microbial counts, L_S is the specific coefficient of lethality (i.e., the disinfection efficacy when C and t are equal to 1) n is the dilution coefficient, which depends on the specific disinfectant, pH and temperature, and it is often close to 1 for chlorine based disinfection and can be applied successfully when treating water that has a consistent chemical demand.

The model can be applied to wastewater disinfection with chlorine when there is certainty that a single mode of disinfection is used. With respect to chlorine disinfection, there are two different forms of chlorine that can be used to provide disinfection, either free chlorine or combined chlorine (or chloramines). When sodium hypochlorite is applied to wastewater effluent, hypochlorous acid is produced; and, if ammonia is present in the treated effluent at concentrations greater than about 2.0 mg/L, hypochlorous acid will react with ammonia (NH_3) to form chloramines:

$$NH_3 + HOCl \rightarrow NH_2Cl\ (monochloramine) + H_2O$$

$$NH_2Cl + HOCl \rightarrow NHCl_2\ (dichloramine) + H_2O$$

$$NHCl_2 + HOCl \rightarrow NCl_3\ (nitrogen\ trichloride) + H_2O$$

While free chlorine (as hypochlorous acid) is a more powerful oxidant and has faster bacterial inactivation kinetics, achieving free chlorine disinfection depends on the amount of ammonia and organic compounds in the effluent. This process is well documented, and the breakpoint chlorination process is graphically depicted in **Figure 3-2** (Metcalf & Eddy, 2003).

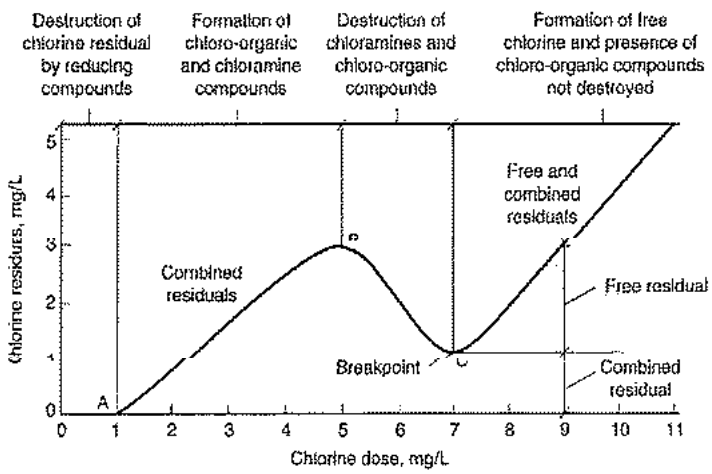


Figure µ-2 Breakpoint chlorination curve (Metcalf & Eddy, 200µ)

It is important to note no significant free chlorine residual is produced unless the breakpoint is reached. Thus, in the case of the Maxson WWTP, it would not be feasible to overcome the ammonia concentrations in the effluent to achieve breakpoint chlorination because the facility is not required to nitrify. While chloramines are slower-reacting than free chlorine, they still provide excellent pathogen inactivation, given adequate contact time. Additionally, chloramination can also significantly reduce

the potential for production of DBPs. However, process control for a chloramine system, particularly for effluent with a complex composition, can be quite challenging.

Process control for chlorine disinfection is typically based on total residual chlorine (TRC) control. The challenge in using this approach for chloramination is that for plants with complex effluent quality, chlorine reactive compounds, such as organic-nitrogen, nitrites, color, or other compounds, may exert a high chlorine demand prior to establishing a measurable residual. Peng (2009) showed that an organic-nitrogen concentration above 2-mg/L would form organo-chloramines (a.k.a. chloro-organic compounds), which although they contribute to the formation of TRC have negligible disinfecting strength. Additionally, organic color may be bleached by chlorine in competing reactions with formation of chloramines and can consume significant concentrations of chlorine. There are other inorganic reactions of chlorine with reduced substances such as sulfides, sulfites, nitrites, ferrous iron, and reduced manganese compounds which react with both free chlorine and combined chlorine. These reactions usually occur within the first minute at which point there is no measureable residual. As a result, it is important to conduct site specific testing to determine the target residual that will allow a facility to utilize TRC for effective process control (Szerwinski, et al., 2012).

Pilot data was treated using the Chick-Watson model to determine kinetic parameters for determining design criteria for a chloramination disinfection system. When data were analyzed, there was a group of data that could not be fit with the model, as shown in **Figure 3-3**. The analysis showed that the model predicted significantly higher inactivation rates than were observed for some samples.

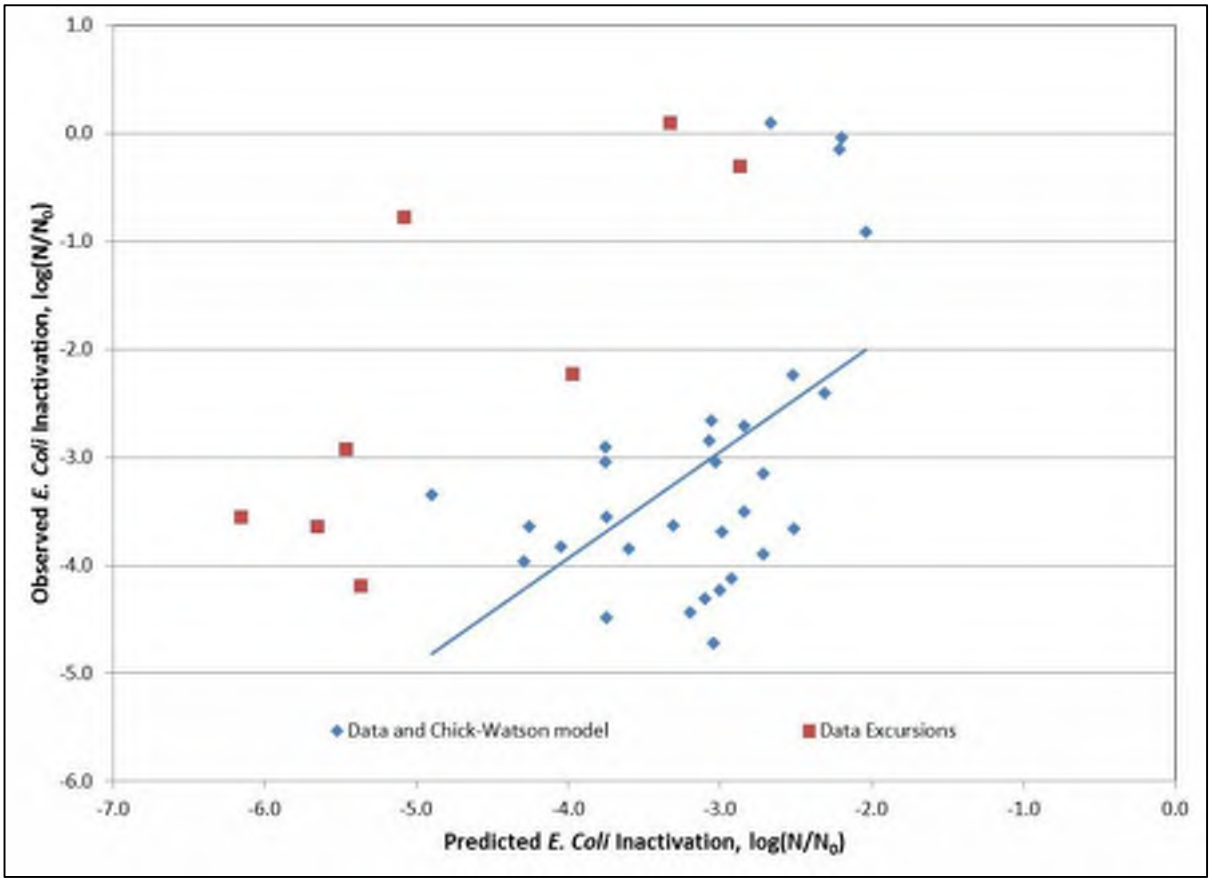


Figure µ-µ Observed versus predicted disinfection performance using the Chick-Watson model

Data were reviewed to determine if the samples that were excursions from this normal disinfection model could be correlated to another effluent parameter measured during the study. It was determined that the majority of data that were excursions from the model were data collected at 30 minutes. Closer evaluation of the data showed that there was no additional benefit of time in terms of bacterial inactivation and that the inactivation generally occurred during the first 15 minutes of contact time. However, this was not always the case, and use of this approach for process control could be challenging.

In order to establish an approach to providing consistent process control, bacterial inactivation results were also plotted as a function of TRC (showing both 15 and 30 minute data) in **Figure 3-4**; a best fit was plotted for the 15 minute data (maximum flow design conditions) and compared to the operational inactivation requirement to set the average operating dose as described in Section 1.4.1. Based on the fitted data, a target residual of 10 mg/L should be used to meet the operational requirements for disinfection.

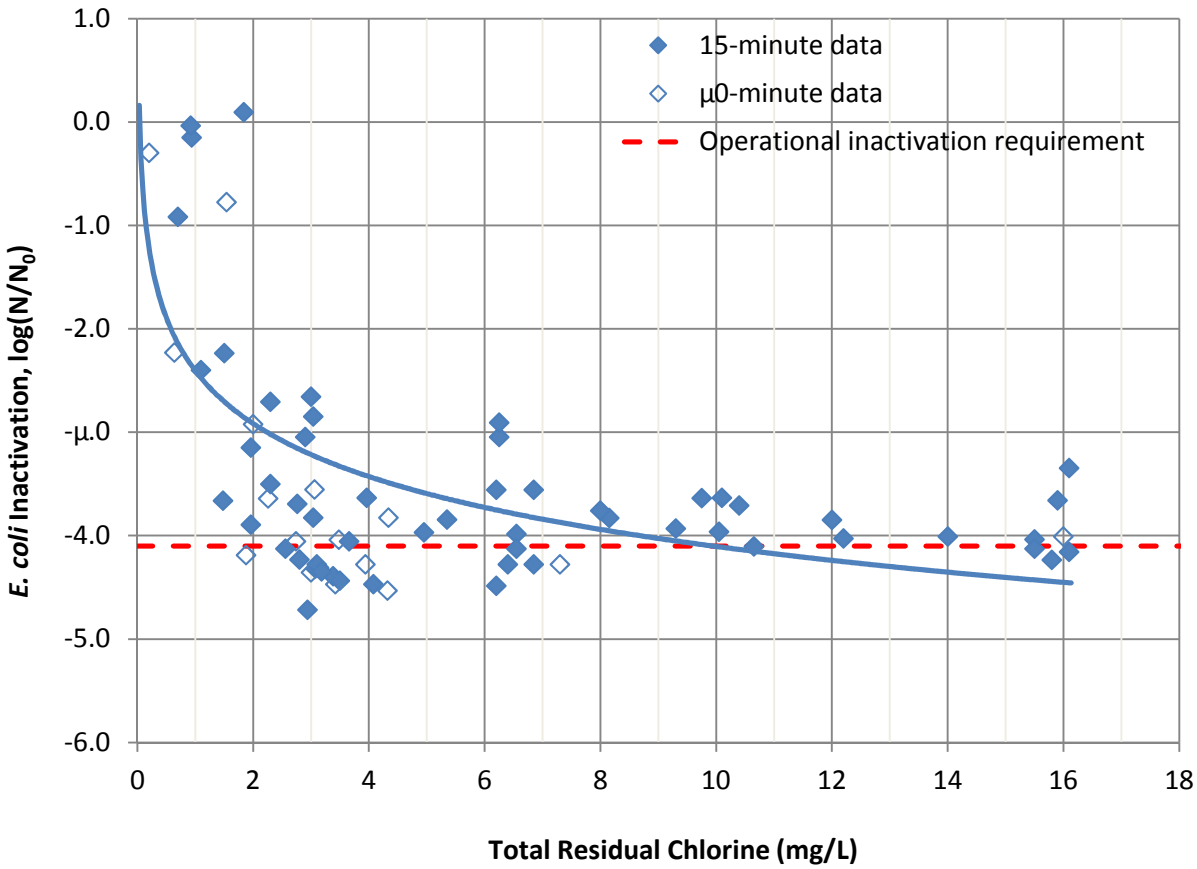


Figure µ-4 *E. coli* inactivation as a function of chlorine residual

µ.2.2 Chlorine Design Dose for *E. coli* Disinfection

In order to establish the basis for design, that is the average, minimum and maximum feed rates to aid in sizing chemical storage facilities and selection of pump sizes, it is necessary to determine the range of chlorine doses that provide the required residuals as described in the previous section. To determine the chemical dose that would need to be applied to achieve the target disinfection rates, the

oxidant demand must be satisfied. The oxidant demand which is operationally defined as the applied dose minus the residual can be added to the target residual to establish the design dose.

Chlorine demand data as a function of color were plotted for doses less than 25 mg/L that provided measurable residuals **(Figure 3-5)**. The 25 mg/L cutoff was used because these concentrations are beyond those that would be required to provide disinfection and more importantly, the interparticle chemical concentration gradients at these concentrations eliminate diffusion boundaries that impact disinfection efficacy and these factors cannot be accounted for in these tests. Chlorine demand data were similarly plotted as a function of UVT **(Figure 3-6)**. In the case of color, there was no clear relationship between the effluent color and chlorine demand. For UVT, there is a slight, apparent relationship between effluent UVT and chlorine demand, however, this relationship is weak and not statistically significant.

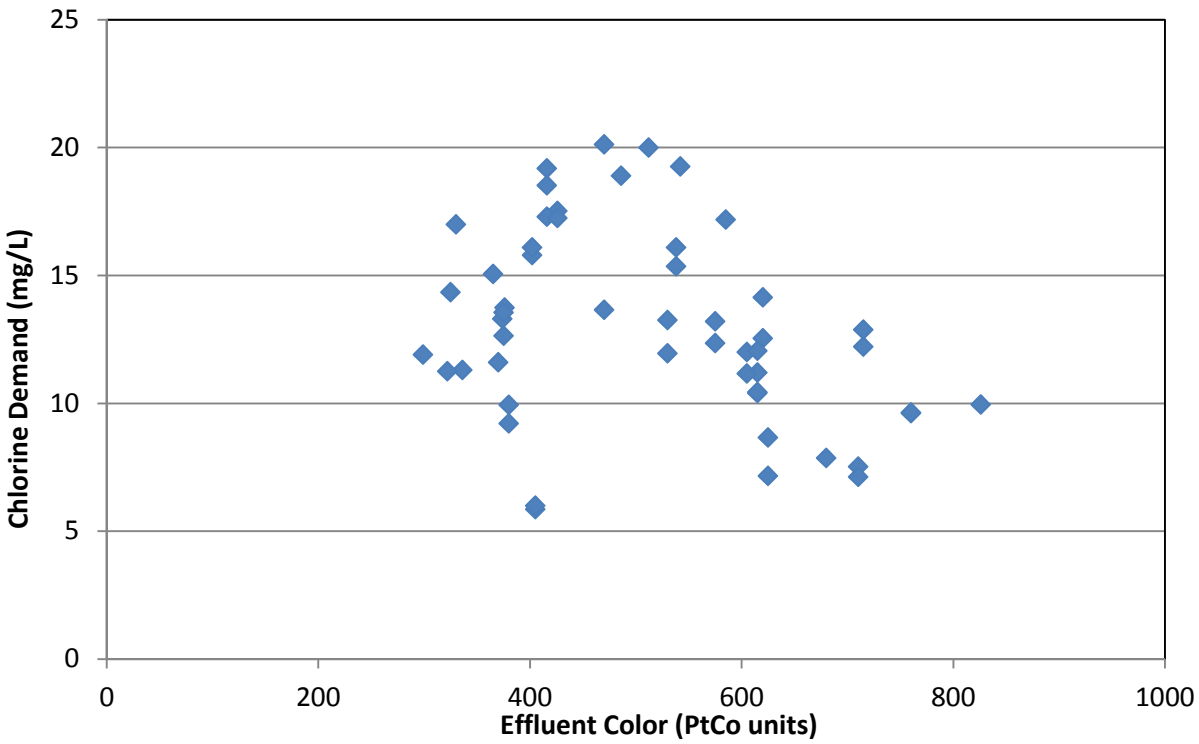


Figure µ-5 Chlorine demand as a function of color

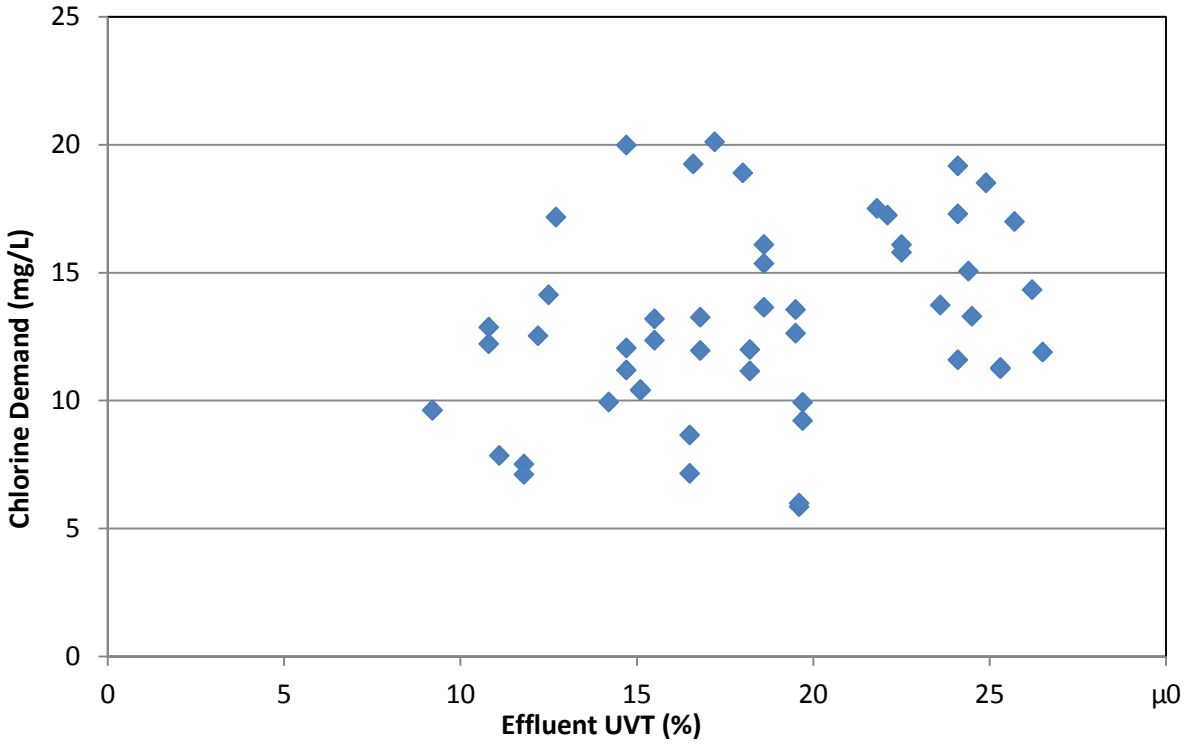


Figure µ-6 Chlorine demand as a function of UVT

Chlorination by application of bulk sodium hypochlorite was inconsistent for achieving required *E. coli* inactivation, (**Figure 3-7**). Results showed that when inactivation is achieved, the process is generally accomplished within the minimum 15 minutes contact time required by the *Tennessee Design Criteria for Sewage Works* for peak flow conditions, when doses are applied that provide a residual that would consistently be in excess of 10 mg/L. The challenge is that there are no clear process control parameters, other than total residual chlorine to help indicate when high chlorine demands would be observed. Thus, due to the highly variable nature of the efficacy of the process, it is recommended to set the sodium hypochlorite design dose at 20 mg/L for the purposes of this evaluation.

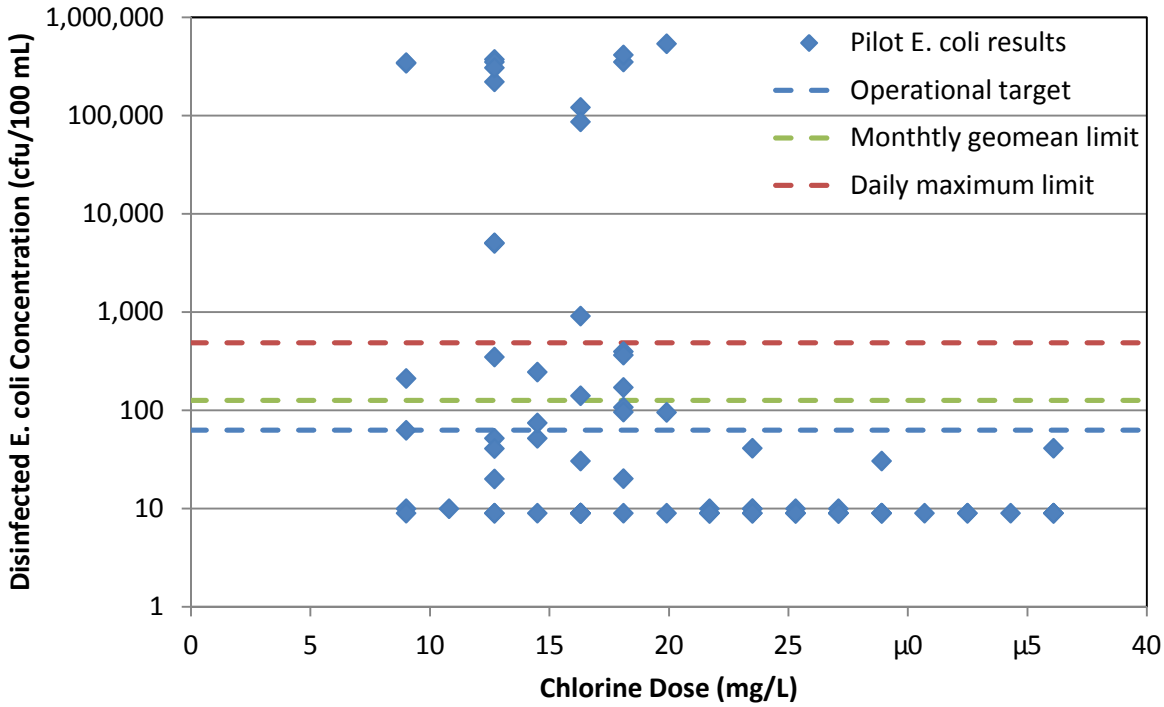


Figure µ-7 *E. coli* results as a function of applied chlorine dose

µ.µ Peracetic Acid Test Results

Disinfection, by bulk liquid PAA is relatively new method of municipal wastewater disinfection in the US. However, this method of disinfection is gaining interest due to its ability to provide bacterial inactivation performance at costs competitive to other mature technologies without the formation of regulated DBPs. PAA has been applied to the food, beverage, medical and pharmaceutical industries as a disinfectant for many years and has been demonstrated for municipal wastewater disinfectant in Europe with PAA disinfection being applied for effluent reuse (with an *E. coli* limit of 10 cfu/100mL) at the largest WWTP in Milan, Italy (Nosedo WWTP with an average flow of 110 mgd) since 2006 as shown in **Figure 3-8**.

PAA disinfection at the Maxson WWTP, by application of bulk liquid PAA, would require the construction of a new contact basin and construction of new facilities to house chemical storage and feed equipment, which could be provided as part of a PAA solutions package from FMC. For piloting at the Maxson WWTP, a 15% PAA solution (VigorOx II) and a diaphragm pump were provided by FMC for testing. The PAA solution was pumped into the pipe reactor through a static mixer to achieve doses ranging from 4.5 to 15 mg/L as shown in **Figure 3-9.**

Figure µ-8 Nosedo WWTP, Milan Italy (image from: http://www.google.com/imgres?q=nosedo+milano+wwtp&um=1&sa=N&biw=1175&bih=645&hl=en&tbm=isch&tbnid=gCARV5pXzQnHKM:&imgrefurl=http://www.bonatti.it/Projects/Nosedo-Waste-Water-Treatment-Plant-Milan&docid=ivw6zuCUXowPKM&imgurl=http://www.bonatti.it/var/bonatti/storage/images/media/images/nosedo-waste-water-treatment-plant_1/9247-1-eng-GB/Nosedo-Waste-Water-Treatment-Plant_1_imagelarge.jpg&w=550&h=µ68&ei=SH_MUdPsOYLC4AOvmYDgCA&zoom=1&iact=hc&vpx=2&vpy=1µ0&dur=297&hovh=184&hovw=275&tx=1µ8&ty=106&page=1&tbnh=140&tbnw=214&start=0&ndsp=20&ved=1t:429,r:0,s:0,i:81)

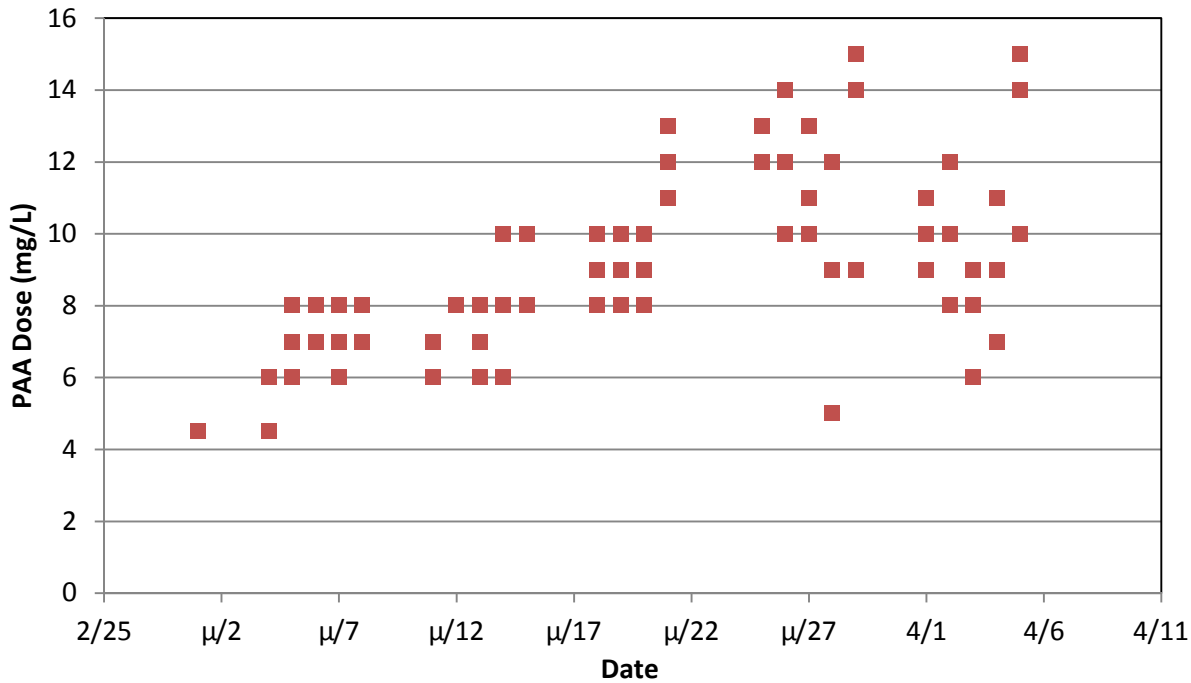


Figure µ-9 PAA dose range for pilot period

µ.µ.1 Peracetic Acid Residual, and *E. coli* Disinfection

There are a number of disinfection process control strategies that can be employed to manage a PAA disinfection system, but in general PAA has been operated using a dose pacing methodology. If the oxidant demand is variable, it can be paced using total residual PAA concentration, similar to use of TRC for chlorine disinfection. PAA residual control should be linked to site-specific performance data through testing, as conducted during this study. These site-specific water quality parameters could include color, chemical oxygen demand (COD), UVT, etc.

The "CT" approach that is traditionally used for chlorine disinfection as previously described for chlorination is not fully adequate to assess the effectiveness PAA disinfection because of differences in chemical half-lives and, as a result, it necessary to capture the decay kinetics and combine these with a valid microbial inactivation model to describe the process. There are a number of models that have been developed to address this effect and most are generalizations of the Chick–Watson formula. Among the published models, Hom's model is probably the most widely used to account for deviations from the first-order kinetics of the Chick-Watson formula.

$$log\left(\frac{N}{N_0}\right) = -kC^n t^m$$

In Hom's model, m is used to account for either shoulders or tailing which may occur from a number of different factors, but with respect to PAA disinfection, and it can be used to account for the shorter half-life of PAA. The model has been validated in several studies, showing that Hom's model is the most appropriate for describing PAA disinfection of secondary wastewater effluent for coliform organisms (Rossi et al., 2007; Azzellino et al., 2011). These studies were evaluated because of the need to address process control for WWTPs in Italy that had switched to PAA disinfection to meet the rigorous Italian standards for DBPs. For data collected through laboratory testing at the Nosedo

WWTP previously described, Antonelli et al. (2011) demonstrated that the PAA performance was consistent with the mathematical representation of the variables where:

- k is the disinfection rate constant otherwise known as the specific coefficient of lethality and depends on the target organism (here, *E. coli*) and other factors such as bacterial association with TSS.
- When n < m, t (contact time) is the primary factor affecting inactivation and longer contact times will provide additional disinfection benefit.
- When n ~ m, and t and PAA residual are similar in their effect on inactivation.
- When n > m, chemical residual overrides contact time with respect to disinfection efficacy.
- When m < 1, there can be a tailing-off behavior at very long contact times.

Uncensored bacterial counts and residual measurements (i.e., results were greater than non-detection, which cannot be interpreted in the analysis of the model) were analyzed using Hom's model. The predicted versus observed results for bacterial inactivation are shown in **Figure 3-10**. The detection limit for measurement of *E. coli* was 10 cfu/100 mL, the lowest measurable PAA residual was 0.6 mg/L, and the and highest applied PAA dose used in the analysis 10 mg/L. Hom's model data was adequate for representing the data collected during the study, and there were no clear outliers when data were censored as described.

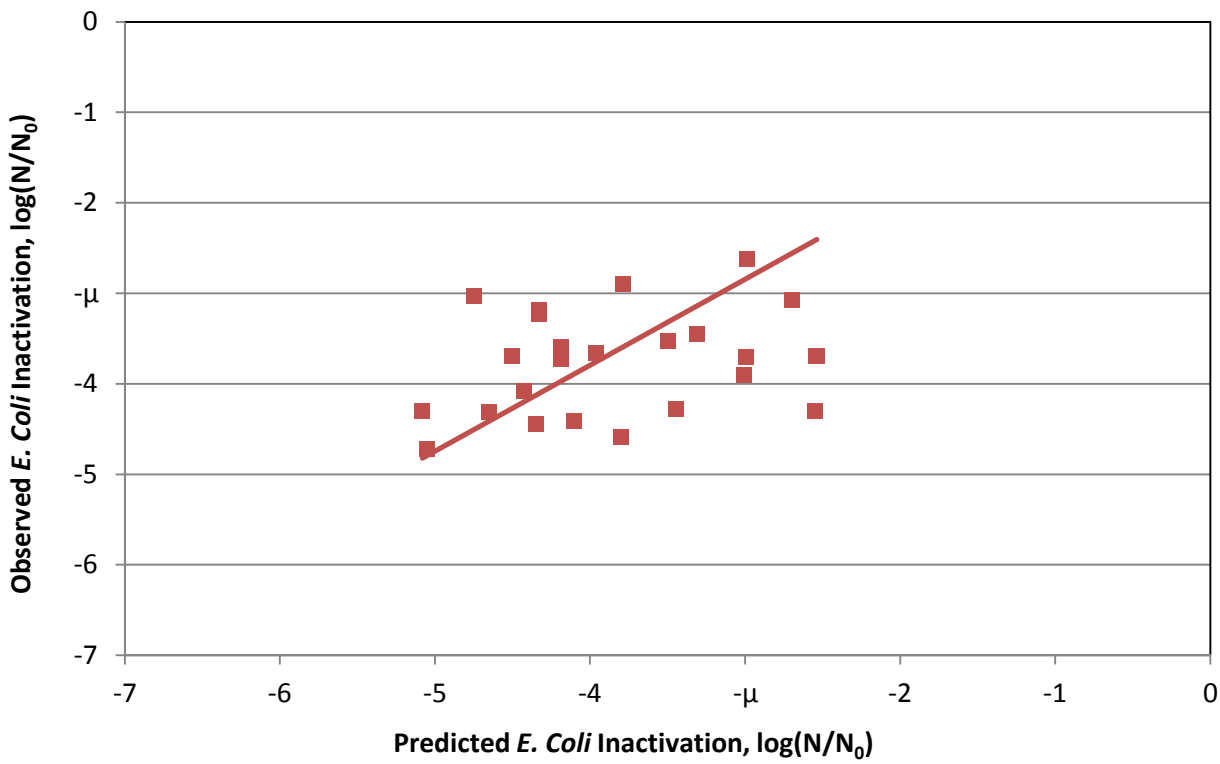


Figure µ-10 Observed versus predicted disinfection performance using Hom's model

The kinetic parameters determined using Hom's model are k = 0.6, n = 0.5 and m = 0.52 which are consistent with other studies of *E. coli* inactivation. Thus, data may be interpreted, with n ~ m, that contact time and residual are equally important factors affecting inactivation and longer contact times

will provide additional disinfection benefit. When m < 1, there can be a tailing-off behavior at very long contact times so there is a limit to which the additional benefit could be observed. In order to determine whether an increased contact time (from 15 to 30 minutes) would provide additional disinfection benefit, additional bench testing was conducted on a sample collected on July 22, 2013. Data from this test date for several PAA doses and contact times are shown in **Figure 3-11.** The data shows, as anticipated, that at PAA doses above 4 mg/L, there is a clear benefit to an increased contact time.. As a result, Hom's model developed based on 15 minute pilot data could be applied to predict average performance at up to 30 minutes contact time.

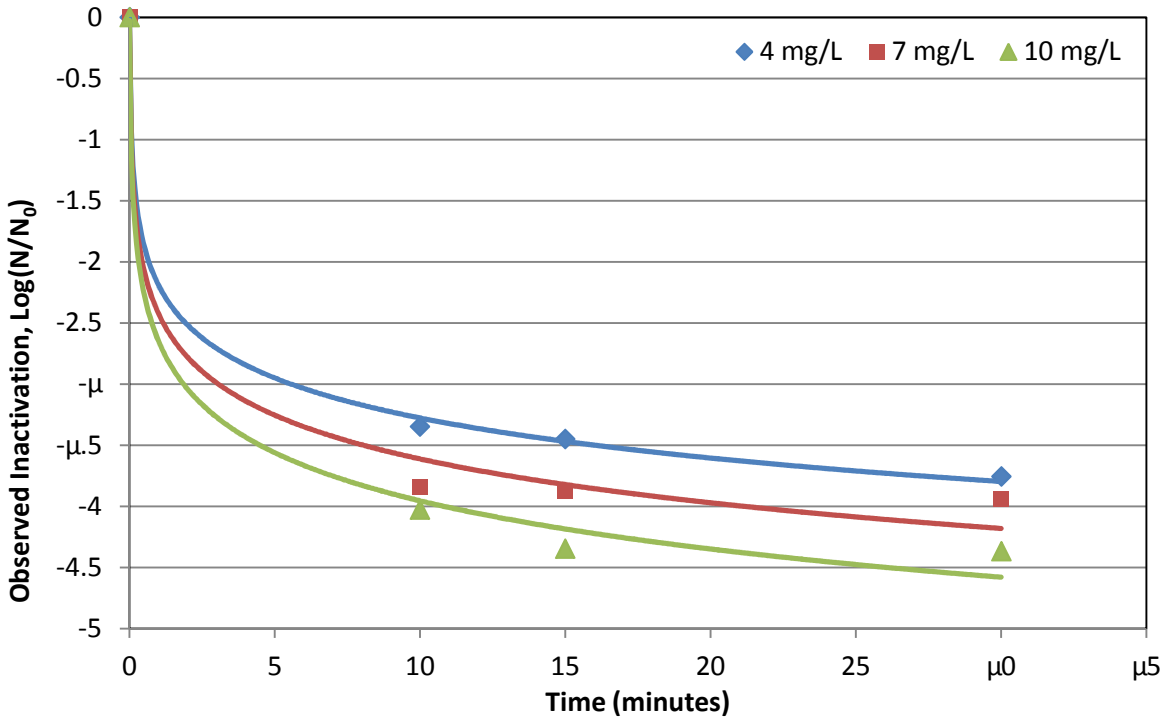


Figure µ-11 Bench test results for disinfection of Maxson effluent at 10, 15 and µ0 minute contact times, for three PAA doses (testing conducted by FMC in support of cost proposal for PAA)

µ.µ.2 PAA Design Dose for *E. coli* Disinfection

In order to establish the basis for design, that is the average, minimum and maximum feed rates to aid in sizing chemical storage facilities and selection of pump sizes, it is necessary to determine the range of PAA doses that provide the required inactivation rates as described in the previous section. To determine the chemical dose that would need to be applied to achieve the target disinfection rates, the target dose was determined using the model developed in this analysis. Using the average effluent *E. coli* concentration and the operational target of 63 cfu/100 mL for a 15 minute contact time, a calculated target residual of 3.0 mg/L must be achieved as shown in **Table 3-2**. In order to achieve these target residuals, the oxidant demand must be satisfied and this value must then be added to the target residual to establish the design dose. Because the target residual concentration required for disinfection is > 2.0 mg/L, quenching (the equivalent of dechlorination for chlorine) would be required under the current draft NPDES permit. The estimated design dose was determined by adding the oxidant demand of 6.0 mg/L, which was determined by calculating the average over the entire set of pilot data, to the target residual.

Table µ-2 Calculated PAA residual and dose to meet target *E. coli* concentration at 15 minutes contact time

Target Effluent Condition, N (cfu/100 mL) =	126			6µ		
Effluent *E. Coli*, N_0 (cfu/100mL)	$\log(N/N_0)$	C_{168}	Dose	$\log(N/N_0)$	C_{84}	Dose
500,000	-µ.60	2.µ2	8.28	-µ.90	2.71	8.67
1,000,000	-µ.90	2.71	8.67	-4.20	µ.12	9.08
2,000,000	-4.20	µ.12	9.08	-4.50	µ.57	9.5µ

If the average contact time is longer than 15 minutes the data could be extrapolated using Hom's model, as supported by data presented in Figure 3-11. Under this condition, it is possible to reduce the target residual under average operating conditions to less than 2.0 mg/L which would allow the facility to be operated without residual quenching, as shown in **Table 3-3.**

Table µ-µ Calculated PAA residual and dose to meet target *E. coli* concentration at µ0 minutes contact time

Target Effluent Condition, N (cfu/100 mL) =	126			6µ		
Effluent *E. Coli*, N_0 (cfu/100mL)	$\log(N/N_0)$	C_{126}	Dose	$\log(N/N_0)$	$C_{6µ}$	Dose
500,000	-µ.60	1.19	7.15	-µ.90	1.µ9	7.µ5
1,000,000	-µ.90	1.µ9	7.µ5	-4.20	1.60	7.56
2,000,000	-4.20	1.60	7.56	-4.50	1.8µ	7.79

To determine whether there was a process control parameter that could be used to predict chemical demand, similar to the analysis conducted for chlorine, PAA demand was evaluated with respect to both color and UVT. In both cases, there was no apparent relationship between oxidant demand and color or UVT; and the graphs have not been shown.

Figure 3-12 shows E. coli inactivation as a function of PAA dose, and **Figure 3-13** shows E. coli inactivation as a function of PAA residual. These data represent the difficult operating conditions that were experienced during the pilot period. **Figure 3-13** indicates that a higher target residual than predicted by the Hom's model may be required to achieve disinfection compliance. The recommended design dose would be in excess of 10 mg/L as shown in **Figure 3-12**. Using the target residual of 7.0 mg/L as indicated in **Figure 3-13**, a design dose of 13 mg/L can be established by adding the average PAA demand as described in the previous paragraphs. Thus, due to the highly variable nature of the efficacy of the process, it is recommended to set the PAA design dose at 13 mg/L.

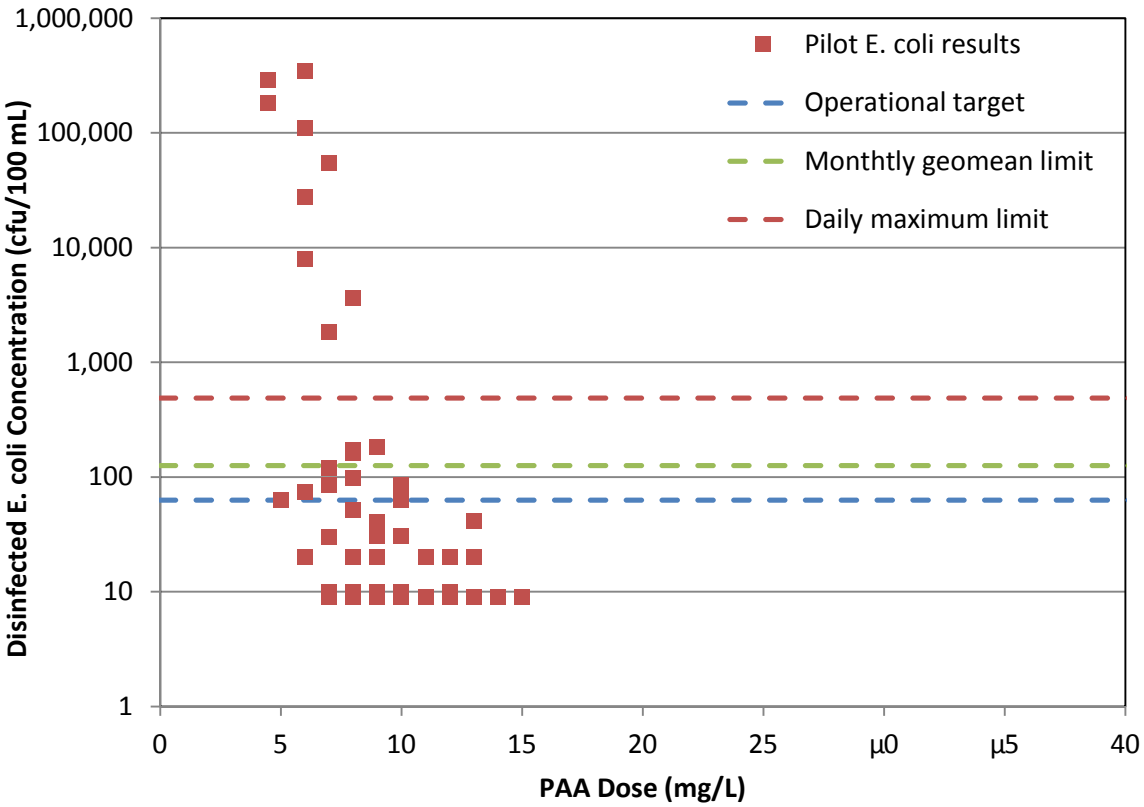


Figure µ-12 *E. coli* results as a function of applied PAA dose at 15 minutes

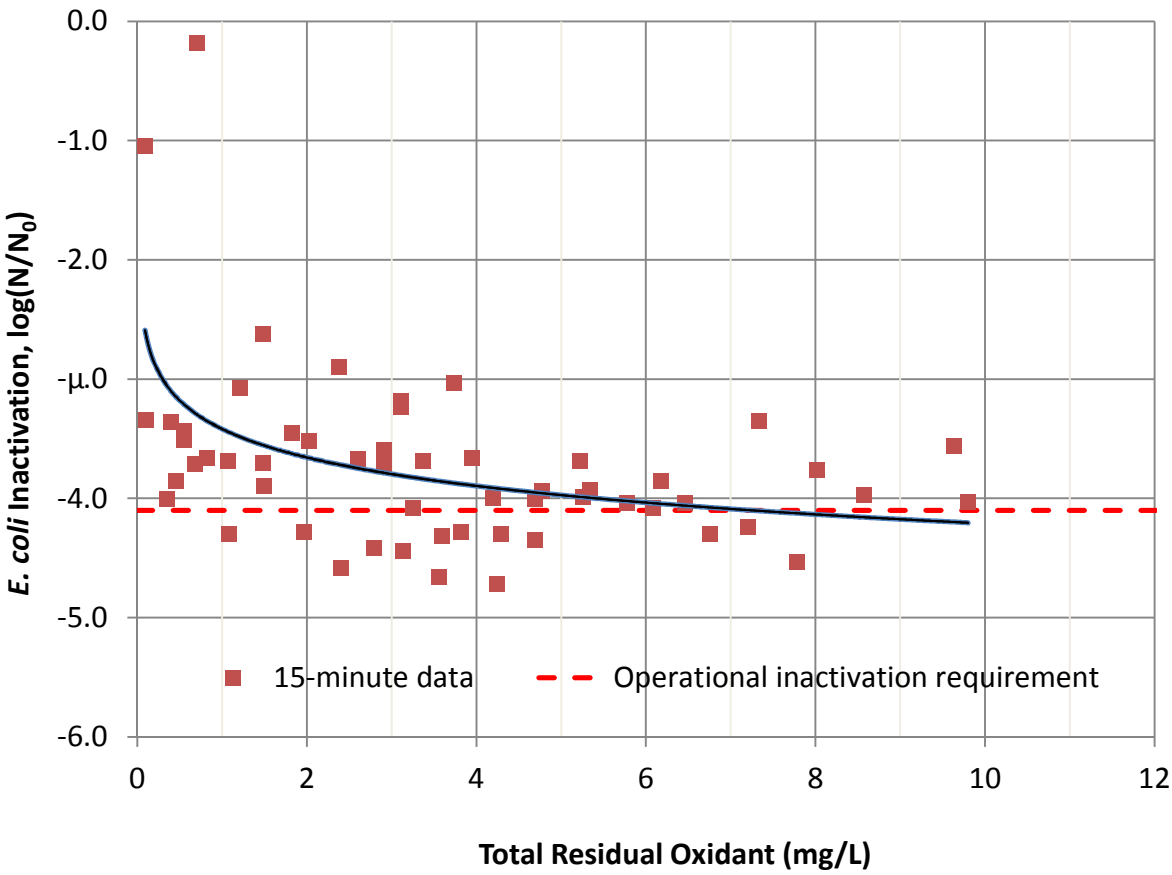


Figure µ-1µ *E. coli* inactivation as a function of PAA residual

Disinfection by application of PAA was demonstrated to be effective for achieving required *E. coli* inactivation. Results show that inactivation is accomplished within the minimum 15 minutes contact time at peak flow, and there is additional benefit that is obtained with longer contact times. Thus, for the purposes of this evaluation it is recommended that the chemical contact time requirements for PAA be designed to be equivalent to the required contact time for a chlorine disinfection system.

µ.4 Disinfection By-Products

As noted in Section 1.4.2, testing was conducted during the pilot study to evaluate the potential formation of DBPs. While the concern regarding DBP formation is primarily linked to use of chlorine based disinfection methods, some testing was also conducted on samples treated with PAA to confirm that DBP formation would not be a concern. Testing showed that there was no NDMA detected in any sample tested. Results for dioxins and THMs are shown in **Figures 3-14** and **3-15**.

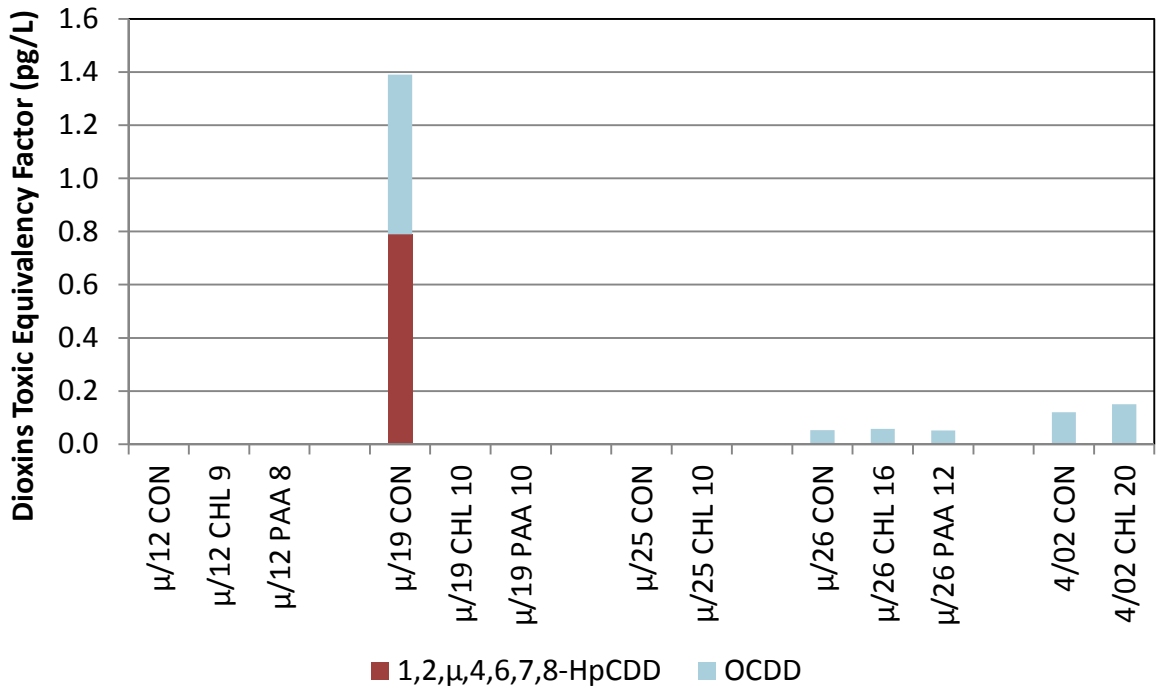


Figure µ-14 Toxicity equivalents for control and disinfected samples collected during pilot testing

Note: x-axis labels contain the date of the test, the type of disinfectant
No bar indicates that the constituent was not detected.
(CHL – hypochlorite, PAA – peracetic acid, CON - control (no disinfectant). All doses in mg/L).

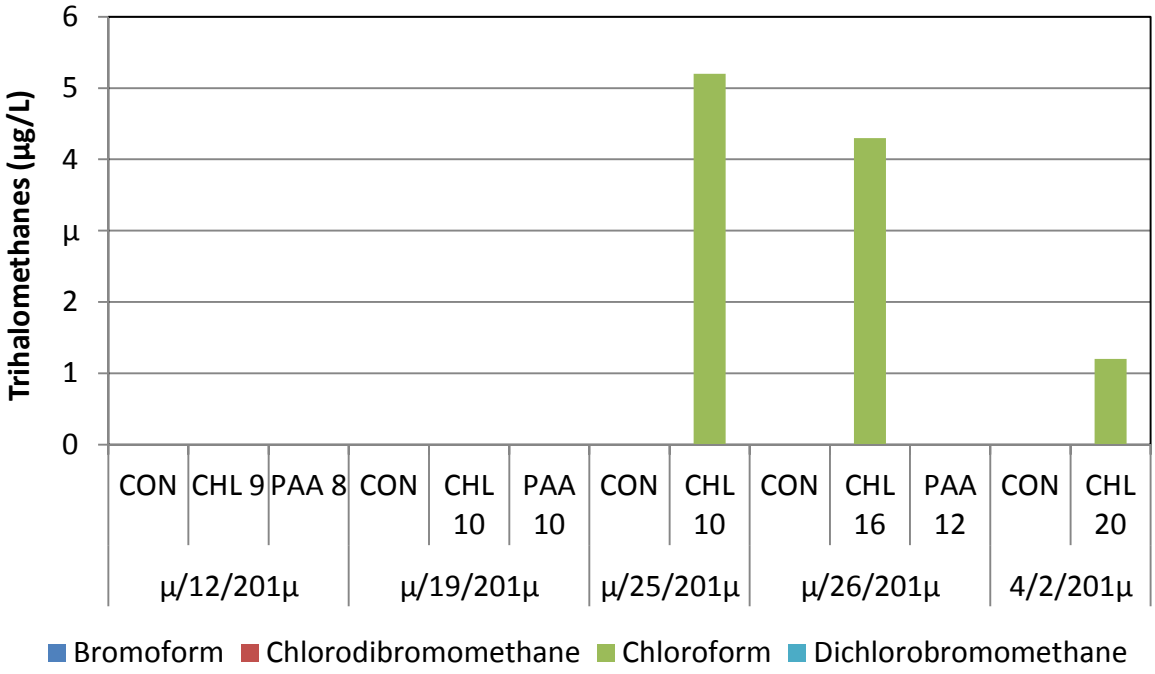


Figure µ-15 TTHM results for control and disinfected samples collected during pilot testing

Note: x-axis labels contain the date of the test, the type of disinfectant
No bar indicates that the constituent was not detected.
(CHL – hypochlorite, PAA – peracetic acid, CON - control (no disinfectant). All doses in mg/L).

Dioxin test results showed that one congener, octachlorodibenzo-*p*-dioxin (OCDD), was present in the treated effluent at less than permit limits on three dates and the compound persisted through the disinfection treatment process on two events. In the test, performed on March 19, 2013, 1,2,3,4,6,7,8-heptachlorodibenzo-*p*-dioxin (HpCDD) was detected in the undisinfected effluent, but it did not persist into the disinfected effluent. All other detections of dioxin compounds were less than the permitted limit of 1 pg/L.

With respect to trihalomethane compounds, no chloroform was present in any control samples. On three dates, March 25, 2013, March 26, 2013, and April 2, 2013 chloroform formation was noted with addition of high doses of chlorine. No chloroform formation was associated with PAA addition. In all cases, the resulting concentrations of chloroform were orders of magnitude lower than the instream water quality criteria of 4,700 ug/L.

µ.5 UV Disinfection Test Results

UV inactivation of microorganisms is a biophysical process; in practice, the primary germicidal activity occurs at a UV light wavelength of 254 nm. UV light at this wavelength alters the DNA of microorganisms and when sufficient UV dose is applied, microorganisms are rendered incapable of reproducing, effectively inactivating them. Thus, sizing of any UV disinfection system is based on delivering a required UV dose, which is a function of the UV intensity and the exposure time that wastewater is retained in the UV reactor. The equation used to calculate UV dose is shown below:

$$\text{UV Dose} = I \times t$$

Where: I = UV intensity, in milliwatts per square centimeter (mJ/cm^2)
t = exposure time, in seconds (s)
UV Dose, in mJ/cm^2 or milliJoules per square centimeter (mJ/cm^2)

The actual UV intensity and exposure time required to deliver the necessary dose are a function of the UV system, operating parameters and water quality. Exposure time is ideally the average hydraulic retention time within the UV reactor (or the reactor volume divided by the flow rate). The actual exposure time is a function of reactor volume, flow rate, mixing conditions within the reactor and extent of short-circuiting.

Water quality has the greatest effects on performance of a UV system because it can alter the UV intensity delivered within the reactor and, consequently, the UV dose received by the organisms in the wastewater. The most important water quality parameters are UVT and TSS concentration and TSS particle size distribution. UVT is the percentage of UV light, at 254 nm wavelength that is not absorbed (i.e. transmitted) after passing through a 1-centimeter water sample. As UV light passes through wastewater its intensity is attenuated by some substances. The relationship between UV intensity and transmittance is directly proportional, i.e., the higher the transmittance the higher the intensity available. TSS will absorb and scatter UV light, effectively lowering UVT. Additionally, the size of these solids affects the disinfection process; large suspended solids have the capability of screening or shading the target microorganisms, preventing them from receiving their required UV dose with larger particles having a higher impact. Thus, there is a generally accepted practical upper limit of TSS that can be effectively treated by UV disinfection of 30 mg/L. And, in the case of the equipment used in this study, Trojan Technologies will only guarantee process performance of their system in effluent that never exceeds 30 mg/L TSS.

µ.5.1 Establishing UV Dose

T1 is a nonpathogenic virus that is used in the validation of UV systems to approximate their effectiveness against target organisms such as E. coli. UV doses are often described as reduction equivalent doses (RED) meaning the UV dose that would inactivate a given amount of validation organism such as T1. In general, disinfection of E. coli in a typical secondary effluent requires a T1 reduction equivalent dose (RED) of 15 - 20 mJ/cm2 to meet a 126 cfu/100 mL as a monthly geometric mean. However, there can be site specific factors that impact the effective dose and these are primarily related to the characteristics of the TSS particles in the effluent, as described above. Thus, in order to estimate the site-specific dose to meet disinfection compliance, a laboratory test called a collimated beam study should be conducted over a range of plant operating conditions. The collimated beam study involves collection of an undisinfected wastewater sample and exposing the sample, in a continuously stirred reactor (usually a petri dish), to increasing UV doses. The target microorganism is measured after each dose is applied and the results are plotted to establish the target dose.

Collimated beam tests were run throughout the pilot study. Results from the collimated beam tests conducted during the pilot study are plotted along with the data from the bench test analysis conducted in September 2012 (CDM Smith, December 2012) in **Figure 3-16**. Results showed that, in general, *E. coli* inactivation below the daily maximum limit of 487 cfu/100 mL could be easily achieved at relatively low doses, from approximately 7 – 15 mJ/cm^2 (see green circles in Figure 3-16). However, as the target effluent *E. coli* concentrations decrease to 126 cfu/100mL which is the monthly geometric mean and 63 cfu/100mL which has been set as an operational target, there is a greater variability in the required design dose (as shown by the brown and red circles in Figure 3-16).

Thus, in order to consistently achieve the *E. coli* operational target, a design dose of as high as 37 mJ/cm^2 could be required. However, it is important to note that the TSS concentrations of samples tested were all in excess of 30 mg/L with the exception of three samples collected on September 17 and 18, 2012 and a third sample on March 19, 2013. Thus, in many cases, the treatment efficiency was better than expected; however, there were other samples that would require in excess of 19 mJ/cm^2, which is the design dose recommended by Trojan if a TSS concentration consistently below 30 mg/L could be achieved.

It is important to note that the pilot testing was conducted during the most difficult operational period of the year to determine the feasibility of providing bacterial compliance using UV disinfection. Results from this study clearly indicate that it would be difficult to provide bacterial compliance under the highly variable effluent quality that is experienced at the plant. It is well-known that UV is an effective technology that can provide a cost effective approach to disinfection when a consistent effluent quality can be achieved. Thus the recommended design dose for UV disinfection is currently to be set at approximately 35 – 40 mJ/cm^2. If upstream process improvements could be implemented to provide effluent TSS that is consistently below 30 mg/L, then it is possible to reduce the design dose to the design dose recommended by the UV equipment manufacturer of 19 mJ/cm^2.

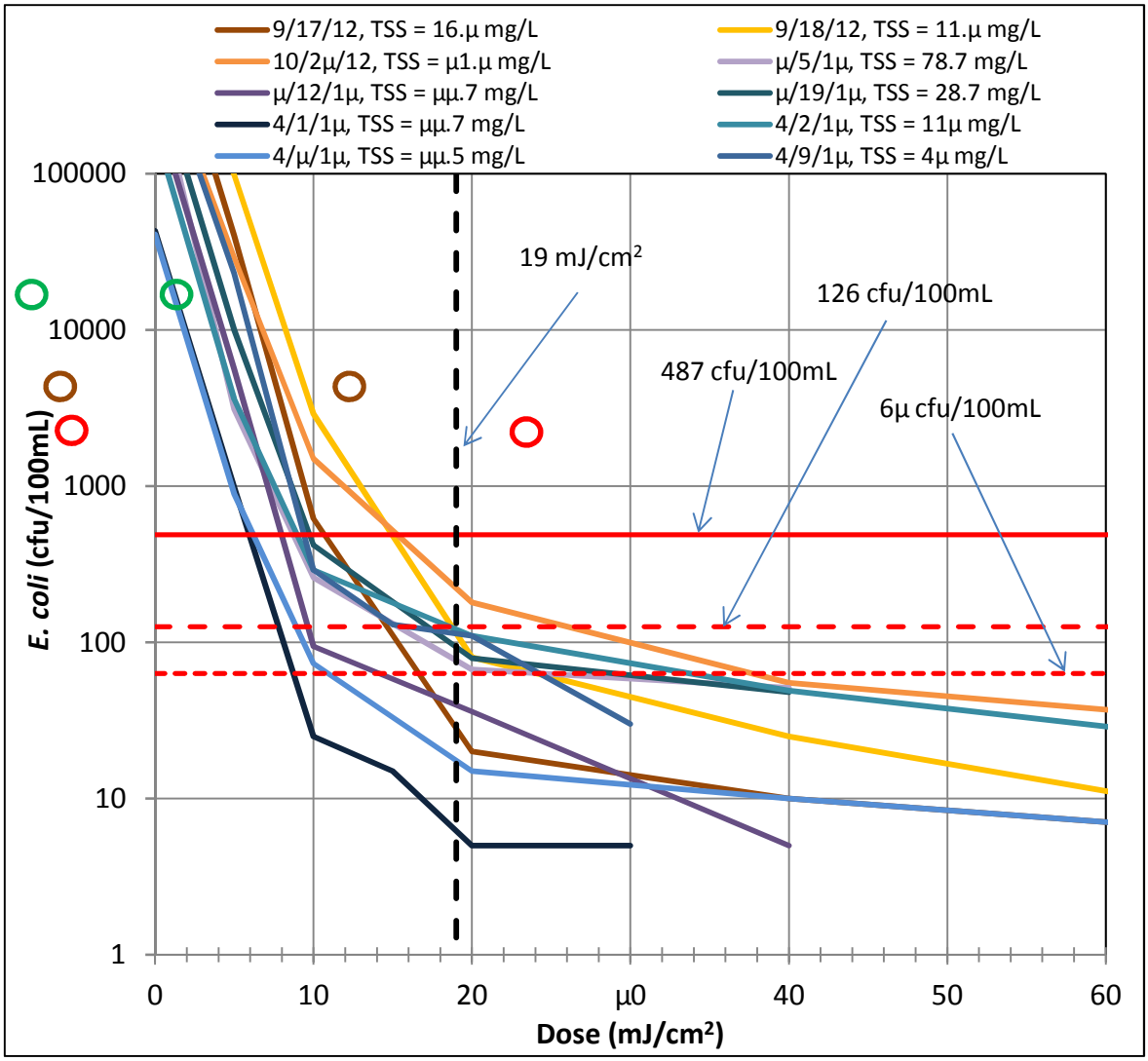


Figure µ-16 UV inactivation of *E. coli* in samples of Maxson WWTP effluent

Clearly there is a significant effect of TSS concentration on UV dose-delivery because particles can scatter UV light as well as shield bacteria within the TSS particles. This shielding effect is also a function of particle size. With respect to the actual range of particle sizes that can impact UV disinfection efficacy, the Water Environment Research Foundation (1999) indicated that 11 to 12 microns is the particle size where particle shielding starts to affect disinfection. However, the extent to which bacteria associate with particles appears to vary widely and is site specific. Factors that affect bacterial association with particles include particle size, the nature of the particles, treatment type, and sludge age. Several studies have demonstrated that the protection provided by particles increases with particle size (Ho and Bohm, 1981; Qualls et al., 1983 and 1985). These studies showed that both the dose and the level of survival at which the dose-response curve begins to tail decreases with a

decrease in the size of particles. Particles larger than 20 microns have been clearly shown to be more important in shielding than smaller particles (Qualls et al., 1983 and 1985).

As a result, it is of interest to characterize the size distribution of TSS from a given facility. The average TSS value for Maxson effluent during the pilot period was 51 mg/L, well above the historical average of 30 mg/L. Additional data was collected with respect to characterizing TSS in the samples that were collected for collimated beam testing. Data were collected using a FloCAM® particle size analyzer which is an automated particle analysis instrument that uses digital imaging for measuring size and shape of microscopic particles in a fluid medium. An example of the graphical output from the analysis is provided in **Figure 3-17**.

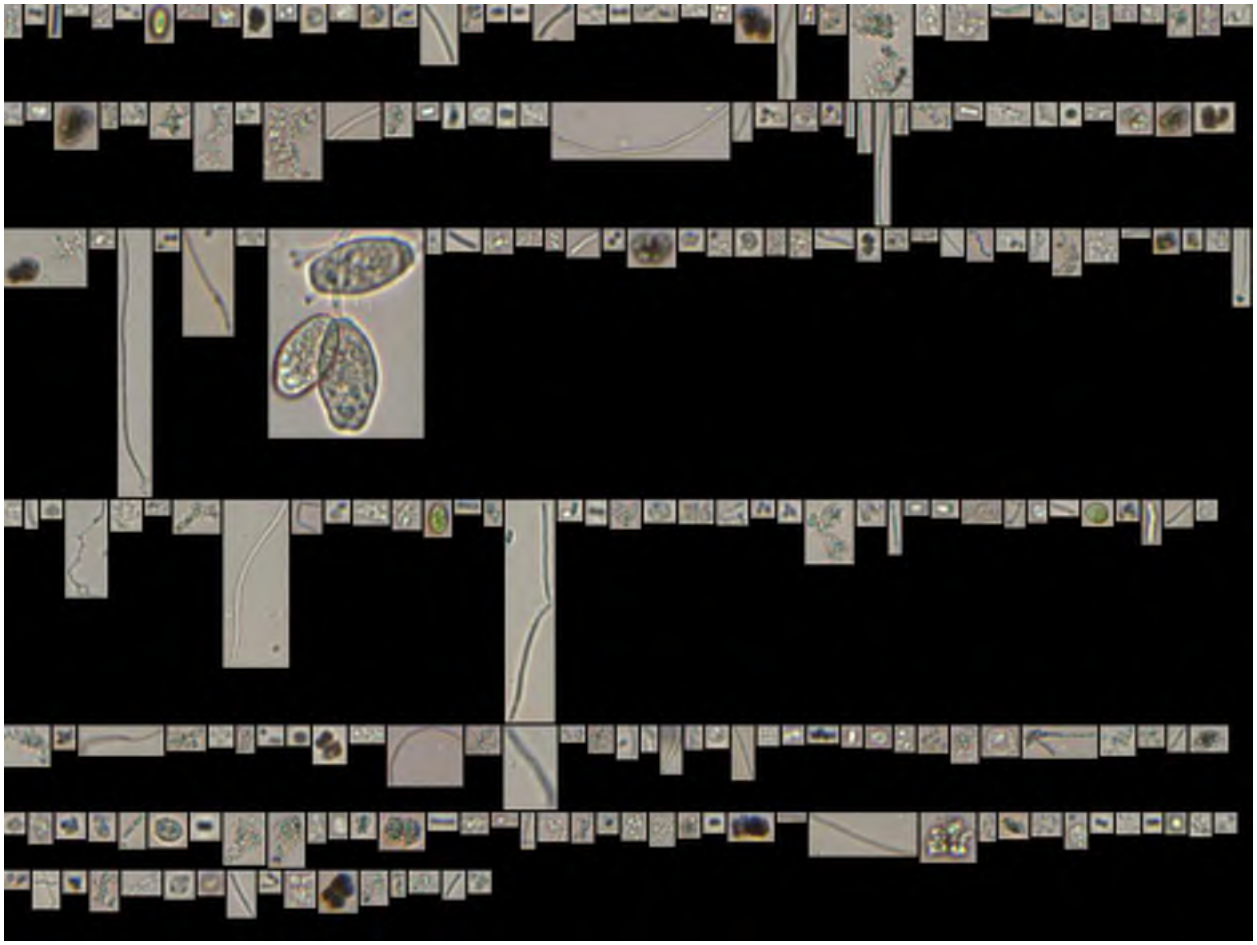


Figure µ-17 Example output from FloCAM® for samples collected from Maxson WWTP

A summary of the average particle size distributions of all TSS samples characterized during the pilot are shown in **Figure 3-18**. The information provided in **Figure 3-18** shows that about 85% of TSS particles are smaller than 20 µm which could be why better than expected performance is sometimes observed for high TSS samples. The drawback to small particles is that they may not settle well in secondary clarifiers.

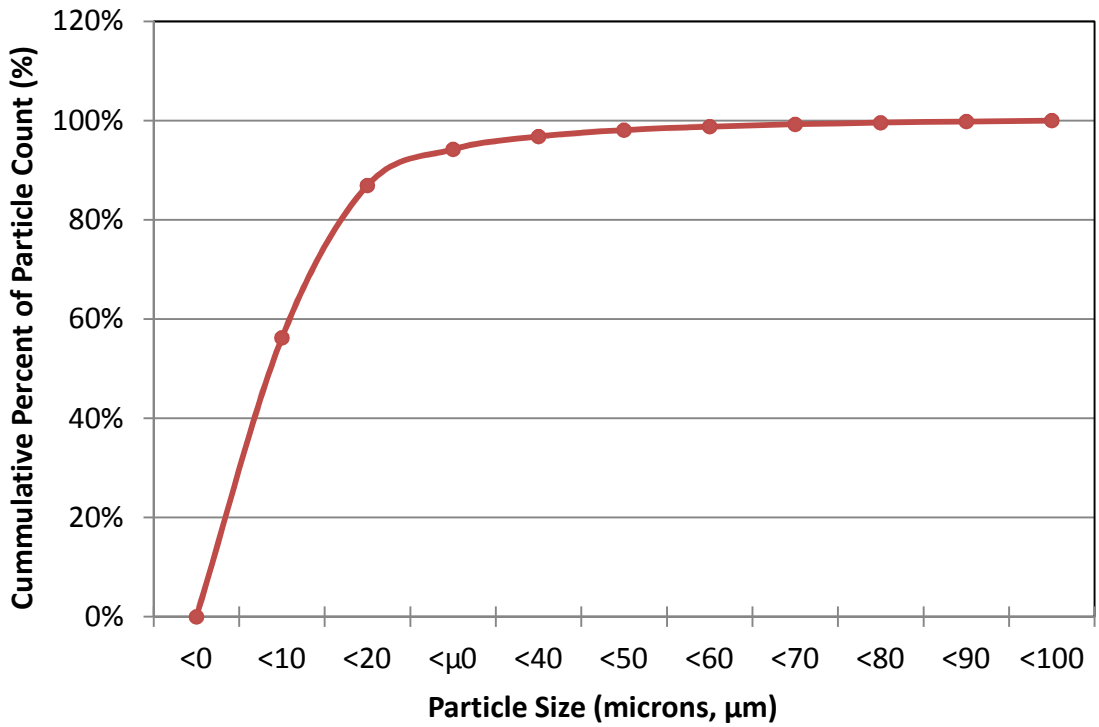


Figure µ-18 Average of all particle size distribution analyses corresponding to collimated beam tests conducted during the pilot period

µ.5.2 Validation of the Third-Party Bioassay

For wastewater disinfection, there are formally recognized protocols for verification of UV equipment for specific applications. These include procedures described in the 1986 US EPA Municipal Wastewater Disinfection Design Guidance Manual (EPA, 1986) as well as the IUVA Uniform Protocol for Wastewater UV Validation (Whitby et al., 2011) which is focused on low dose applications for secondary effluent. These protocols provide validation of the performance of specific equipment over a prescribed operating range (flow, UVT, power, etc.) as defined by the manufacturer for a specific disinfection application (e.g., reuse or secondary effluent disinfection). Only UV systems that have been bioassay validated using one of the aforementioned protocols should be considered for application at the Maxson WWTP.

At one time, UV doses were calculated based on a Point Source Summation (PSS) method, using the physical dimensions of a UV system, known UV lamp characteristics and expected UV transmittance, to calculate UV dose. The drawbacks to this approach were that the computed conditions in the UV reactor frequently did not reflect the true delivered UV dose. While numerous secondary wastewater UV disinfection systems worldwide have been successfully designed utilizing this method, there have been some capacity failures due to the “black box” design of the UV system in which the engineered safety factor is not well known. Bioassay validation of UV systems (in contrast to PSS) is based on data collected during validation testing. For bioassay validation of a UV system, surrogate organisms are used in lieu of the target organism, and hydraulic performance and real intensity distribution of the UV system are taken into account.

There are a number of different surrogate organisms that have been used for sizing UV systems. And, while MS2 has most frequently been used as a standard surrogate organism in the UV industry, there

are drawbacks to use of this for sizing equipment systems for secondary effluent applications (Salveson and Bell, 2012). The objective for selecting a bioassay organism is to most closely match the dose-response of the target organism used in compliance monitoring. For inactivation of organisms such as total or fecal coliforms, where high UV doses are not necessary to achieve discharge compliance, T1 is the preferred surrogate organism. More detailed information on validation methods to account for reduction equivalent dose bias for wastewater UV reactors is provided by Wright et al. (2009). The bioassay equation developed for the TrojanSIGNA pilot was based on T1. Information collected during piloting was used to verify this bioassay for applicability at this site. The validation equation is based on lamp power, hours of bank operation, flow rate, and UVT.

In order to validate the equipment for this application, a preliminary equipment layout was developed based on the collimated beam derived dose. The validation factor for T1 to *E. coli* is nearly unity (1) therefore the calculated T1 RED is nearly equal to the dose determined by the collimated beam testing. The proposed equipment configuration for the Maxson WWTP includes a layout with four banks in series. The number of channels will be finalized when the final design UVT is established. Thus, to interpret data collected during this evaluation, it is important to understand that the single bank in the pilot system represents only one-fourth (1/4) of the total design dose of a proposed system and the inactivation rates that are observed would represent roughly 1/4 of the design rate (e.g., ¼ * 4-log inactivation = 1-log inactivation).

To verify the applicability of the third party validation equation, inactivation data generated from the pilot test was compared to that predicted by the validation equation, using collimated beam test data. **Figure 3-19** shows comparison of measured and predicted T1 RED which were considerably closer in value than anticipated, particularly considering that only one sample had a TSS value less than 30 mg/L. That sample, collected on March 19, 2013 had a TSS of 28.7 mg/L; the difference in the measured RED was within 5-percent of the predicted value and is identified in **Figure 3-19**. The information shown in **Figure 3-19** shows, that even at TSS concentrations that extend beyond 30 mg/L, disinfection could be achieved for some samples, providing additional operational flexibility with respect to TSS. Plotted as measured versus predicted dose, a strong statistical correlation was noted as shown in **Figure 3-20**.

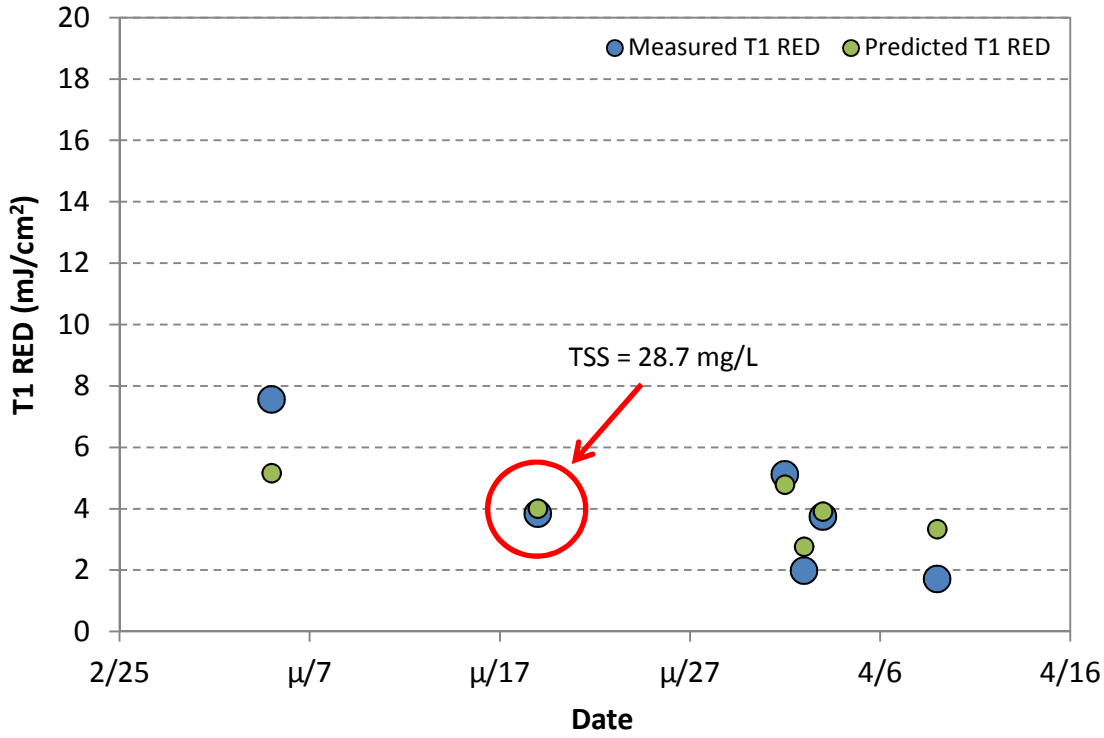


Figure µ-19 Comparison of pilot test results to results predicted by validation equation

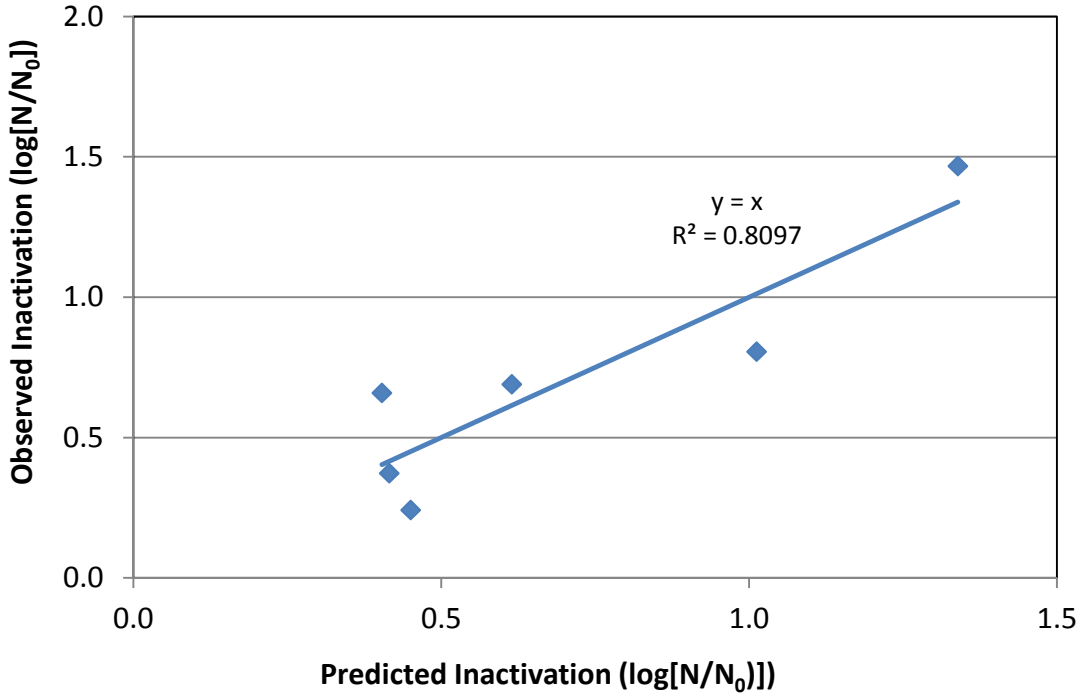


Figure µ-20 Measured versus predicted *E. coli* inactivation from collimated beam sample evaluation

In addition to the analysis conducted using collimated beam test data to confirm disinfection performance, daily *E. coli* grab samples were averaged to calculate the T1 RED. The challenge with this method is that the sample collected in the UV system influent is not the same "packet" of water that is collected at the effluent of the system, and additional variability is introduced into the calculation of dose. Nonetheless, the predicted dose calculated from the daily *E. coli* inactivation data showed good correlation with the predicted dose as shown in **Figure 3-21.** As noted previously, this is remarkable considering that a substantial fraction of samples had TSS values in excess of 30 mg/L.

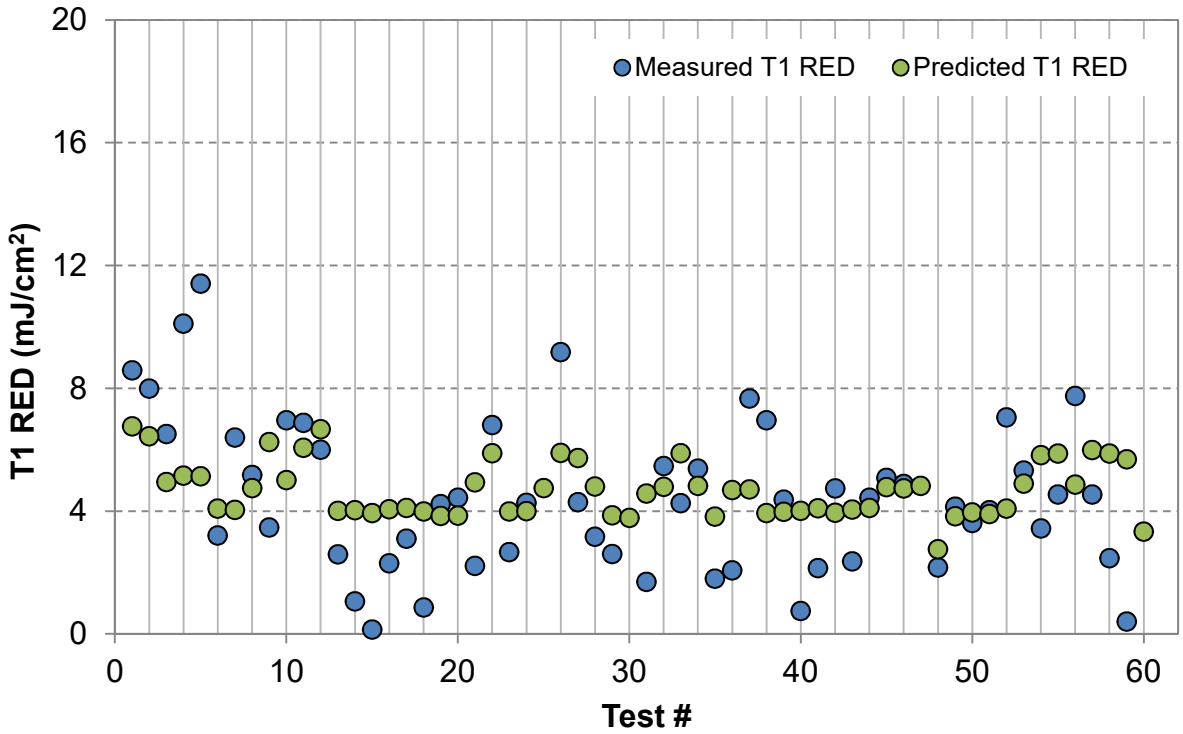


Figure µ-21 Comparison of all pilot test results to results predicted by validation equation

In summary, the UV design dose as determined by collimated beam could be set at 19 mJ/cm^2 assuming that upstream process improvements could be implemented to consistently improve effluent water quality. Until the water quality is improved consistently, UV disinfection is not a viable option at the Maxson WWTP.

µ.6 Summary of Results

As previously described, water quality has a strong impact on the design dose for any disinfection method. For sodium hypochlorite and PAA, chemical dose is impacted by chemical demand which can sometimes be predicted using online monitoring parameters such as color or UVT. However, in this evaluation there was no clear relationship allowing either UVT or color to support predicting chemical demand. As a result, for both of these processes, it is recommended to use the doses identified by evaluation of dose response and residual response relationships as described in Sections 3.2.2 and 3.3.2. The recommended residual set point for design doses for sodium hypochlorite and PAA are 20 mg/L and 13 mg/L respectively. In the case of both chemical disinfectants, because the residual concentrations that are required to meet bacterial compliance are high and in excess of the total

residual chlorine or total residual oxidant limit proposed in the permit a dechlorination or quenching system would be required.

With respect to UV disinfection, as the plant is currently configured and operated, the process is likely not feasible. However, if other process improvements are implemented at the facility that would allow consistent TSS performance below 30 mg/L, it is possible that a design dose of 19 mJ/cm^2, as a T1 RED, could be applied; however, additional collimated beam tests would be recommended upon implementation of process improvements. Further, while UVT is relatively low in the plant effluent, there are equipment systems available that are validated to 15-percent UVT; process control for this type of system would be based on an internal program that uses flow and UV intensity sensor signals which change in response to UVT. And, while issues associated with low UVT may be overcome by increasing the UV intensity (by adding more equipment), this same approach cannot be used to address treatment for effluent with TSS higher than approximately 30 mg/L.

The City of Memphis recognizes the impact of water quality on the disinfection process and the associated costs. As a result, a treatment process evaluation has been conducted to analyze potential process improvements that could improve effluent quality and process control. A copy of the process evaluation memorandum is provided in **Appendix A**. The recommendations in the process evaluation report provide a summary of process improvements that would allow the plant to consistently achieve TSS concentrations such that all three disinfection technologies are technically feasible.

Section 4

Conceptual Cost Estimates

Planning level cost estimates have been developed for implementation of chlorine, PAA and UV disinfection using the results obtained during this pilot testing as well as the process evaluation that was conducted to address effluent quality consistency. Costs developed in this preliminary analysis are based on general requirements of each system, including chemical storage requirements, energy costs and auxiliary equipment. These estimates rely on the use of previous estimates and historical data from comparable work, estimating guides, handbooks and costing curves, and are intended for planning purposes and comparing alternatives. For that reason, subtotaled and totaled costs have been rounded to two significant figures. Costs are provided in current (2013) dollars without escalation. The actual cost of any project will depend on actual labor and material costs for competitive bids, project complexity, competitive market condition, actual site conditions, final scope of work, implementation schedule, continuity of personnel and engineering.

It is important to note that in all cases, conservative assumptions regarding equipment redundancy including EPA Class I Reliability guidelines were applied to each system. With more detailed engineering information, the equipment costs and associated contingencies could be reduced. Lifecycle costs were calculated using the following assumptions: project life of 20 years, 4.13 percent interest rate, 3.00 percent inflation rate, and 2.00 percent electric escalation rate, above the base inflation rate. Maintenance labor costs were estimated at a fully loaded labor rate of $40.00 per hour.

4.1 Sodium Hypochlorite Disinfection System Cost

Sizing a hypochlorination and sodium bisulfite dechlorination system requires experimental confirmation of the residual chlorine concentration (C_R) that yields sufficient bacterial inactivation for a given contact time (T). With the design dose determined, sizing the components of a hypochlorination system is straightforward; because total residual chlorine is a permit requirement, dechlorination facilities are required. Operation of a bulk hypochlorite system is comparable to other liquid chemicals fed at treatment plants. Sodium hypochlorite solution can be added directly to the water from storage tanks with chemical feed pumps. Mixing is necessary at the point of chemical addition to optimize chemical use rates and can be accomplished with a chemical induction system with or without a mixer provided in the contact tank.

While sodium hypochlorite does not require highly specialized equipment, the sizing, design and operation of a chlorination system with liquid sodium hypochlorite is specified under the *Tennessee Design Criteria for Sewerage Works*. Chapter 10.2 provides the specific design guidance for disinfection using chlorine, in absence of site-specific data:

- *Contact chambers shall be sized to provide a minimum of 30 minutes detention at average design flow and 15 minutes detention at daily peak design flow, whichever is greater.*
- *The contact chambers should be baffled to minimize short-circuiting and back mixing of the chlorinated wastewater to such an extent that plug flow is approached.*
- *For treatment facility designs of 0.5 mgd and greater, continuously modulated dosage control systems should be used. The control system should adjust the chlorine dosage rate to accommodate*

fluctuations in effluent chlorine demand and residual caused by changes in waste flow and waste characteristics with a maximum lag time of five minutes. These facilities should also utilize continuous chlorine residual monitoring.

4.1.1 Sodium Hypochlorite System Description as Basis of Cost

At the Maxson WWTP, two of the existing clarifiers were originally constructed as chlorine contact tanks designed to provide the TDEC required detention time. While an existing structure is potentially available for renovation to its original purpose, it has been assumed that a new structure would be provided for providing the necessary contact time for disinfection. A bulk liquid hypochlorite and sodium bisulfite dechlorination system at Maxson will also require new equipment including a tank farm with bulk storage tanks and secondary containment, a chemical storage and feed building including chemical metering pumps and control, chlorine residual analyzers, injection and chemical mixing in the contact basins, and dechlorination chemical injection and mixing at the end of the basin. The required chemical storage and feed systems will include storage for 14 days of chemicals for average flows. All chemical feed pumps will be provided with the appropriate turndown and redundancy to meet EPA class I reliability guidelines.

4.1.2 Summary of Hypochlorite System Capital Costs

Cost estimates for the proposed modifications were obtained from CDM Smith's construction services group, CCI. Major equipment capital costs and construction cost estimates were developed and include new bulk hypochlorite and bisulfite chemical storage and feed equipment, electrical upgrades, instrumentation and controls, and necessary site work. Line item allowances for instrumentation and controls, electrical upgrades and other related facility modifications have been provided based on recent cost estimates from similar projects. While the exact size and layout of equipment will be determined during final design this section summarizes the assumptions used in developing cost estimates for the alternatives evaluation.

4.1.2.1 Chemical Storage Facilities and Feed Equipment

The new system includes a new chlorine contact tank to provide 15 minutes of contact time, as previously noted. Site/civil modifications will be required to provide chemical deliveries to new chemical storage facilities. Additionally, it is recommended to house chemical feed systems in a protected environment and it has been assumed that a new chemical feed building would be provided. While the geotechnical analysis has not been conducted, the chemical feed building may also require alleviation of buoyant forces since construction would potentially be in the levee zone; conservative costs have been provided to account for such construction conditions.

Chemical storage will be provided in tanks located outdoors with appropriate secondary containment; planning level costs have assumed that the storage time for sodium hypochlorite is 14 days because Memphis has ready access to chemical suppliers that can provide adequate frequency of chemical deliveries. A 30-day upper limit for storage should be not be exceeded, even if chemical use rates decrease during certain periods because sodium hypochlorite solutions are unstable and will decompose during storage. The degree of decomposition increases with the length of storage, temperature, exposure to sunlight, impurities in the solution, and decreasing pH; off-gassing can also be an issue with extended storage periods.

The chemical feed building will be constructed from durable materials that can be easily maintained and will be consistent with the architectural finishes already onsite. This design will meet the hazardous building type criteria for the type and quantity of materials to be stored and the hazardous

building type will be designed to meet the required local codes. Personnel safety equipment, emergency showers/eye washes and other necessary equipment will be provided. An automatic sprinkler system may be required for the chemical storage building and these discussions will be coordinated with the local fire marshal at 30% design to confirm if an emergency sprinkler system and any other emergency systems are required.

As the basis for developing costs, it has been assumed that the new chlorine contact tank could be located approximately south of the existing final (retrofitted) clarifiers with a new chemical feed building located in the vicinity. While the exact location of the building would be determined during final design, the size of the building would be approximately 50-ft by 50-ft in plan; it will also have an electrical room and maintenance room. The containment areas for chemical feed equipment in the building will be coated to protect the concrete against accidental chemical spills and will require a large pad size; and, the feed equipment for different chemicals will remain in separate containment areas to prevent accidental mixing of spilled chemicals.

4.1.2.2 Site Work and Hydraulic Upgrades

In order to facilitate chemical deliveries, provisions for minor site improvements have been included in this cost. In addition to providing for chemical delivery to new chemical storage facilities, which have been assumed to be an outdoor tank farm with appropriate secondary containment as noted above, yard piping and other hydraulic upgrades may be necessary to move chemicals from the storage areas to day tanks and ultimately the final feed point. The costs have included an allowance for these improvements. Effluent flow monitoring for implementation of dose pacing and residual control will be necessary for process control for any of the disinfection alternatives. However, because this cost will be similar for all three alternatives, it was not considered a differentiator in the process evaluation and has not been included in the cost estimate; the most cost-effective method of flow monitoring will be determined during detailed design.

4.1.2.µ Instrumentation and Controls

A new control system shall be put in place to monitor and control the sodium hypochlorite system which includes online instrumentation for total chlorine residual analysis. Signals from the online analyzers will be used to provide automatic control for sodium hypochlorite and sodium bisulfite feed. All Input/Output (I/O) signals from the disinfection system shall be hardwired to a PLC located at the chemical feed building. Additional coordination will be required with the plant staff to provide that the proposed system can be integrated into the existing plant process control system.

4.1.2.4 Electrical Upgrades

Electrical requirements for equipment such as analyzers and chemical feed pumps is quite low compared to other major equipment at a wastewater treatment facility and based on the experience from sizing electrically operated equipment for other chemical disinfection systems, the total connected load of the disinfection system is often a small part of the overall power draw with the majority of the connected power being required for heating/ventilating/air conditioning equipment for support structures. The chlorination and dechlorination processes require several small motors in the range of approximately 5 horsepower. The largest process motor loads are anticipated to be equipment to provide chemical induction and rapid mix. Generally, the electrical requirements for hypochlorite systems would be rated for 480-V, 3-phase or 240-V, 3-phase power, depending upon the equipment selected for installation. Instrumentation devices, such as level sensors, analyzers, samplers, receptacles, light fixtures and other miscellaneous loads will be designed to operate on a

120-V, 1-phase power source. Considering these factors, a typical electrical allowance has been provided as a percentage of the chemical facilities costs.

4.1.2.5 Summary of Capital Costs

A summary of the capital costs for the sodium hypochlorite disinfection system described here is provided in **Table 4-1** using the hypochlorite dose information obtained from the pilot testing performed in 2013.

Table 4-1 Summary of capital costs for chlorination-dechlorination system

Capital Costs for Chlorination/Dechlorination System at the Maxson WWTP Facility			
Contact Tank	LS	$	µ,600,000
Chemical Storage Facilities and Feed Equipment	LS	$	µ,µ00,000
Site Work (Hydraulic Upgrades + Rail Upgrades)	LS	$	1,500,000
Instrumentation & Controls	LS	$	µ50,000
Electrical Upgrades	LS	$	500,000
Construction Contingency	µ0%	$	1,700,000
Direct Costs Subtotal		**$**	**11,000,000**
Contractor GC Field General Conditions	10%	$	1,100,000
		$	12,100,000
Contractor GC Indirects, Overhead & Profit	10%	$	1,210,000
		$	1µ,µ00,000
Contractor Bonds and Insurance	µ.65%	$	490,000
Total Construction Cost		**$**	**1µ,800,000**
Planning, Design and Construction Services	15%	$	2,100,000
Utility Administration, Legal, Bonds & Insurance	µ%	$	410,000
Total Capital Cost		**$**	**16,000,000**

* Lump Sum

4.1.µ Operations and Maintenance Costs for Hypochlorite System

The key operations costs are related to the chemical use; however, it is also anticipated that it would take a full-time employee to monitor and maintain the system to provide consistent disinfection performance and optimize chemical use, year round. Using this information and the design doses previously described, a calculation of the annual operations costs associated with current process conditions is provided in **Table 4-2**; the sodium hypochlorite chemical dose also includes a 30-percent scale up factor for mixing and dispersion taking the recommended 20 mg/L dose to 26 mg/L for the purposes of cost estimating**.** It should also be noted, that while the equipment estimated for this alternative is expected to have a service life of approximately 20 years, there will be some replacement parts required during that service life. These costs, assuming an 8-hour per day labor allowance, are minor compared to the annual chemical costs and have not been included in this planning level evaluation.

Table 4-2 Summary of operating costs for chlorination-dechlorination system for current conditions

Annual O&M Costs for Chlorination/Dechlorination System at the Maxson WWTP Facility (Current Conditions)		
Average treated flow (mgd)	90	
Days per year of treatment	µ65	
Chlorine dose (mg/L)	26.0	
Percent solution bulk hypochlorite, % (bulk truck delivery)	12.5	
Specific density of bulk hypochlorite (lbs/gal)	9.8	
Gallons per year, as delivered	5,810,000	
Price per gallon, as delivered	$0.75	
Annual chemical costs for chlorine		$ 4,400,000
Sodium bisulfite dose (mg/L)	15	
Percent solution sodium bisulfite (%)	40	
Specific density of sodium bisulfite (lbs/gal)	11.2	
Gallons per year, as delivered	917,000	
Price per gallon, as delivered	$1.28	
Annual chemical costs for bisulfite		$ 1,200,000
Operations and Maintenance (hours/day)	8	
Fully loaded labor rate ($/hour)	$40.00	
Annual maintenance costs		$ 120,000
Lifecycle (years)	20	
Discount rate	4.1µ%	*P/A factor =*
Inflation rate	µ.00%	17.87
Annual Costs		$ 5,700,000
Present Value of Annual Costs		$ 102,000,000

If the City determines that it will provide process upgrades that would be required to support UV disinfection, the chlorine demand is anticipated to be reduced by up to half of the current conditions. Similar calculations were made for the proposed upgraded conditions and were compiled to represent the total annual operations and maintenance costs for application of chlorination-dechlorination by bulk hypochlorite and sodium bisulfite (**Table 4-3**). The summary includes the total of estimates for chemicals and operation and maintenance staff similar to the current conditions.

Table 4-µ Summary of operating and maintenance costs for chlorination-dechlorination considering upstream process upgrades

Annual O&M Costs for Chlorination/Dechlorination at the Maxson WWTP Facility (Upgraded Conditions)		
Average treated flow (mgd)	90	
Days per year of treatment	µ65	
Chlorine dose (mg/L)	1µ	
Percent solution bulk hypochlorite, % (bulk truck delivery)	12.5	
Specific density of bulk hypochlorite (lbs/gal)	9.8	
Gallons per year, as delivered	2,910,000	
Price per gallon, as delivered	$0.75	
Annual chemical costs for chlorine		$ 2,200,000
Sodium bisulfite dose (mg/L)	8	
Percent solution sodium bisulfite (%)	40	
Specific density of sodium bisulfite (lbs/gal)	11.2	
Gallons per year, as delivered	459,000	
Price per gallon, as delivered	$1.28	
Annual chemical costs for bisulfite		$ 590,000
Operations and Maintenance (hours/day)	8	
Fully loaded labor rate ($/hour)	$40.00	
Annual maintenance costs		$ 120,000
Lifecycle (years)	20	
Discount rate	4.1µ%	*P/A factor =*
Inflation rate	µ.00%	17.87
Annual Costs		$ 2,900,000
Present Value of Annual Costs for Disinfection		$ 52,000,000

4.2 Peracetic Acid System Costs

Sizing a peracetic acid (PAA) system is similar to sizing a hypochlorite system in that it requires experimental confirmation of the residual concentration (C) that yields sufficient bacterial inactivation for a given contact time (T). With the design dose determined, sizing the components of a peracetic system is straightforward. Total residual oxidant is a permit requirement, but quenching facilities will not be required due to the very low peracetic acid residual required to achieve inactivation. Operation of a bulk peracetic system is much simpler than other liquid chemicals fed at treatment plants because the maintenance of the analyzers and chemical feed equipment is provided as part of the chemical vendor's scope of supply. Peracetic acid solution can be added directly to the water from storage tanks with chemical feed pumps. Mixing is most desirable at the point of chemical addition and can be accomplished with a chemical induction system provided either with or without mechanical mixers.

The guidance in the *Tennessee Design Criteria for Sewerage Works*, Chapter 10.2, is directed toward hypochlorite systems and does not directly apply to the sizing, design and operation of peracetic acid systems. However, based on implementation of PAA disinfection at other facilities, and pilot testing results, contact times and contact basins that are appropriate for chlorine based disinfection are also appropriate for PAA disinfection.

4.2.1 PAA System Description as Basis of Cost

At the Maxson WWTP, as previously noted there is no functional existing contact basin and a new structure would be required to provide the required detention time. A bulk PAA system at Maxson

would require site work to provide for a chemical storage facility, including tanks for bulk storage and secondary containment. In addition, a chemical feed equipment building would be necessary to house chemical metering pumps and controls that would be provided by the chemical vendor; it has been assumed that storage tanks would be provided by the City. Similar to chlorine, chemical injection and chemical mixing equipment would be required to be installed in the contact basins along with PAA residual analyzers (also provided by the chemical supplier) that would be required for process control.

The required chemical storage and feed systems will include storage for 14 days of chemicals for average flows. All chemical feed pumps will be provided by the chemical supplier with the appropriate turndown and redundancy to meet EPA class I reliability guidelines. A cost proposal from FMC Environmental Solutions is provided in **Appendix B**. Electrical requirements for equipment such as analyzers and chemical feed pumps is quite low compared to other major equipment and given the lower chemical flow doses and flows that are required for PAA disinfection, in addition to the potential elimination of dechlorination facilities, the total connected load of the disinfection system is anticipated to be nearly half that of the chlorine disinfection system. Considering these factors, an electrical allowance has been provided as a percentage of the chemical facilities costs that were developed for a chlorination-dechlorination system. Similar to the chlorine alternative, costs for providing effluent flow monitoring have not been included in this evaluation; the costs for flow monitoring will be similar for both alternatives and the most cost-effective flow monitoring method will be determined during detailed design.

4.2.2 Summary of Peracetic Acid System Capital Costs

Cost estimates for the proposed modifications were obtained from CDM Smith's construction services group, CCI. Construction cost estimates were developed and include a new 15 minute contact tank and a new building to house new bulk peracetic acid chemical storage and feed equipment that would be provided by the PAA supplier; minor electrical upgrades required for supplying the chemical feed facilities, and necessary site work are also included in the chemical storage facilities estimate. Line item allowances for these improvements have been provided based on recent cost estimates from similar projects. It is of note that line items including site work and electrical upgrades are substantially lower for PAA than for chlorine because smaller chemical storage facilities are required for PAA and dechlorination (and oxidant reduction) is not required. A summary of capital costs for the PAA disinfection system described is provided in **Table 4-4.**

Table 4-4 Summary of capital cost for PAA disinfection system

Capital Costs for PAA Disinfection at the Maxson WWTP Facility			
Contact Tank	LS	$	µ,600,000
Chemical Storage Facilities and Feed Equipment	LS	$	2,000,000
Site Work (Hydraulic Upgrades + Rail Upgrades)	LS	$	1,500,000
Electrical Upgrades	LS	$	µ00,000
Construction Contingency	µ0%	$	1,100,000
Direct Costs Subtotal		**$**	**8,500,000**
Contractor GC Field General Conditions	10%	$	850,000
		$	9,400,000
Contractor GC Indirects, Overhead & Profit	10%	$	940,000
		$	10,µ00,000
Contractor Bonds and Insurance	µ.65%	$	µ80,000
Total Construction Cost		$	10,700,000
Planning, Design and Construction Services	15%	$	1,610,000
Utility Administration, Legal, Bonds & Insurance	µ%	$	µ20,000
Total Capital Cost		**$**	**12,600,000**

4.2.µ Operations and Maintenance Costs for PAA System

Similar to chlorination-dechlorination, the key operations costs for PAA disinfection are related to the chemical use. Proposal costs for PAA were obtained from a process solutions provider (**Appendix B**) that provides PAA inclusive of chemical storage and feed equipment as well as the calibration and maintenance of all related equipment. For this analysis, it has been assumed that labor costs associated with PAA disinfection would take up to 4 hours per day to monitor and maintain the system to provide consistent disinfection performance. The proposal cost information includes an unspecified performance guarantee (to be negotiated if PAA is selected for implementation) based on effluent TSS concentrations. The operations and maintenance costs for the current process operations are summarized in **Table 4-5.**

Table 4-5 Summary of operating and maintenance costs for PAA disinfection under current conditions

Annual O&M Costs for PAA Disinfection at the Maxson WWTP Facility (Current Conditions)		
Average treated flow (mgd)	90	
Days per year of treatment	µ65	
PAA cost ($/MG)	$25µ	
Annual chemical costs for PAA		$ 8,µ00,000
Operations and Maintenance (hours/day)	4	
Fully loaded labor rate ($/hour)	$40.00	
Annual maintenance costs		$ 60,000
Lifecycle (years)	20	
Discount rate	4.1µ%	*P/A factor =*
Inflation rate	µ.00%	17.87
Annual Costs		$ 8,400,000
Present Value of Annual Costs		$ 149,000,000

In order to compare the costs of treatment with chlorine under the assumption that upstream process upgrades would be implemented to provide improved effluent TSS, an estimate is also provided in **Table 4-6**.

Table 4-6 Summary of operating and maintenance costs for PAA considering upstream process upgrades

Annual O&M Costs for PAA Disinfection at the Maxson WWTP Facility (Upgraded Conditions)		
Average treated flow (mgd)	90	
Days per year of treatment < 15 mg/L	24µ	
Days per year of treatment 15 - µ0 mg/L	122	
PAA cost for TSS < 15 mg/L ($/MG)	$89	
PAA cost for TSS 15 - µ0 mg/L ($/MG)	$15µ	
Annual chemical costs for PAA		$ µ,600,000
Operations and Maintenance (hours/day)	4	
Fully loaded labor rate ($/hour)	$40.00	
Annual maintenance costs		$ 40,000
Lifecycle (years)	20	
Discount rate	4.1µ%	*P/A factor =*
Inflation rate	µ.00%	17.87
Annual Costs		$ µ,600,000
Present Value of Annual Costs		$ 65,000,000

4.µ UV Disinfection System Cost

The actual dose required to meet disinfection compliance depends on site-specific factors at a given WWTP. Once dose has been determined, as previously described in Section 3.5.1, the UV intensity and exposure time required to deliver the necessary dose are a function of the UV system, operating parameters and water quality. The effluent water quality affects the performance of a UV system by altering the UV intensity delivered within the reactor and, consequently, the UV dose received by the organisms in the wastewater. The most important water quality parameters are UVT and the TSS concentration and particle size as previously noted. As a result, if UV disinfection is to be a feasible process alternative at the Maxson WWTP, it will be necessary to implement process improvements that would provide effluent quality that consistently meets an upper limit of 30 mg/L of TSS, similar to most conventional secondary WWTP designs.

In order to provide an estimate of the costs associated with process upgrades to support UV disinfection, the City has requested that CDM Smith conduct a holistic evaluation of the liquid processes at the Maxson WWTP to address solids loading and clarifier performance to ensure disinfection optimization. Other process objectives related to the analysis included a discussion of concerns with odor control at the plant, particularly at the existing biotowers and potential future capacity issues at the plant. The process analysis report is provided in **Appendix A** and recommends demolition of the existing biotowers and conversion of the process to conventional activated sludge.

Even if effluent quality is ideal, delivery of the UV dose is key to ensuring compliance with the discharge permit limits. Equipment sizing and process control are essential to successful UV operation. In order to maintain system control as well as efficiency, automatic control will be used; the system will be provided with capabilities for manual override. Automated controls should only be applied over the range of water quality and operational conditions for which the system has been validated.

For wastewater disinfection, there are formally recognized protocols for verification of UV equipment for specific applications. The standard protocol used for sizing equipment for this evaluation was the IUVA Uniform Protocol for Wastewater UV Validation Applications (2011) which is focused secondary effluent applications. This protocol provides validation of the performance of specific equipment over a prescribed operating range (flow, UVT, power, etc.) as defined by the manufacturer for a specific disinfection application (e.g., reuse or secondary effluent disinfection). A UV system that has been bioassay validated using the aforementioned protocol has been considered for application at the Maxson WWTP.

In addition to selecting the appropriate equipment to deliver the design dose, there are operational considerations that must be addressed when implementing UV disinfection. Fouling of the external surfaces of the lamp sleeves and other wetted components (e.g., monitoring windows of UV sensors) of UV reactors is one of these factors. Fouling reduces the transmittance of UV light and can affect measured UV intensity and dose monitoring that is used for automatic process control. System fouling can be, and is accounted for, with a fouling/aging factor in the design of a UV system as well as provisions for automatic mechanical and chemical cleaning systems.

4.µ.1 UV System Description as Basis of Cost

For UV disinfection at the Maxson WWTP, an open channel reactor containing arrays of UV lamps would be provided. The UV system would include a power supply, an electrical system, lamps, quartz sleeves, a cleaning mechanism, as well as a mechanical system to lift the system from the channel for maintenance. Power is provided to the UV system through electronic drivers that also control UV lamps. The UV process can be controlled using flow or dose pacing, with the most efficient systems utilizing both signals. Thus, the UV control system requires a flow signal, as well as a sensor system for monitoring UVT and UV intensity. With respect to flow monitoring, it was assumed that the flow measurement would be conducted using a Parshall flume at the end of each UV channel. The reactor design will be optimized for delivery of the UV dose and hydrodynamics while providing redundancy and flexibility for variations in flow rates. As a result if, UV disinfection is selected as the preferred method of disinfection, it is recommended to conduct computational fluid dynamics modeling of the system to ensure appropriate flow split and good reactor hydraulics.

Because UV disinfection has a practical limit of application at a maximum TSS concentration of 30 mg/L, additional upstream process improvements have been included in the evaluation as described in **Appendix A**. For the purposes of developing the conceptual cost for UV at the Maxson WWTP, a comprehensive capital cost was applied that reflects the recommended process upgrades as outlined in the description of Alternative 1 which includes removal of the biotowers and upgrade of the liquid process to conventional activated sludge.

4.µ.2 Summary of UV System Costs

A cost proposal was obtained from Trojan Technologies based on the system that was piloted at the Maxson WWTP. The proposal included costs for a low-pressure, high output UV system to treat wastewater at three different UVT values, representing the range of values that are observed at the facility. Based on the UVT data previously collected at the facility and considerations for process upgrades at the facility, it is anticipated that a design UVT of 35% could be achieved. The 45 percent UVT scenario was used as the basis for cost the UV option cost estimate; the equipment required to treat effluent with a 45 percent UVT would include 5 channels (4 duty and 1 standby), with 4 banks per channel; each bank has 64 UV lamps, for a total of 1280 lamps (**Figure 4-1**).

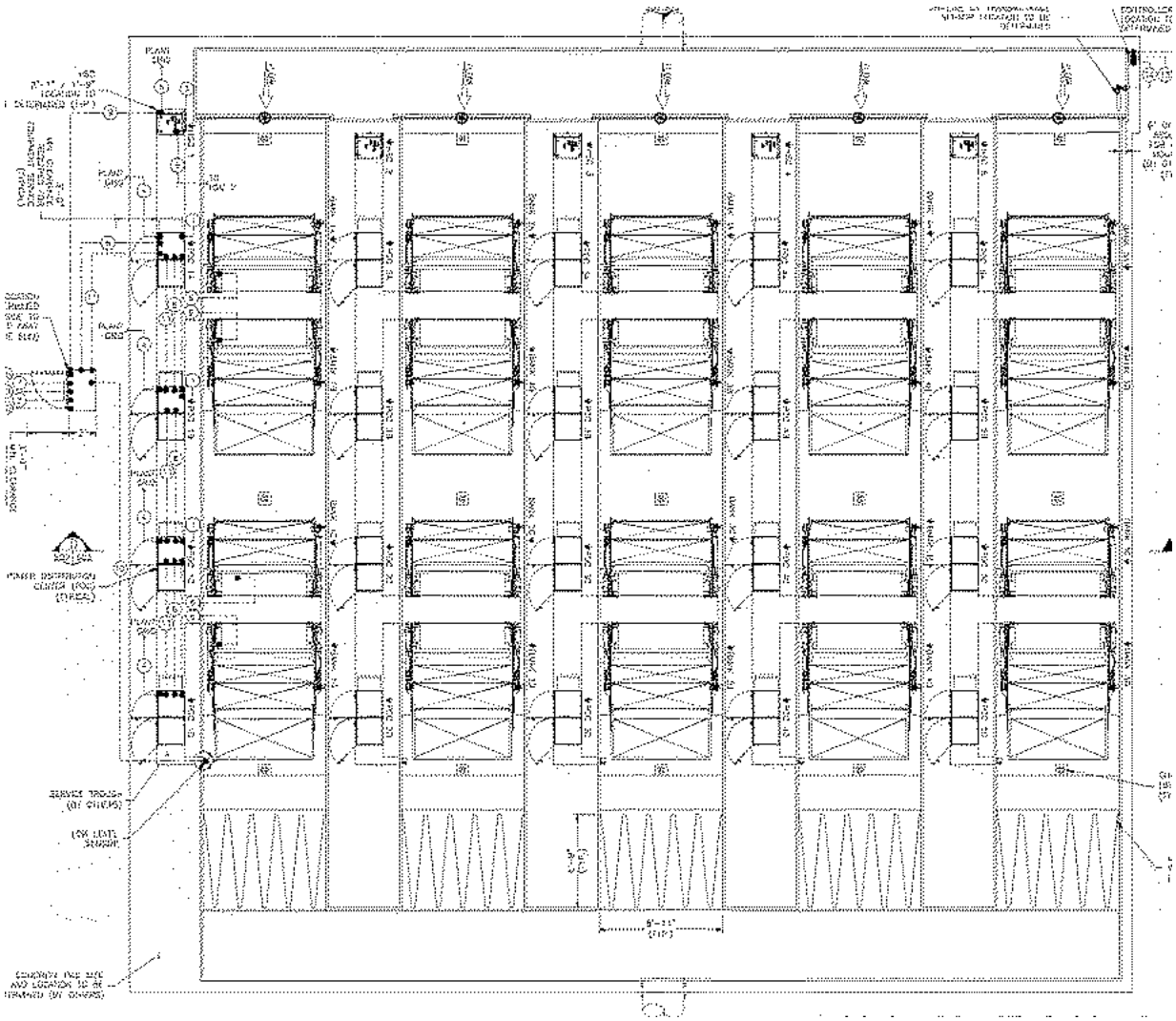


Figure 4-1 Proposed layout for UV disinfection system equipment (5 channels with 4 banks of 64 UV lamps per channel)

Cost for the UV disinfection system also includes allowances for electrical improvements, instrumentation and controls, and necessary site work and yard piping. Because disinfection is a critical process, electrical requirements for UV disinfection typically include electrical redundancy. In Tennessee, dual power feeds meet this requirement; the City already has dual power feeds to the WWTP with automatic switchgear in place. In practice, there can be power surges or interruptions associated with switchover; to protect UV equipment and provide continuous disinfection, it is recommended to include 5 minutes of uninterruptable power supply. Equipment costs, along with construction cost estimates are summarized in **Table 4-7**.

Table 4-7 Summary of capital cost for UV disinfection system

Capital Costs for UV Disinfection at the Maxson WWTP Facility			
UV Equipment	LS	$	9,µ00,000
New UV Structure and Parshall Flumes	LS	$	2,200,000
Electrical Upgrades & UPS	LS	$	1,µ00,000
Construction Contingency	µ0%	$	µ,800,000
Direct Cost Subtotal		**$**	**17,000,000**
Contractor GC Field General Conditions	10%	$	1,700,000
		$	18,700,000
Contractor GC Indirects, Overhead & Profit	10%	$	1,900,000
		$	21,000,000
Contractor Bonds and Insurance	µ.65%	$	800,000
Total Construction Cost		$	21,800,000
Planning and Engineering Design	15%	$	µ,µ00,000
Utility Administration, Legal, Bonds & Insurance	µ%	$	650,000
Total Capital Cost		**$**	**26,000,000**
Capital Cost Process Upgrades		**$**	**7µ,000,000**

Note: Provided capital costs for process upgrades represent the average cost of the conventional activated sludge and step-feed option for Alternative 1 of the Maxson WWTP Process Alternatives Evaluation (**Appendix A**).

4.µ.µ Operations and Maintenance Costs for UV System

Annual maintenance labor costs were estimated at 4 hours per day. Annual replacement costs for lamps and ballast are also estimated based on the guaranteed life of these items for year-round operation of the system at average flow. A summary of the annual operations and maintenance costs for the UV disinfection system to provide treatment of effluent from an upgraded liquid treatment process is provided in **Table 4-8**.

Table 4-8 Summary of operating and maintenance costs for UV disinfection

Annual O&M Costs for UV Disinfection Maxson WWTP Facility		
Average treated flow (mgd)	90	
Number of Lamps per MGD	6.4	
Days per year of treatment	µ65	
UV dose (mJ/cm2) as T1	19	
Number of lamps at average flow	576	
Power input per lamp (watts)	1000	
Annual Electric Usage (kW-hr/yr)	5,000,000	
Electricity cost ($/kW-hr)	$0.076	
Annual electricity costs for UV		$ µ80,000
Guaranteed lamp life (hours)	15,000	
Lamp replacement cost	$675	
Guaranteed ballast life (years)	10	
Ballast replacement cost	$990	
Annual costs for lamp replacement		$ 2µ0,000
Annual costs for ballast replacement		$ 57,000
Maintenance, hours/day	4	
Fully loaded labor rate, $/hour	$40.00	
Annual maintenance costs		$ 58,000
Lifecycle in years	20	
Discount rate	4.1µ%	*P/A factor =*
Inflation rate	µ.00%	17.87
Power escalation rate	2.00%	*P/A g* 21.85
Annual Costs		$ 7µ0,000
Present Value of Annual Costs		$ 14,000,000

4.4 Lifecycle Costs Analysis

Because there are different cost impacts, capital versus operating costs, with respect to the different disinfection technologies, conducting lifecycle analysis is a necessary step in evaluating process alternatives. In order to simplify the analysis for the purposes of decision-making, the operation costs of the liquid process upgrades have been disregarded. It is important to note, if the upstream liquid processes are not upgraded as described in **Appendix A**, then UV disinfection is not a feasible option. While the process upgrades are a significant capital cost, there are additional benefits that are achieved by implementation of these improvements including addressing odor control issues and long-term capacity needs. This may need to be revisited as the City reviews the potential for implementation of the liquid process upgrade alternatives as described in **Appendix A**.

For this analysis, the capital costs and general conditions costs have been summarized along with annual operations and maintenance cost estimates. Capital costs for PAA and chlorine alternatives include installation of a contact tank to provide 15 minutes of contact time. The net present value (NPV) of the annual costs were calculated assuming a project life of 20 years, 4.13 percent interest rate and a 3.00 percent inflation rate for all disinfection alternatives. Summing the total capital costs (including general conditions and services) and the NPV of annual costs provides a comparative

lifecycle cost to aid in selection of the preferred disinfection alternative. A summary of costs for all three disinfection alternatives, including the scenarios where liquid process upgrades could be implemented to improve effluent quality, are provided in **Table 4-9**; costs are also represented graphically in **Figure 4-2.**

Table 4-9 Lifecycle analysis for disinfection alternatives under current conditions and conditions assuming liquid process upgrades

Cost Parameter	Hypochlorite	Hypochlorite Optimized	Peracetic Acid	Peracetic Acid Optimized	UV Optimized
Equipment and Facility Upgrades	$11,000,000	$84,000,000	$8,500,000	$81,500,000	$90,000,000
General Conditions and Services	$5,000,000	$5,000,000	$4,100,000	$4,100,000	$9,000,000
Total Capital Costs	**$11,000,000**	**$89,000,000**	**$12,600,000**	**$85,600,000**	**$99,000,000**
Annual O&M	$5,700,000	$2,900,000	$8,400,000	$µ,600,000	$7µ0,000
20-Year NPV of O&M	$102,000,000	$52,000,000	$149,000,000	$65,000,000	$14,000,000
Total 20-Year NPV	**$118,000,000**	**$141,000,000**	**$162,000,000**	**$151,000,000**	**$11µ,000,000**

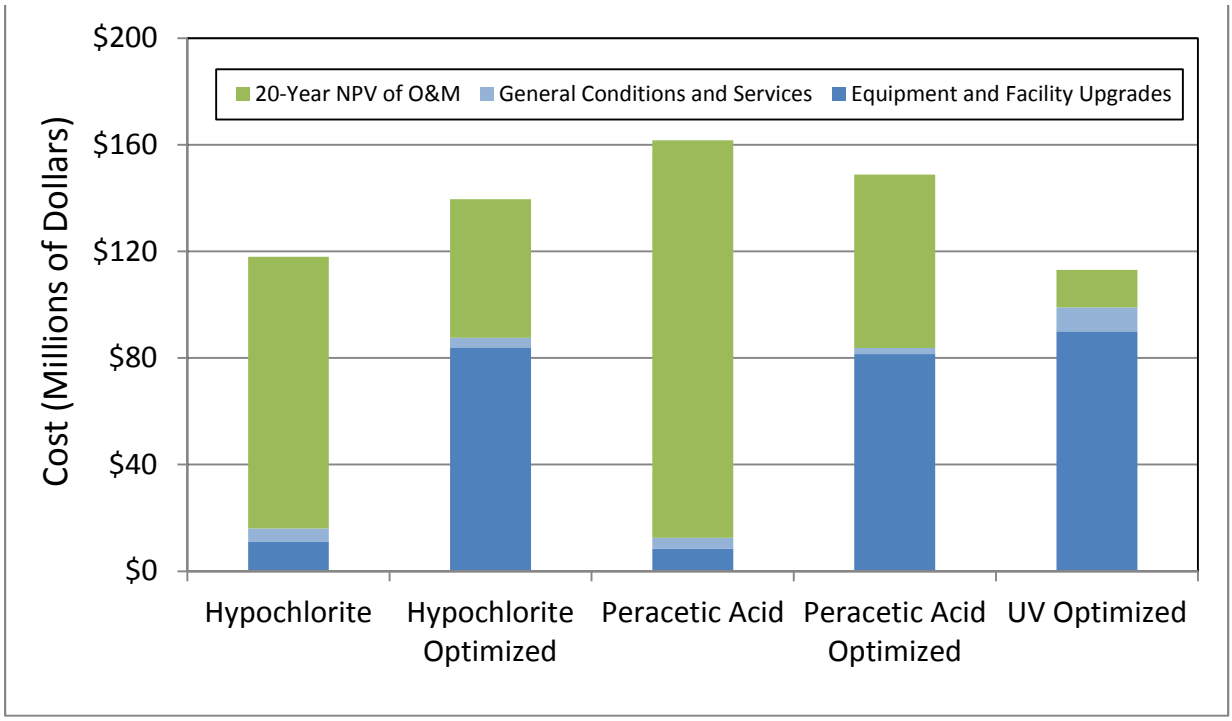


Figure 4-2 Lifecycle costs for disinfection alternatives

Section 5

Supplemental Testing & Evaluation

Since the completion of the previous pilot work, performed by CDM Smith in 2013, two major changes have occurred at the Maxson WWTP. First, during the 2013 pilot testing, a portion of the plant treatment process was being bypassed to allow for the construction/installation of the new fine screen facility prior to the primary clarifiers. Second, a major industrial contributor (Cargill) to the Maxson WWTP closed and was anticipated to result in a significant reduction in overall plant loading. As a result, supplemental pilot testing of peracetic acid (PAA) and supplemental UV related analysis were performed, as was bench testing of UV and PAA as a combined disinfectant. The supplemental testing and final disinfection alternative evaluation based upon the results of the testing are presented in the *Maxson WWTP Supplemental Pilot & Bench Disinfection Testing Report* found in **Appendix C**, and are summarized in this section.

5.1 Supplemental Pilot and Bench Testing Objectives

The purpose of the additional testing was to gather data to supplement the bench and pilot testing previously conducted at the Maxson WWTP. In order to confirm the results of previous testing, in light of the recent changes at the facility, the following objectives were addressed with respect to meeting limits for *Escherichia coli* (*E. coli*) as outlined in the current draft National Pollutant Discharge Elimination System (NPDES) permit:

- Refine the design criteria for PAA disinfection to meet disinfection limits
  - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times
  - Determine the design dose for average conditions to support calculation of associated operating costs
- Confirm the UV disinfection design dose to support estimates of capital and operating costs

The key objectives of the bench scale UV/PAA disinfection study included:

- Quantify and compare disinfection kinetics among several UV and PAA combinations including:
  - PAA alone, UV alone, UV followed by PAA, PAA followed by UV, simultaneous disinfection with UV and PAA.
- Propose a mechanistic model to describe the efficacy of the combined disinfectant

5.2 Supplemental Pilot and Bench Testing Results & Analysis

5.2.1 Supplemental PAA Pilot Test Results & Analysis

The PAA pilot testing commenced on Monday, May 4th, and continued through Friday, June 5th, 2015; samples were collected and submitted to Environmental Testing and Consulting Laboratory, located in Memphis, Tennessee. Sample collection and analytical methods were similar to those done in the

original PAA pilot performed in 2013. Complete results and analysis of data are provided in **Appendix C**, however a summary of the supplemental PAA pilot testing data analysis is included here.

CDM Smith worked to develop a disinfection kinetics model that best represent all the PAA pilot testing data. Standard methods for describing PAA disinfection efficacy are still being developed because the application of PAA as a wastewater disinfectant is relatively recent. CDM Smith has historically applied the Hom's model to disinfection datasets, as described above in Section 3.3. Although the correlation between the model and the measured data is 81%, there does appear to be some over-prediction at low inactivation and under predication at high inactivation. Because of the spread between the model and the measured data that was observed in the application of Hom's model, the standard concentration * time (CT) model was also applied to determine if a better fit could be found for the data. The correlation between the standard CT model was slightly stronger (84%), and displays less over and under prediction, than the Hom's model. However, there is still observable spread between the model and the measured data. A final predictive model, the Double Exponential Decay model, was applied to determine if a stronger correlation could be found. This model also utilizes the integral CT method, but uses a more complex correlation between CT and log inactivation. In this model, the bacterial population was divided into two parts, an easy to inactive portion which represents free floating bacteria, and a hard to inactivate portion, which represents particle associated bacteria. The resulting correlation is shown in **Figure 5-1**. The data is best correlated to this model (90%), and the spread between the data and the model is reduced. The PAA dosing recommendations were generated from this model.

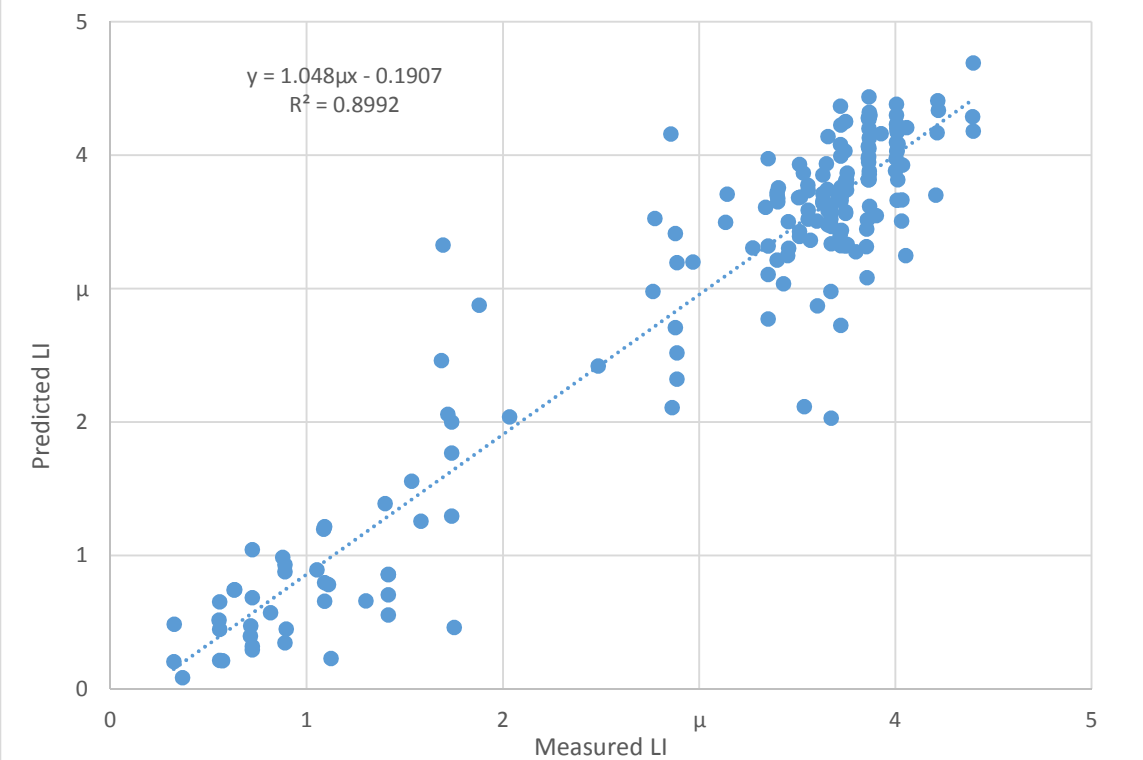


Figure 5-1 Correlation between Measured Log Inactivation and Double Exponential Decay Model Predicted Inactivation

Three disinfection design criteria were established to reflect average, peak, and minimum conditions at the WWTP. The basis for the design criteria are described in Section 4, of **Appendix C**. The model predicted CT values for these design criteria are summarized in **Table 5-1**. For conservatism, a safety factor of 1.3 is applied to the CT values to help account for scale up between the pilot and full scale application. This is shown in the CT* column.

The required CT can be achieved through numerous combination of time and PAA dose.

Table 5-1: Required PAA CTs and Design Points

Flow Conditions	Flow (MGD)	Required Log Inactivation	CT*
Permitted Average	90	µ.92	87.1
Peak Hour	170	µ.82	74.1
Daily Minimum	50	2.81	22.4

*CT results include a 1.µx safety factor for scaling up to full scale

It is worth noting that as part of the supplemental pilot and bench testing a review of the required log inactivation for the disinfection system was performed. The required log inactivation was determined based on review of a combined dataset including data measured during the supplemental PAA pilot study, data measured during the collimated beam analyses, and data from daily plant operations between 2010 and 2013. **Table 5-2** summarized the relevant statistic from this expanded dataset, and compares it against that shown in **Table 1-1**. The datasets are identical, with the exception being the average values are slightly different. The combined dataset, referred to going forward as the "dataset," was utilized for determining the revised log inactivation.

Table 5-2: Relevant Influent *E. coli* Statistics

Statistic	Updated Values	Table 1-1 Values
Maximum	5.7×10^6	5.7×10^6
Average	7.3×10^5	7.4×10^5
Minimum	1.3×10^4	1.3×10^4
Geometric Mean	5.2×10^5	5.2×10^5
10 Percentile	1.5×10^5	--
20 Percentile	2.4×10^5	--
30 Percentile	3.3×10^5	--
40 Percentile	4.6×10^5	--
50 Percentile	5.6×10^5	--
60 Percentile	7.3×10^5	--
70 Percentile	9.3×10^5	--
80 Percentile	1.3×10^6	--
90 Percentile	1.6×10^6	--
99 Percentile	--	2.0×10^6

For peak conditions, bacterial concentrations will be reduced from the 90th percentile from the dataset to one half of the daily permit limit of 487 cfu/100 mL, which is 244 cfu/100 mL. This is equal to a log inactivation of 3.82. For average conditions, the bacterial concentrations will be reduced from the

geometric mean from the dataset to one half of the monthly permit limit of 126 cfu/100 mL, which is 63 cfu/100 mL. This is equal to a log inactivation of 3.92. This is slightly different from what was presented in Section 1.4.1, as those log inactivation calculations utilized the average from that dataset, rather than the geomean, which is done here for the revised log inactivation calculation. The reason for this adjustment is because the monthly permit limit is a 30 day geomean value, therefore the value from the dataset should also be a geomean not an average. For minimum conditions, bacterial concentrations will be reduced from the 10th percentile from the dataset to one half of the daily permit limit of 487 cfu/100 mL. This is equal to a log inactivation of 2.81.

Minimum Daily Inactivation Rate Required: $\log(1.5 \times 10^5) - \log(2.44 \times 10^2) = 2.81$
Average Monthly Inactivation Rate Required: $\log(5.2 \times 10^5) - \log(6.\mu \times 10^1) = \mu.92$
Maximum Daily Inactivation Rate Required: $\log(1.6 \times 10^6) - \log(2.44 \times 10^2) = \mu.82$

The difference between the original log inactivation (4.1) and the revised log inactivation of 3.92 is small.

In order to size the PAA system, a cost optimization was performed to determine the most effective combination of contact time and dose to reduce overall lifecycle costs. This was accomplished by limiting the capital cost of the contact tank to less than $10 million, and increasing the PAA contact tank (CT) size to ensure that the resulting residual PAA concentration were between 0.4 mg/L and 1.5 mg/L at the end of the CT. Based on these design criteria, a sodium bisulfite system is not required.

5.2.2 Supplemental UV Collimated Beam Results & Analysis

Several new collimated beam (CB) analyses were performed during the supplemental PAA pilot testing to determine if disinfection requirements have changed due to changes in plant influent since 2013. A comparison of the recent and historical CB data performed by Trojan Technologies is shown in **Figure 5-2**. These represent the average of the entire dataset from each year. There is no significant difference between the two datasets. The effectiveness of a UV disinfection system relies heavily on the UV transmittance (UVT) of the influent to the system. During the pilot period, the observed UVT was 16%. As discussed previously, it is anticipated that upgrades to the secondary treatment process would result in an improvement to the effluent UVT. However the industrial users have an impact on the UVT of the influent at the Maxson WWTP, which is more impacted by both color and TSS. The exact effluent UVT improvement from the upgraded treatment process cannot be quantified at this point, however it is assumed that it would be around 20%. As a result a UVT of 20% was utilized to develop the revised capital costs.

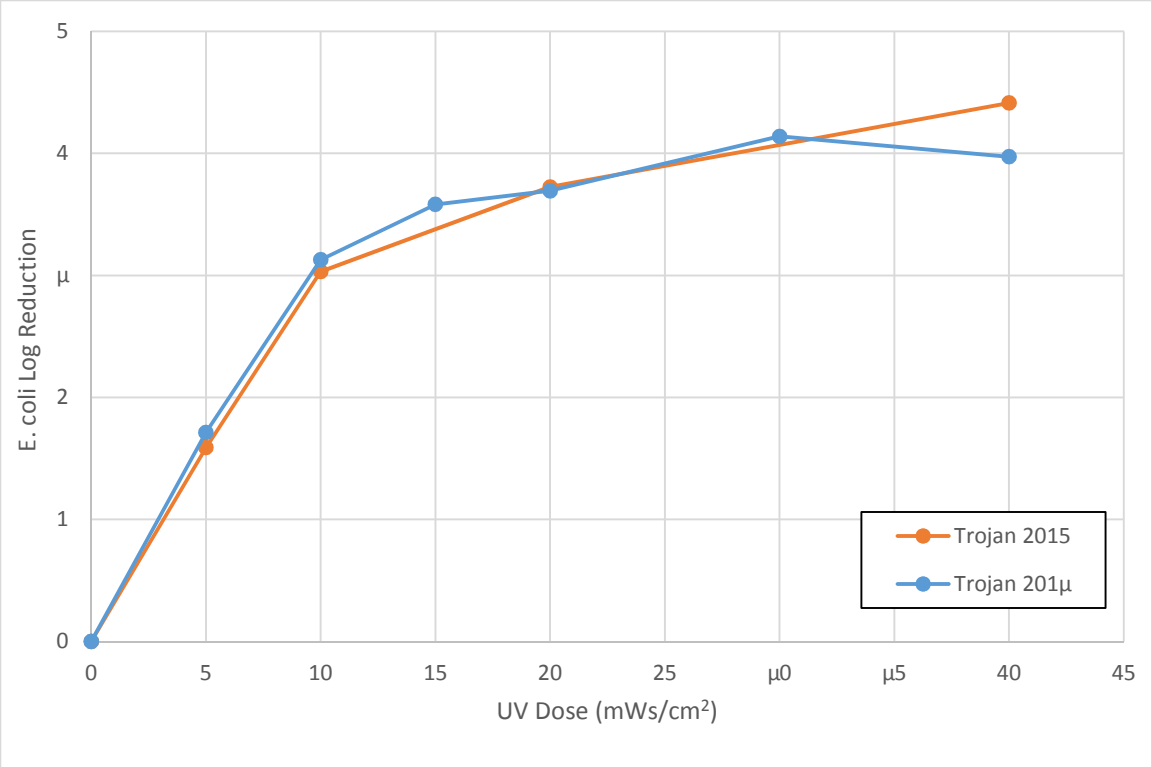


Figure 5-2: Comparison of Recent and Historical Collimated Beam Data

5.2.µ UV/PAA Test Results & Analysis

In order to investigate the feasibility and economics of implementing a combined disinfection technology strategy, bench testing was conducted to inform process selection and sizing. UV/PAA bench testing was conducted at the Maxson WWTP the week of September 21, 2015. Samples of secondary effluent were collected twice daily and were treated at bench-scale, on site. In this study, secondary effluent samples were treated with various combinations of UV doses, between 2.5 – 40 mJ/cm^2, and PAA CTs, between 2.5 – 50 mg·L^{-1}·min. To evaluate different operational scenarios the following five combinations were applied: PAA alone, UV alone, PAA followed by UV, UV followed by PAA, and simultaneous UV and PAA.

A mechanistic model was developed, based upon the results of the combined UV/PAA disinfection bench test, to predict the results of combined disinfection using UV and PAA. Results indicated that the most effective combination of the two is UV followed by PAA. **Figure 5-3** was developed to illustrate the different combinations of UV and PAA that would be required to maintain an effluent concentration of 126 cfu/100 mL of *E. coli.* Although the results are promising, further research is required to accurately describe the effect of combined disinfection, and the economic analysis that was performed based on the results did not indicate significant economic savings through application of a combined disinfection system. The full UV/PAA bench testing report is included in **Appendix C**.

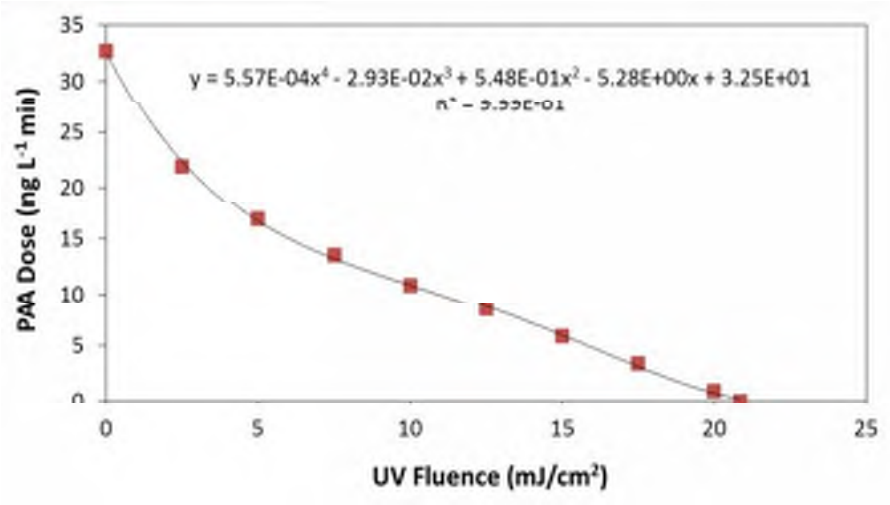
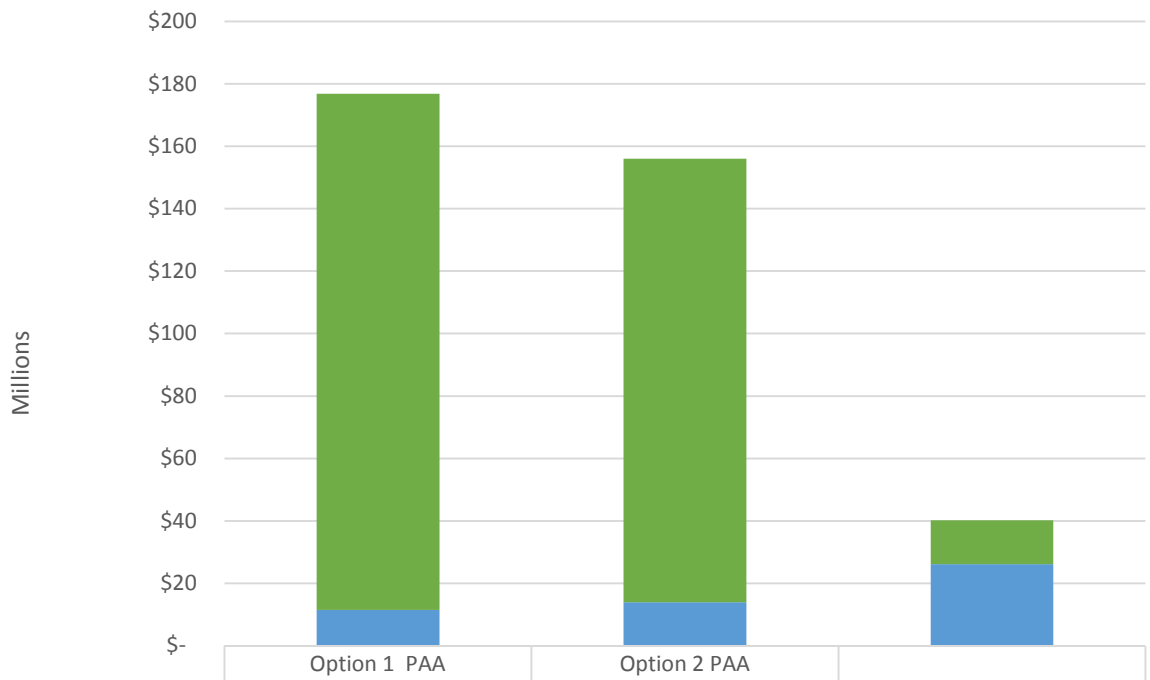


Figure 5-µ: Model predicted combinations of PAA dose and UV fluence required to achieve a E. coli disinfection target of 126 cfu / 100 mL when applying the sequential UV→PAA treatment process.

5.µ Revised Conceptual Cost Estimates

Based upon the supplemental testing performed in 2015, the conceptual costs for UV and PAA were revised. Comparative 20 year lifecycle costs for three alternative disinfection systems are illustrated in **Figure 5-4**. The first alternative is a PAA system with a contact tank providing 31 minutes of contact time at average flow, the second is a PAA system providing 31 minutes of contact team at peak flow, and the third is a UV system designed to treat effluent with a 20% UVT.



	Option 1 PAA 25µ,000 cubic ft	Option 2 PAA 489,000 cubic ft	20% UVT Design UV System
Total Annual Cost	$165,µ00,000	$142,000,000	$14,000,000
Total Capital Cost	$11,500,000	$14,000,000	$26,200,000
Lifecycle Costs	$177,000,000	$156,000,000	$40,000,000

Figure 5-4 20 Year Lifecycle Analysis of Three Disinfection Options

Providing more contact time at average flow for the PAA system eliminated the need for quenching with sodium bisulfite, although the capital costs for a small sodium bisulfite was included for emergency use. Although the lifecycle costs of the UV alternative is lower than that of the two PAA alternatives, the City of Memphis and CDM Smith discussed the impacts caused by the variability of the low UV transmittance seen in the Maxson WWTP effluent. The variability likely stems from the change in processes and raw materials utilized by industrial users within the City's collection system. Based upon these discussions it was decided to eliminate UV from the list of disinfection alternatives. Results of the detailed cost analysis and the supplemental pilot data indicate that the most cost effective contact tank size to reduce overall lifecycle cost is 489,000 cubic ft. As a result, the most cost effective disinfection alternative is PAA - Option 2.

Section 6

Recommendations

Based on a review of the analysis presented in this report, CDM Smith recommends disinfection with PAA at the Maxson WWTP. While testing conducted in support of this evaluation has demonstrated that both sodium hypochlorite and UV disinfection were also effective for achieving bacterial inactivation to meet permit compliance for *E. coli* at the Maxson WWTP; there are concerns regarding the use of chlorine disinfection, and there are uncertainties associated with low UVT effluent and further degradation of the effluent UVT. Implementation of PAA disinfection requires additional upstream process upgrades and considerations should be evaluated regarding the additional operations costs associated with these liquid process upgrades during final design.

Chlorine disinfection has the same life cycle cost as UV disinfection and is lower than PAA disinfection, however the use of a chlorination disinfection system has additional permitting requirements that include additional testing under Section 3.6.1 of the permit, as follows, making the technology more challenging to implement: ***"3.6.1 Additional Permittee Submittals (If Chlorination Disinfection System Selected).***

> *Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly generated byproducts are related to TRC according to the compliance schedule…"*

If the City opts to implement PAA disinfection and the associated secondary treatment process upgrades to address chemical oxidant demands in the effluent there are significant ancillary benefits to this decision. While PAA disinfection has the highest lifecycle cost, the low capital cost of the PAA disinfection system combined with the avoidance of additional permitting requirements as described above, has resulted in PAA disinfection being the selected disinfection alternative for the Maxson WWTP. Additionally, proceeding in this direction may enable the City to address other major concerns regarding odor control and future capacity issues at the Maxson WWTP.

Section 7

References

Azzellino A., Antonelli M., Canziani R., Malpei F., Marinetti M., Nurizzo C. (2011). Multivariate Modelling of Disinfection Kinetics: A Comparison among Three Different Disinfectants. *Desalination and Water Treatment*, 29 (1/3): 128-139.

CDM Smith (2012), Maxson WWTP Disinfection Bench Testing Report.

Ho, C-F. H.; Pitt, P.; Mamais, D.; Chiu, C.; Jolis, D. (1998). Evaluation of UV Disinfection Systems for Large-Scale Secondary Effluent. *Water Environ. Res*., 70 (6), 1142–1150.

Peng, W.; 2009. What is Behind Chlorine Residuals? – Two Plants with Two Strategies in the Same City; *Proceedings of the 2009 Water Environment Federation Technical Exhibition and Conference*.

Qualls, R. G.; Flynn, M. P.; Johnson, J. D. (1983). The Role of Suspended Particles in Ultraviolet Disinfection. *J. Water Pollut. Control Fed*., 55 (10), 1280–1285.

Qualls, R. G.; Ossoff, S. F.; Chang, J. C. H.; Dorfman, M. H.; Dumais, C. M.; Lobe, D. C.; Johnson, J. D. (1985). Factors Controlling Sensitivity in Ultraviolet Disinfection of Secondary Effluents. *J. Water Pollut. Control Fed*., 57 (10), 1006–1011.

Rossi S., Antonelli M., Mezzanotte V., Nurizzo C. (2007). Peracetic acid disinfection: a feasible alternative to wastewater chlorination. *Water Environment Research*, 79 (4): 341-350.

Salveson, A. and Bell, K.Y. (2012). Sizing UV systems using the right bioassay. *Proceedings of the 2012 WateReuse Association Annual Conference.*

Szerwinski, A., Bell, K. and Bordewick, K. (2012). Chloramination in a Partially Nitrified Effluent: Process Control Solutions and Case Study. *Proceedings of the 2012 Water Environment Federation Technical Exhibition and Conference.*

US Environmental Protection Agency (EPA). (1986). Design Manual – Municipal Wastewater Disinfection. *USEPA Office of Research and Development, Cincinnati, OH, EPA/625/1-86/021.*

Water Environment Research Foundation (1999). The Effect of Upstream Treatment Processes on UV Disinfection Performance. Edited by Darby, J., Emerick, R., Loge, F., and Tchobanoglous, G. Project 96-CTS-3.

Whitby, G.E.; O. Lawal; P. Ropic; S. Shmia; B. Ferran and B. Dussert, B. (2011). "Uniform Protocol for Wastewater UV Validation Applications." *IUVA News.* 13(2):2633.

Wright, H., Wade, T., Salveson, A., Poust, S., Slater, A., Collins, D., Meier, J., and Dearnley, I. 2009. New Validation Methods Account for RED Bias with Wastewater UV Reactors. *Proceedings of the Water Environment Federation, Disinfection Conference, Atlanta, GA.*

Technical Memorandum

To: *Paul Patterson*
Scott Morgan, PE
Mike Brower

From: *CDM Smith Inc.*

Date: *November 27, 2013*

Subject: *T.E. Maxson WWTP Process Alternatives Evaluation*

1.0 Introduction

The T.E. Maxson WWTP (Maxson WWTP) is located in the southwest portion of Memphis, Tennessee at 2685 Steam Plant Road. The WWTP currently treats an average of 70 million gallons per day (mgd) of wastewater, serving the City of Memphis (City) since its commissioning in 1975. With upgrades over the years, the current liquid treatment process consists of coarse bar screens, grit removal, recently installed fine bar screens, primary clarification, high-rate biotowers, activated sludge and secondary clarification.

The City is currently planning an upgrade to provide disinfection as the final treatment process to meet requirements in the current draft National Pollution Discharge Elimination System (NPDES) permit. The process that will ultimately be selected to provide disinfection is directly impacted by the secondary effluent quality. In addition to the need to address effluent quality to minimize the costs of the new disinfection process, the facility is experiencing an increase in wastewater flows and loads, which has prompted the City to evaluate the existing plant and operations to determine what would be required to meet the original design flow of 90 mgd. As a result, the City has requested that CDM Smith conduct a holistic evaluation of the liquid processes at the Maxson WWTP to address the following objectives:

- Solids loading and clarifier performance to ensure disinfection optimization;
- Discuss concerns with odor control at the plant, particularly at the existing biotowers; and
- Potential future capacity issues at the plant.

This technical memorandum provides a summary of the process evaluation and includes an analysis of the biological treatment processes, consideration of solids loading, clarifier performance, biotower process performance, and capacity related issues. Additional evaluation of

biosolids handling, which was not identified in this scope of work, may be necessary depending upon the improvements selected for further consideration.

2.0 Evaluation Approach

Historical plant data were obtained from the City and analyzed to develop a basis of evaluation of the plant. Peaking factors for the average-day (AD), average-day maximum-month (ADMM) and maximum-day (MD) loading conditions were determined based on this analysis. These peaking factors were applied to the plant's permitted average day flow of 90 mgd as a basis for evaluating the liquid treatment processes; the design flows and loads are summarized in **Table 2-1**.

Table 2-1 Influent Design Conditions

Influent Parameters	AD	ADMM	MD
Flow (mgd)	90	126	153
BOD5 (ppd)	515,700	562,100	727,100
TSS (ppd)	426,300	550,000	703,500
TKN (ppd)	75,100	90,100	112,600
TP (ppd)	15,000	18,000	22,500
Minimum monthly Water Temp (deg C)	14	14	14

Table 2-2 provides a summary of the current draft NPDES requirements at the permitted average design flow of 90 mgd. In addition to permit compliance, this evaluation also considers the need to consistently achieve effluent total suspended solids (TSS) of less than30 milligrams per liter (mg/L). This is lower than the concentration required for discharge, according to the NPDES permit, but is a requirement for ultraviolet (UV) disinfection to be a feasible disinfection alternative. There are potential impacts on the solids handling processes as a result of the lower TSS objective, which will require further evaluation, based on the modifications selected for the liquid process.

Table 2-2 Effluent NPDES Requirements

Effluent Parameter	Maximum Daily	Average Monthly
BOD5 (mg/L)	84 (40% removal)	42 (85% removal)
TSS (mg/L)	96 (40% removal)	48 (85% removal)

There is currently no ammonia-nitrogen limit in the NPDES permit, and a total nitrogen limit is not anticipated in the foreseeable future; therefore, nitrification has not been included in the liquid treatment process evaluation. However, the alternatives have been developed such that, if

nitrification is required in a future effluent limit, the process improvements could be incorporated into any potential upgrades that would be required to achieve nitrification. While any of the alternatives developed could be later upgraded to achieve nitrification, each alternative has a different site footprint. Generally to achieve nitrification, the biomass maintained under aerobic conditions would need to be increased by approximately four times over that identified in this evaluation, which results in the need for additional aeration tankage and/or clarifiers.

While the current permit does not include nitrification or nutrient removal as requirements, there is the potential that nutrient limits will be implemented in some future permit cycle. The driver is implementation of State-developed nutrient reduction strategies, which are a major focus of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Task Force) responsible for the national strategy to reduce, mitigate, and control hypoxia in the Northern Gulf of Mexico and improve water quality in the Mississippi River Basin. The Task Force was established in 1997 and consists of 5 federal agencies and 10 state agencies.

The Task Force objectives include having each state develop and implement its own nutrient reduction strategy, which provides flexibility for tailoring the strategy's approach and components. At the same time, the Task Force recognizes that all state strategies need to include certain essential components to achieve overall goals. The participating states include Arkansas, Indiana, Illinois, Iowa, Louisiana, Kentucky, Minnesota, Mississippi, Missouri, Ohio, Tennessee and Wisconsin. Most of these states have already completed their strategies, while Arkansas, Kentucky and Tennessee continue to work on completing the final documents.

While Tennessee has yet to publish this guidance, several other discharge permits in the state reference the approach to how the state will implement its nutrient strategy. The Tennessee Department of Environment and Conservation (TDEC) has been developing its strategy to reflect the goals of EPA's March 16, 2011, *Memorandum: Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions*. The Tennessee approach uses regional USGS SPARROW models to determine the required performance level from WWTPs within hydrologic unit code 10 (HUC 10) watersheds.

TDEC is utilizing the "SPARROW" model (SPARROW refers to SPAtially Referenced Regressions on Watershed attributes), which relates in-stream water-quality data to spatially referenced watershed characteristics, including contaminant sources and transport factors to support its strategy. Tennessee has aggregated the South Atlantic Gulf and Tennessee (SAGT) region model output for nitrogen and phosphorus for HUC-10 watersheds within Tennessee's borders. Thus, for West Tennessee, output from the Lower Mississippi, Arkansas-White-Red, and Texas Gulf River Basin Model (MRB5) will be applied with the focus being on agricultural reductions. However, this does not eliminate the possibility of nutrient limits in WWTP permits in future permit cycles. It is anticipated that if limits are imposed in the future, TDEC would first implement seasonal nitrification requirements (i.e., summer ammonia limits). If additional actions are deemed

necessary as the strategy is implemented, then it is anticipated that TDEC would provide these more restrictive limits (total nitrogen or total phosphorus limits) in a phased approach.

2.1 Existing Capacity Evaluation

The current average flow at the plant is approximately 70 mgd, and given the influent wastewater strength, the plant is currently at or above its original design influent biochemical oxygen demand (BOD) load. With an increase to 90 mgd (design flow), the treatment objectives cannot be met with the existing plant infrastructure. Facility improvements will be required to accommodate the increased flow and load in order to meet permit requirements, as well as to provide adequate effluent quality for implementing UV disinfection, if selected as the preferred disinfection alternative.

The activated sludge process is currently operated with a low solids retention time (SRT), approximately one day, to avoid overloading the secondary clarifiers. While the plant is generally able to achieve permit requirements using this approach, this mode of operation is unstable and does result in episodic permit excursions with respect to TSS. However, based on current biotower performance with respect to soluble BOD removal, it is not possible to increase the SRT with the existing volume in the aeration tanks (even including the volume that was originally designed as aerobic digesters), which are undersized to handle the design flow from the biotowers at the current loading rate, without overloading the secondary clarifiers.

On August 27th, 2013 CDM Smith facilitated a workshop with City staff to discuss current plant operations and potential technologies appropriate for application at the facility to meet treatment requirements. Several process alternatives were discussed and the alternatives were narrowed to the most feasible options. **Figure 2-1** provides a summary of the processes to be evaluated; because each unit process option impacts the next downstream process, alternatives are presented as a decision tree. For example, if the existing biotowers process would remain, then a decision would need to be made whether it is more cost effective to add intermediate clarifiers or additional aeration basin volume. In summary, three comprehensive process alternatives have been evaluated and the results of that analysis are provided in this memorandum.

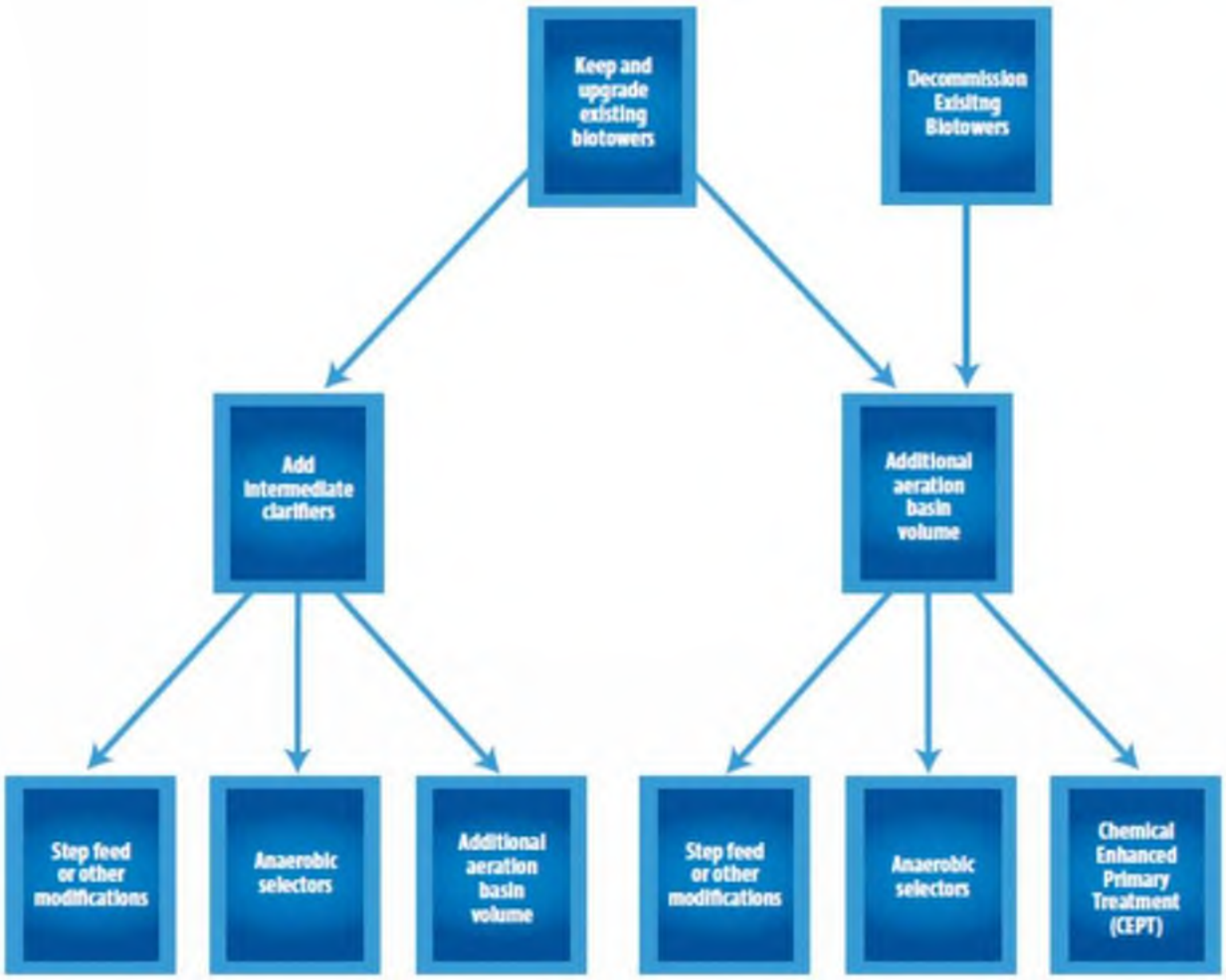


Figure 2-1 Alternatives Evaluation Decision Tree

2.2 Biotower Evaluation

With respect to the decision to keep or eliminate the existing biotowers, CDM Smith evaluated the performance of the original biotower media and compared performance to that reported for new plastic media, based on the projected loading to the process. Four biotowers were constructed in 1984 with redwood media; two additional biotowers were installed in 1997 with western cedar media. The media is past its anticipated service life and the possibility of structural failure and collapse of the media support structure presents an ongoing risk.

The performance of the biotowers could be improved by replacing the original media with new media. New media provides a significant increase in the surface area for biofilm growth, resulting in more efficient soluble BOD removal. A comparison of the soluble BOD removal by the existing original media and the anticipated removal by new media is shown in **Figure 2-2**. The performance of new media is based on modeling runs completed by Brentwood Industries using their Cross-

Flow Plastic Media. To meet the treatment objectives at the design flows and loads using the existing biotowers (if they remain) it will be necessary to replace the media. The impact of the biotowers on the aeration basin loading and resulting improvements are evaluated and discussed in Section 3.0.

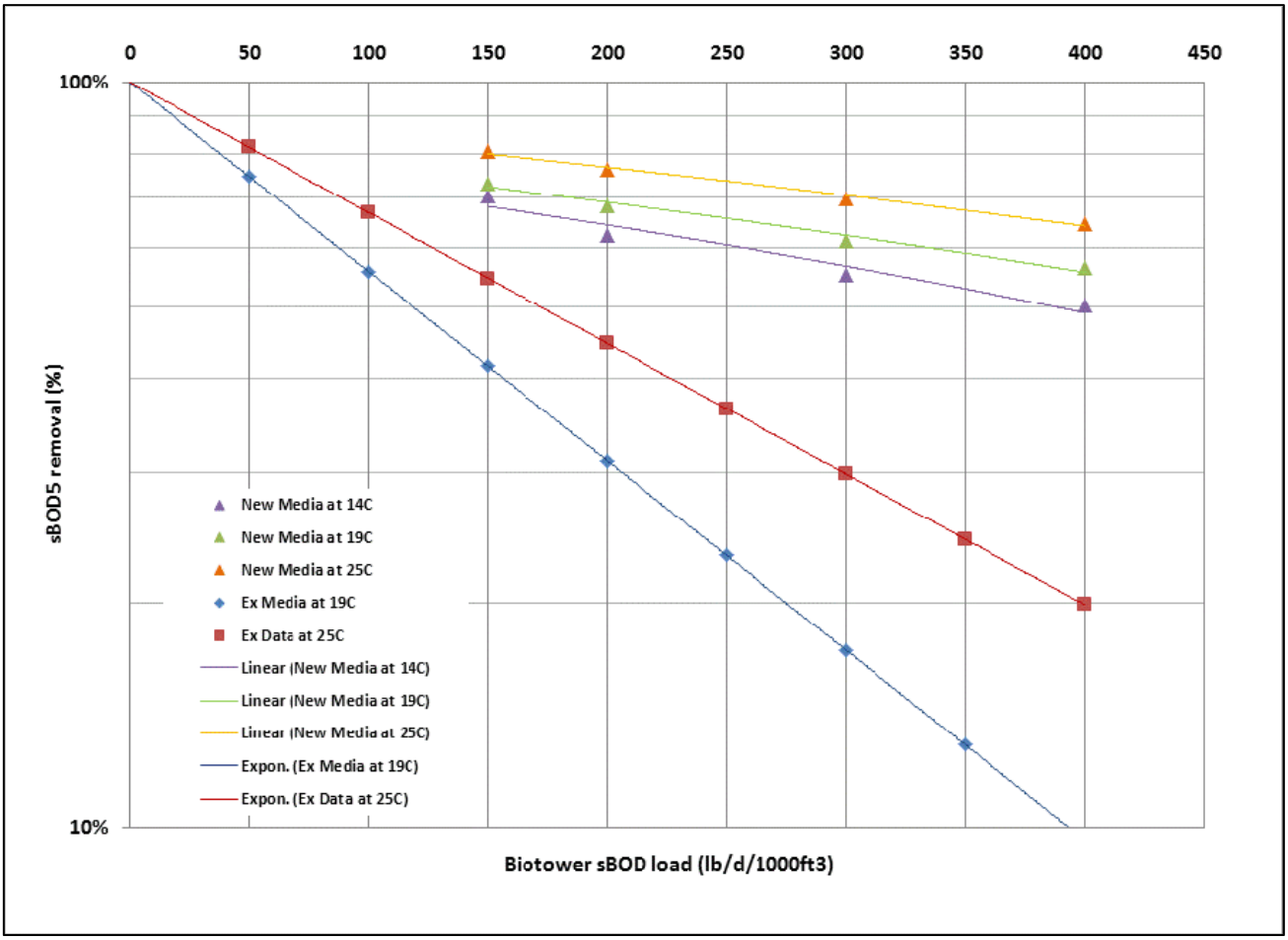


Figure 2-2 New and Existing Media Biotower Performance (% sBOD removal versus sBOD load)

3.0 Treatment Alternatives

Three treatment alternatives have been identified for detailed evaluation based on the decision tree presented in Figure 1. The requirements of each alternative are described in this section. The evaluation of each alternative includes a description of the required modifications to the liquid process train to meet the current draft NPDES permit requirements over the range of flows and loads associated with an average design flow of 90 mgd (no nitrification), and meet the TSS requirement of less than 30 mg/L on a consistent basis, for UV disinfection. In order to provide a stable activated sludge process, a minimum SRT of 2 days was selected as the basis of design. The implications with respect to the solids handling process are noted under each alternative, but

upgrades to accommodate the additional sludge handling has not been included in this evaluation. It is recommended that the City review the solids handling processes if process improvements are advanced beyond the conceptual stage.

3.1 Alternative 1: Abandon Existing Biotowers and Expand Activated Sludge Process

Alternative 1 includes abandoning the biotowers in place and expanding the activated sludge process to meet treatment requirements. CDM Smith developed a desktop tool that was utilized to determine the loading to the activated sludge process without the soluble BOD removal provided by the biotowers, so that process modifications could be identified to address future flows and loads associated with a design capacity of 90 mgd.

The average daily design flow, including sidestream recycle, to the activated sludge process is 95.8 mgd with an ADMM BOD load of 485,000 pounds per day (ppd) and a TSS load of 297,000 ppd. With an aerobic SRT of 2 days and a mixed liquor suspended solids (MLSS) of 3,400 mg/L, 29.7 million gallons (MG) of aerobic tank volume is required. The existing aeration basins provide 18.5 MG of aerobic tank volume, requiring an additional 11.2 MG to be constructed. New aeration basins would operate similarly to the existing system, i.e., in two-pass plug flow mode. As an alternative to this bioreactor configuration, the existing and new tankage could be modified to operate in step-feed mode, which would require less aerobic volume; however, step-feed would require modification of the tanks to accommodate multiple feed points. The total aeration tank volume required for step-feed operation is 24 MG (versus 29.7 MG in conventional mode), which would require an additional 5.5 MG of tankage to the existing system to be constructed (footprint 50,000 square foot (SF)) instead of the 11.2 MG required for the conventional mode.

To provide adequate clarification with one unit out of service, 12 secondary clarifiers are required, assuming a sludge volume index (SVI) of 150 milliliters per gram (mL/g). This SVI is characteristic of a well-settling biomass and in order to consistently achieve this level of performance, an anaerobic selector should also be anticipated as part of this alternative. Selectors have established proven performance at many operating plants. The preliminary sizing of an anaerobic selector, based on a hydraulic retention time (HRT) of 1 hour (forward flow only) is 3.8 MG; the selector would be included between the primary clarifiers and aeration tanks.

The return activated sludge (RAS) capacity recommended for this scenario is 100% of the average flow (or 90 mgd). The existing RAS pumping system has a capacity of 104 mgd with all pumps in service; however, due to the proposed location of the new clarifiers it is recommended that a new RAS pump station be constructed and dedicated to these clarifiers. The total solids from primary sludge, combined with the waste activated sludge (WAS), are approximately 641,000 ppd, or 3.6 dry tons per mgd, on an ADMM basis. The increase in WAS can be accommodated using an additional pump with disposal to the existing lagoons. The increase in primary sludge may require longer operation of the solids handling process with the existing belt filter presses (BFP), or require additional units to be installed.

Expanding the existing activated sludge process to accommodate these loads would require construction of additional aeration tanks, a new blower building, an anaerobic selector, secondary clarifiers, and RAS and WAS pumps housed in a new pump station. This alternative would also include removal and disposal of the media in the biotowers, though the structures would not be demolished, but instead abandoned in place. It is recommended that the biotower structures not be demolished as the space is not required for other needs at this time and they could be used in the future if required to meet increased loading or future ammonia limits requiring nitrification be added to the process. **Table 3-1** provides a summary of process upgrades to implement this alternative. The analysis conducted for Alternative 1 assumes that additional blowers, clarifiers and pumps would be provided in a configuration similar to conventional plug-flow treatment.

Table 3-1 Expand Activated Sludge Process, No Biotowers

Process Upgrades	Future Required	Existing	New Construction
Aeration			
Aeration Tank Volume (MG)	29.7	18.5	11.2
Anaerobic Selector Tank Volume (MG)	3.8	0	3.8
Aeration Tank Footprint (SF)	265,000	165,000	100,000
Air Requirement (SCFM)	335,000	240,000	95,000
Total Blower HP	19,000	9000	10,000
Total Number of Blowers	10 total 9 duty	6	4
Clarification			
Secondary Clarifier Units (135 FT Diameter)	12	8	4
Solids			
WAS Pumping Capacity (MGD)	13.5 total 9.0 duty	9.0	4.5
Total Number of WAS Pumps	3	2	1
RAS Pumping Capacity (MGD)	125 total 90 duty	104	21
Total Number of RAS Pumps	8 total 6 duty	6	2
Total Solids Production (ADMM PPD)	641,000	NA	NA
Total Solids Production (DT/MGD)	3.6	NA	NA

3.2 Alternative 2: Upgrade Biotowers and Add Intermediate Clarifiers

Upgrading the existing biotowers with new media would significantly increase their performance as noted earlier. The biotowers could remove more soluble BOD; however, increased solids concentrations in the biotower effluent would occur because of increased biomass production and resultant sloughing. These solids, if not removed, would increase the solids loading to the aeration tanks and significantly impact the activated sludge process capacity. To avoid construction of additional aeration tankage and upgrades to the ancillary systems to accommodate these solids, intermediate clarifiers could be added downstream of the biotowers.

Conceptually, six (6)164-ft diameter intermediate clarifiers would provide a surface overflow rate (SOR) of 706 gallons per day per square foot (gpd/sf) at average daily flow (ADF) and would remove an estimated 330,000 ppd day of solids. The resultant ADMM load to the downstream activated sludge process would be 166,000 ppd BOD and 26,000 ppd TSS. With an aerobic SRT of 2 days the existing aeration tank volume is adequate for treatment operating at a MLSS concentration of 1,600 mg/L, requiring no upgrade to the tank volume or the air supply system. The aeration tank volume required for this scenario at a MLSS of 1,600 mg/L is 18.5 MG. In addition, there is sufficient spare volume within the existing aeration tanks to insert an anaerobic selector, sized at 3.8 MG, negating the need to build a new structure for the selector. Incorporating an anaerobic selector into the existing tankage would result in remaining aerobic volume of 14.7 MG and a resulting MLSS concentration of 1,900 mg/L. In addition, due to the lower required MLSS concentration and the reduced solids load to the clarification process, the existing 8 secondary clarifiers and sludge pumping capacity are adequate. The existing clarifiers, with one unit out of service, with a SVI of 150 mL/g, provide a SOR of 900 gpd/sf and a solids loading rate (SLR) of 24 ppd/sf at ADF without the selector and 29 ppd/sf at ADF with the selector . The total solids produced, including primary sludge, intermediate sludge and WAS is approximately 816,000 ppd, or 4.5 dry tons per mgd on an ADMM basis.

This alternative would require media replacement in all six biotowers, biotower odor control, six 164-ft new intermediate clarifiers and an intermediate sludge pump station. The overall depth of the media in the biotowers would be reduced from 21 feet to approximately 18 feet and the floor of the biotowers could be raised to avoid construction of an intermediate pumping station to pump flow to the aeration tanks.

Table 3-2 presents a summary of process upgrade requirements to implement Alternative 2.

Table 3-2 Upgrade Biotowers and Add Intermediate Clarifiers

Process Upgrades	Future Required	Existing	New Construction
Biotowers			
No. Units (135 FT Diameter)	6	6	0
Media Depth (FT)	18	21	18
Odor Control			
Air Requirement (SCFM)	180,000	0	180,000
Total Fan HP	600	0	600
Intermediate Clarification			
Intermediate Clarifier Units (164 FT Diameter)	6	0	6
Anaerobic Selector			
Tank Volume carved out of existing aeration tank (MG)	3.8	0	3.8 (modified existing)
Solids			
Intermediate Sludge Pumping Capacity (MGD)	2.3 total 2.0 duty	0	2.3
Total Number of Pumps	7 total 6 duty	0	7
Total Solids Production (PPD)	816,000	NA	NA
Total Solids Production (DT/MGD)	4.5	NA	NA

Notes:
1. Odor Control requirements based on V&A Report.

Alternative approaches to providing odor control for the biotowers have not been evaluated in this memorandum; odor control was the subject of a separate evaluation recently conducted by V&A. However, should Alternative 2 be selected and advanced to the conceptual design stage, it is suggested that alternative odor control approaches be carefully considered. One option that has been considered for similar applications includes capture of odorous air, and diffusing it into the activated sludge system. This accomplishes two goals: 1) treatment of odor in the aerobic biological process in the aeration tanks; and 2) use of the ventilated air stream as the source of process oxygen. While this odor control approach has merit, and has been successfully used at other facilities, there are several aspects of the approach that are disadvantages and need to be carefully considered. These include:

- The condition/characteristics of the odorous air and the impact of contaminants in the air stream on the process, including condensate handling.
- The material specifications (and cost) that may be required to provide process blowers that can suitably compress the odorous air to the required pressure.

- The potential constraints this approach may place on the ability to adequately control dissolved oxygen in the process tanks, due to the inability to turn down the ventilation rate of the odor control system.

3.3 Alternative 3: Utilize CEPT, Upgrade Biotowers and Expand Activated Sludge Process

Alternative 3 includes addition of chemical enhanced primary treatment (CEPT), upgrade of the biotowers with new media, and expansion of the activated sludge process. In this alternative, additional solids would be removed in primary treatment, reducing the load on the biotowers and the downstream activated sludge process. Additional aeration tank volume would be required, but at a lower volume than Alternative 1.

By adding CEPT, the solids and organic loading to the biotowers could be reduced. The biotowers would be upgraded with new media to further reduce soluble BOD loading to the activated sludge process. As a result, the load to the activated sludge process would be 335,000 ppd BOD and 336,000 ppd TSS under ADMM loading conditions. With an aerobic SRT of 2 days and a MLSS of 3,100 mg/L, the total aeration tank volume required is approximately 24 MG. The existing aeration basins provide 18.5 MG of aerobic tank volume, requiring an additional 5.7 MG to be constructed. Similar to Alternative 1, 12 secondary clarifiers would be required to provide adequate clarification and a new 3.8 MG tank is required for the anaerobic selector. Also similar to Alternative 1, step-feed could be implemented and would require slightly less aerobic volume than plug-flow tanks. Modifications to the existing aeration tanks would be required to accommodate multiple feed points. Additional blowers, clarifiers, and pumps would be the same as for conventional treatment. The total aeration tank volume required for step-feed is 19.6 MG (vs. 24.2 MG for conventional), which would require an additional 1.1 MG of tankage be constructed (footprint of 10,000 SF) instead of the 5.7MG required for the conventional mode.

The required RAS rate for this scenario is 82% of the average flow or 74 mgd. The existing RAS pumping system has a capacity of 104 mgd with all pumps in service; however, due to the proposed location of the new clarifiers it is recommended that a new RAS pump station be constructed and dedicated to these clarifiers. The total solids produced, including primary sludge and WAS, is approximately 726,000 ppd or 4.0 dry tons per mgd on an ADMM basis. The increase in WAS can be accommodated using an additional pump with disposal of biosolids to the existing lagoons. The increase in primary sludge may require longer operation of the solids handling process with the existing belt filter presses (BFP) or require additional units to be installed. The inert chemical solids from the CEPT process would not be biodegraded in the lagoons, and the impacts of the additional inert materials would have to be evaluated, particularly in light of the ongoing work on Lagoon #5. As a result, the chemical sludge from the primaries may require an alternate disposal method.

This alternative would require a chemical feed system and building, media replacement in all six biotowers, biotower odor control, additional aeration tanks and one new blower, secondary

clarifiers, and RAS and WAS pumps. **Table 3-3** presents a summary of process upgrade requirements to implement Alternative 3.

Table 3-3 CEPT, Biotower & Activated Sludge Upgrades

Process Upgrades	Future Required	Existing	New Construction
CEPT			
Chemical Feed System (ferric chloride) - Four 9,000-gal FRP storage tanks with pumps and controls	1	0	1
Chemical Feed System Building (SF)	2400	0	2400
Biotowers			
No. Units (135 FT Diameter)	6	6	0
Media Depth (FT)	21	21	21
Odor control			
Air Requirement (SCFM)	180,000	0	180,000
Total Fan HP	600	0	600
Aeration			
Aeration Tank Volume (MG)	24.2	18.5	5.7
Anaerobic Selector (MG)	3.8	0	3.8
Aeration Tank Footprint (SF)	215,000	165,000	50,000
Air Requirement (SCFM)	246,000	240,000	6,000
Total Blower HP	14,000	9,000	5,000
Total Number of Blowers	7 total 6 duty	6	1
Clarification			
Secondary Clarifier Units (135 FT Diameter)	12	8	4
Solids			
WAS Pumping Capacity (MGD)	13.5 total 9 duty	9	4.5
Total Number of WAS Pumps	3	2	1
RAS Pumping Capacity (MGD)	125 total 90 duty	104 total	21
Total Number of RAS Pumps	8 total 6 duty	6	2
Total Solids Production (PPD)	726,000	NA	NA
Total Solids Production (DT/MGD)	4.1	NA	NA

4.0 Conceptual Layouts of Alternatives

This section presents conceptual level layouts for each alternative. In addition to addressing process modifications for each alternative, the layouts identify a location for the effluent pump station wet well and disinfection facilities, which have been evaluated separately as part of the disinfection study and would be incorporated into the upgrade alternatives.

4.1 Alternative 1: Abandon Existing Biotowers and Expand Activated Sludge Process

Figure 4-1 shows a conceptual layout for Alternative 1 – abandoning the existing biotowers and expanding the activated sludge process as described in Section 3.1. The existing biotower media would be removed and disposed of at a landfill. In order to provide a 3.8 MG anaerobic selector, an approximate footprint of 256 ft x 128 ft would be required for a new basin with a sidewater depth of 15 ft. An additional 11.2 MG, or 100,000 square feet of aeration tank volume (operated in conventional mode), would be required for this alternative and has been preliminary shown west of the biotowers. The two retrofitted clarifiers (Nos. 5N and 5S) would not be used due to hydraulic issues and the space could be repurposed as wet wells for the effluent pump station. Four additional new clarifiers are required and could be located adjacent to the new aeration tanks. The existing blower and RAS buildings do not have adequate space to accommodate additional equipment and a new building is required; the blower and RAS building has been shown adjacent to the new aeration tanks and clarifiers. The disinfection facility would be located between the two sets of secondary clarifiers as a central point for the secondary effluent to combine and be treated.

4.2 Alternative 2: Upgrade Biotowers and Add Intermediate Clarifiers

Figure 4-2 shows a conceptual layout for implementing Alternative 2 – upgrading the biotowers and adding intermediate clarifiers. The existing biotowers would remain and the media would be replaced with "cross flow" type high-surface area media, as manufactured by Brentwood Industries or equivalent. An odor control system would be provided to treat air from the biotowers and this system would be located adjacent to the biotowers. Six intermediate clarifiers would be required to remove solids prior to the activated sludge process and could be located to the east of the existing biotowers. To avoid the need to pump wastewater from the intermediate clarifiers to the aeration tanks, the biotower filter depth would be reduced from the current depth of 21-ft to 18-ft and the floor of the existing structures would be raised. A sludge pump station to convey the settled solids from the clarifiers to the solids handling process would need to be constructed adjacent to the intermediate clarifiers. No new aeration tank volume would be necessary, and there would be sufficient volume in the existing aeration tankage to convert 3.8 MG into an anaerobic selector. The two retrofitted clarifiers (Nos. 5N and 5S) would not be reused and the space could be repurposed for wet wells to the effluent pump station. The disinfection facility would be located west of the secondary clarifiers at the end of the treatment process.

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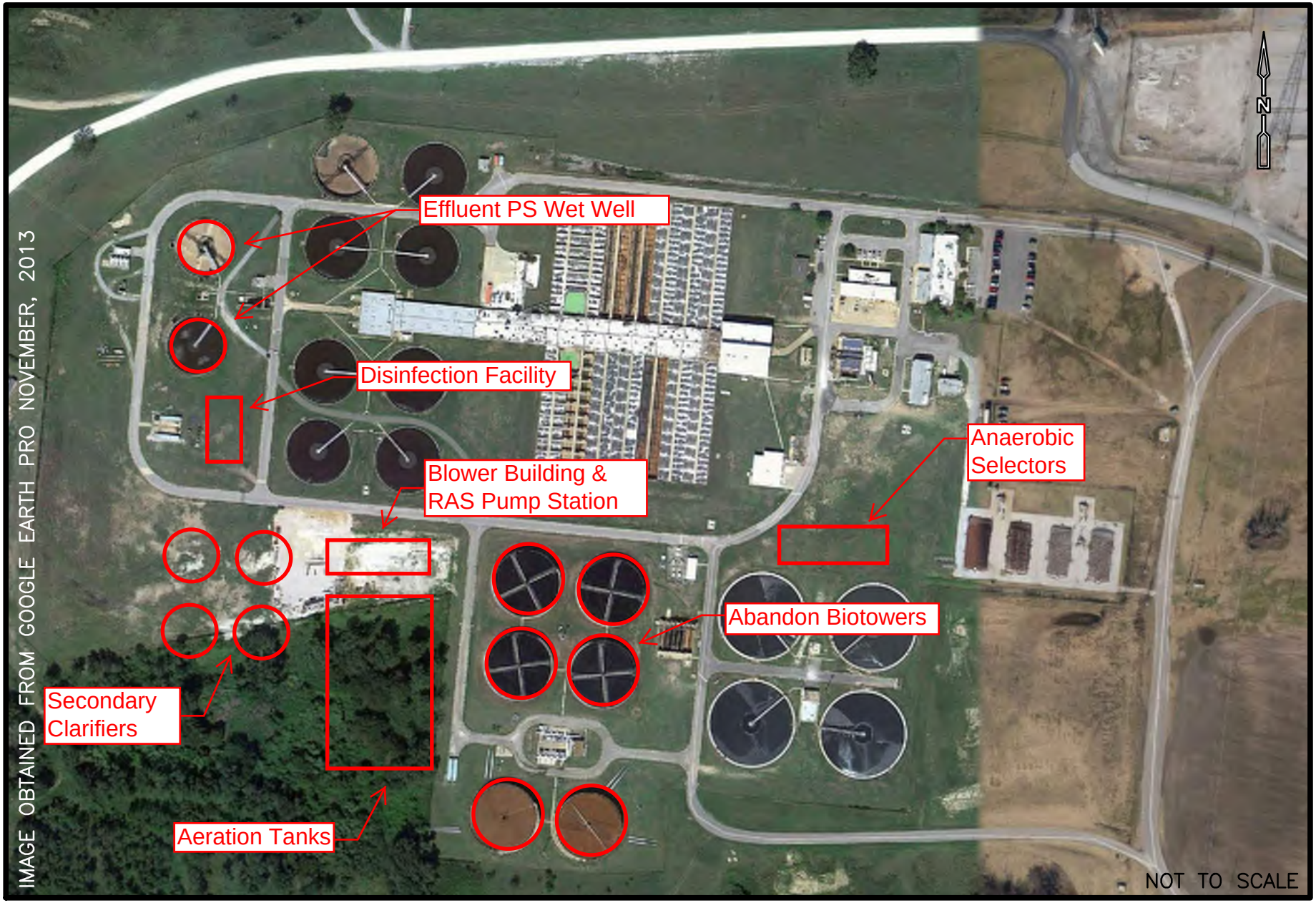

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Figure No. 4-1
Alternative No. 1
NOVEMBER 2013

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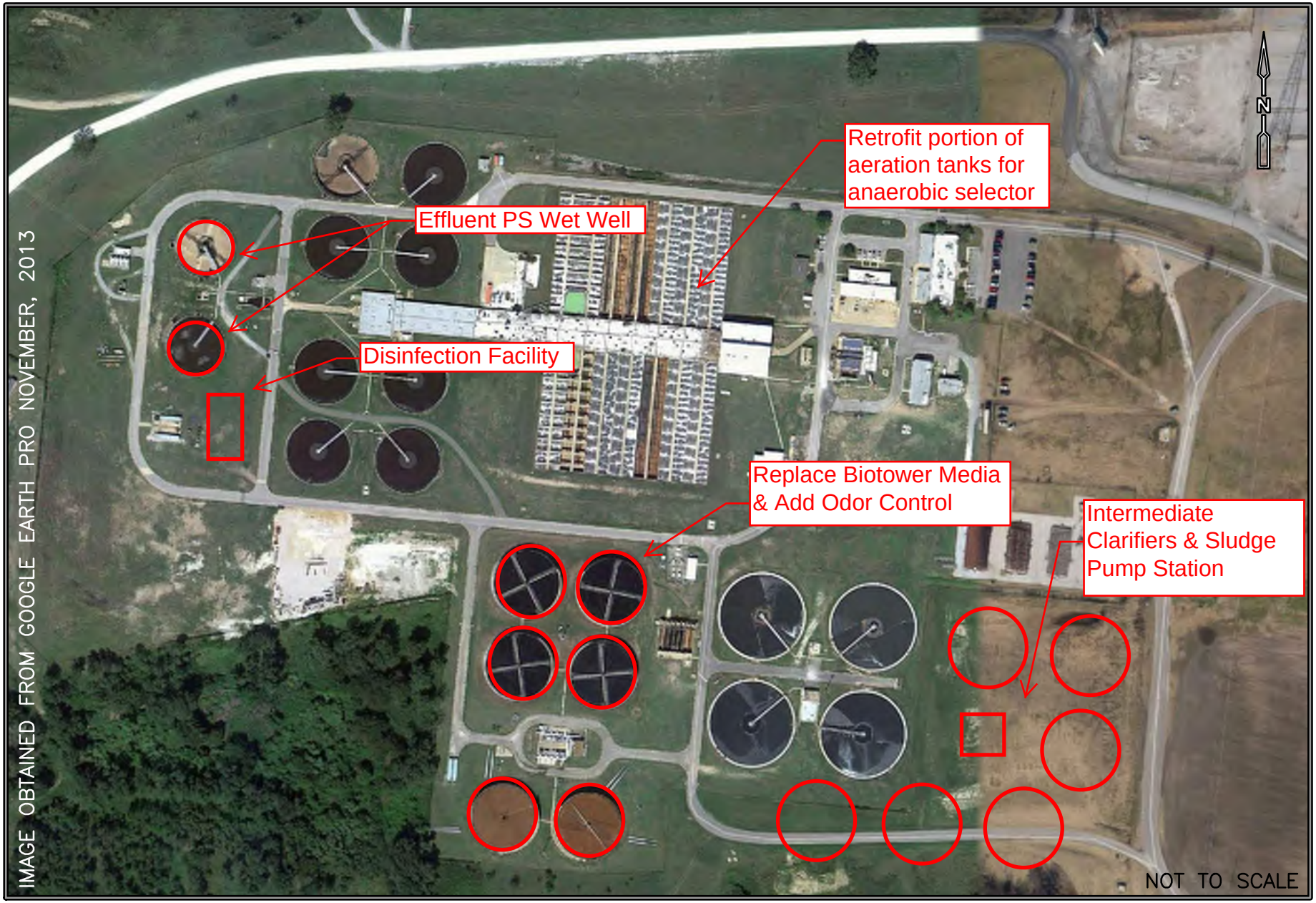

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Figure No. 4-2
Alternative No. 2
NOVEMBER 2013

4.3 Alternative 3: Utilize CEPT, Upgrade Biotowers and Expand Activated Sludge Process

Figure 4-3 shows a conceptual layout for Alternative 3 – utilizing CEPT with upgrades to the biotowers and the activated sludge process. To implement the CEPT process, a chemical feed system would be required in a new building located just to the east of the primary clarifiers. The building would be located adjacent to a plant driveway to facilitate chemical deliveries (assumed to be ferric chloride for this analysis). The CEPT building would house chemical storage tanks, pumps and ancillary mechanical, electrical and instrumentation equipment. The existing biotowers would remain and the media would be replaced with new high-surface area media (as noted in Alternative 2). The biotower depth would remain at 21-ft deep. An odor control system would be provided to treat air from the biotowers; the odor control facility would be located adjacent to the biotowers. A 3.8 MG anaerobic selector, approximate footprint of 256 ft x 128 ft, would be required. An additional 5.7 MG of aerobic volume is required for the activated sludge process and could be located adjacent to the existing tanks. The two retrofitted clarifiers (Nos. 5N and 5S) would not be reused and the space could be repurposed as wet wells for the effluent pump station. Four additional clarifiers are required and could be located adjacent to the biotowers. Due to hydraulic constraints and lack of space in the existing RAS building, a new pump station would be located central to the new clarifiers. The disinfection facility would be located west of the secondary clarifiers at the end of the treatment process.

5.0 Engineer's Opinions of Probable Costs

5.1 Basic Assumptions

For this study, probable capital (construction) costs were estimated based on vendor quotes, estimation of construction quantities and building spaces, cost information from recently completed projects and other relevant sources. Specific capital cost estimating factors include indirect costs, contractor's general conditions, contractor's overhead and profit, contingencies, and engineering and implementation. Indirect costs include costs associated with permits, sales tax, insurance and bonds. Adjustments and changes made during subsequent stages of design would affect the estimates, as would future escalation in the cost of materials, labor, and equipment. Specific capital cost factors used in this memorandum to calculate the probable costs include:

Construction Contingency	30 percent
Contractor GC Field General Conditions	10 percent
Contractor GC Indirects, Overhead & Profit	10 percent
Contractor Bonds and Insurance	3.65 percent
Planning, Design and Construction Services	10 percent
Utility Administration, Legal, bonds & Insurance	3 percent

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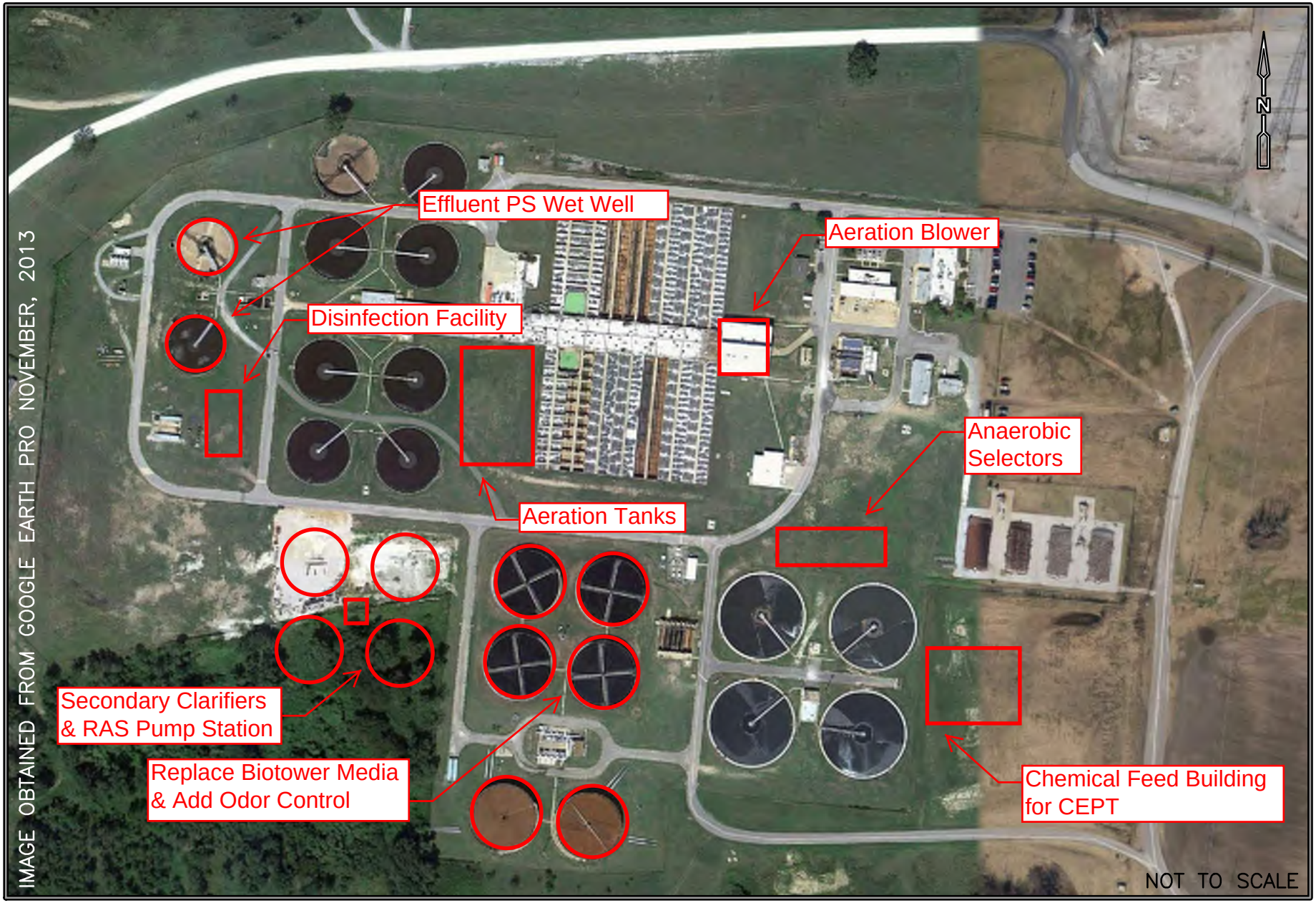

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Figure No. 4-3
Alternative No. 3
NOVEMBER 2013

5.2 Opinion of Probable Project Costs

The capital construction costs for each alternative include the process modifications as described in the previous sections. In addition to the process modifications, estimated costs for potential electrical modifications required to support the process modifications and to retrofit the effluent pump station and wet well were included; however, no actual electrical evaluation or recommendations were completed. The electrical costs included are estimated based on past relevant projects. For planning level purposes, the electrical upgrades have been estimated at 10 percent of the direct construction cost. For each alternative placeholders of $1 million and $3 million, respectively, have been allocated to account for the provision of a new or modified effluent pump station wet well (as an actual design concept was not completed as part of this study) as well as the addition of an anaerobic selector for biological treatment as part of each of the alternatives as discussed above. **Table 5-1** provides a summary of the Opinion of Probable Project Cost (OPPC) for each alternative.

Table 5-1 Opinion of Probable Project Cost

Alternative	Description	Individual OPPC
1	No Biotowers Expand Activated Sludge Process	$78,000,000 Conventional ($68,000,000 Step Feed)
2	Upgrade Biotowers & Activated Sludge Process	$82,000,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$104,000,000

For Alternative 1, which does not utilize the existing biotowers, it was assumed that the biotower media would be removed and disposed of at a landfill and the towers would be abandoned in place. No cost was added for demolition of the tower structures; it is recommended that the structures be abandoned in place as the space is not needed at this time for other purposes. Also, it allows for the biotowers to be put back in operation in the future if the loading conditions change. In addition, the capital cost for the odor control system identified in the August 14, 2013 V&A technical memorandum is included in both Alternatives 2 and 3 at the previously identified cost of $7.2 million. CDM Smith has not independently verified the sizing of this facility or the line item cost.

5.3 Comparative Operational Costs

To compare the approximate differences in operational costs among alternatives, chemical, power, and labor costs associated with each alternative have been developed and are presented in **Table 5-2**. Cost assumptions used in this evaluation include:

Power $0.076 per kilowatt-hour (kWh)

Labor Rate $40/hr.

Ferric chloride ($FeCl_3$) $1.06/gal (obtained verbally from Kemira for 36% solution)

Table 5-2 Comparative Annual Operating Costs

Alternative	Description	Labor Cost	Power Cost	$FeCl_3$ Cost	Comparative Cost
1	No Biotowers Expand Activated Sludge Process	$0	$5,400,000	$0	$5,400,000
2	Upgrade Biotowers & Activated Sludge Process	$17,000	$4,200,000	$0	$4,217,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$250,000	$5,700,000	$2,100,000	$8,050,000

Notes:
1. Operational costs are for alternative comparison only and do not reflect total plant operating cost.

Power costs are differential costs, based on major motor loads that are included in one or more alternatives. The power costs do not include those that apply equally to all alternatives. The process equipment considered for the comparative power consumption includes:

CEPT chemical feed system

Intermediate pump station (from primary clarifiers to biotowers)

Biotower recirculation pumps

Biotower odor control fans

Intermediate clarifiers

Intermediate sludge pumps

Aeration tank blowers

Secondary clarifiers

RAS and WAS pumps

For aeration blower power estimates, horsepower requirements were estimated based on average day demand (at 90 mgd), assuming six months per season based on winter and summer air requirements. The biotower odor control fans were based on a ventilation rate of 30,000 cubic feet per minute (cfm) per biotower, as determined by V&A Consultants in a technical memorandum dated August 14, 2013. The horsepower requirements for the odor control fans were not included in the V&A evaluation; CDM Smith estimated power based on the air requirement determined by V&A to be 100 horsepower (hp). If odor control is to be implemented, the horsepower requirement would be confirmed during subsequent stages of more detailed engineering. The cost of odor control media replacement for the odor control biofilters has not been included in this evaluation. The V&A report indicates that the City may own a low- or no-cost source of media, but it should be noted that the media may need to be replaced every 3-6 years depending on loading to the process. As previously discussed, solids handling has not been included in this evaluation and the associated impacts to operations has not been included in these costs.

5.4 Summary of Life Cycle Costs

The approximate difference in life cycle costs associated with each alternative has been developed and is presented in **Table 5-3**. The lifecycle cost includes the OPCC for construction and the annual operating costs summarized in Table 5-2. Assumptions used in this evaluation include:

Planning period	20 years
Discount rate	4.13 percent
Inflation rate	3.00 percent
Power escalation rate	2.00 percent

Table 5-3 provides a summary of the lifecycle costs of the three alternatives and indicates that Alternative 1 has the lowest capital cost and the 20-year present worth of this alternative with higher operations costs makes Alternative 2 a viable option as well. The power requirement for aeration is the significant operating cost for Alterative 1. Utilizing CEPT (Alternative 3) has both a high capital cost and a high operations cost, primarily due to the need to implement capital improvements in primary treatment, biotowers upgrades and the activated sludge process. Additional chemical requirements also significantly impact the operations costs of Alternative 3.

Table 5-3 Total 20-Year Life Cycle Comparison of Alternatives

Alternative	Description	Capital Cost (OPPC)	20 Year Operations Present Worth	20 Year Total Present Worth
1	No Biotowers Expand Activated Sludge Process	$78,000,000 Conventional ($68,000,000 Step Feed)	$118,000,000	$196,000,000 Conventional ($186,000,000 Step Feed)
2	Upgrade Biotowers & Activated Sludge Process	$82,000,000	$92,000,000	$174,000,000
3	CEPT, Upgrade Biotowers & Activated Sludge Process	$104,000,000 ($94,000,000 Step Feed)	$167,000,000	$271,000,000 ($261,000,000 Step Feed)

5.5 Recommendations

Although a solids handling evaluation was not completed, impacts to the solids handling operations should be considered and fully understood in determining a recommended approach for expanding the WWTP. The operation for solids handling for Alternative 1 and 2 would remain essentially the same as the current operation, with biological solids pumped directly to the lagoons and primary sludge dewatered and discharged to the lagoons. The existing belt filter presses may be adequate for dewatering the increased solids by extending the hours of operation or installing additional units. Alternative 3, CEPT with activated sludge process, produces two types of sludge; an additional chemical sludge is produced from the CEPT process and will require that the sludge be disposed of separately from the biological sludge.

Due to the high capital and operations costs of Alternative 3 coupled with the potential complexities associated with handling inert solids from the CEPT process, this option is not considered a viable alternative and can be eliminated from further evaluation. Alternative 1 and 2 are both feasible options that provide their own benefits to the WWTP. A summary of the advantages and challenges of each of these two alternatives are summarized in **Table 5-4**.

Table 5-4 Non-Cost Comparison of Alternatives 1 and 2

	Alternative 1	Alternative 2
Description	Abandon biotowers and expand activated sludge process.	Upgrade biotowers and add intermediate clarifiers.
Impacts to Process Configuration for Potential Future Ammonia Limit	Aerobic SRT would have to be quadrupled (to 8 days) to nitrify year-round. This would require a 4x increase in aeration basin volume to keep the same MLSS concentration of 3,400 mg/L (this assumes no additional secondary clarifiers). Final configuration with step-feed would have 96 MG of aerobic tankage and 12 secondary clarifiers. Fitting the necessary aeration tank volume on the site may be marginally feasible.	Aerobic SRT would have to be quadrupled (to 8 days) to nitrify year-round. This would require a 2.25x increase in aeration basin volume and four additional secondary clarifiers. Final configuration without step-feed and the selector inside the existing aeration tankage would have 33 MG of aerobic tankage and 12 secondary clarifiers, while increasing the MLSS from 1,900 mg/L to 3,400 mg/L. The additional requirements are less than Alternative 1 because the MLSS concentration for Alternative No. 2 can be raised to equal Alternative No. 1 to offset additional aerobic tankage.
Impacts to Process Configuration for Potential Future TN Requirements	Sufficient soluble BOD for process to be expanded would be available. Anoxic process volume would need to be added; the anaerobic selector volume could be converted to provide at least a portion of the required anoxic volume.	Biotowers would need to be removed, or at least the ability to bypass all or a portion of the flow around the biotowers would be necessary to provide sufficient soluble BOD to the activated sludge process. Anoxic process volume would need to be added; the anaerobic selector volume could be converted to provide at least a portion of the required anoxic volume.
Odor Control	Biotowers and Intermediate Pump Station not required, eliminating this specific source of odor and need for control.	Biotowers and Intermediate Pump Station remain and odor control system will be required.
Additional Capacity/ Process Flexibility	No ability to increase MLSS (3,500 mg/L) in existing tankage, 20 mg/L estimated effluent TSS. No additional process capacity available.	Lower MLSS (1,600 mg/L) requires 13.5 MG of aeration volume of the 18.5 MG available; process flexibility available to allow increase of MLSS in existing tankage; 10 mg/L estimated effluent TSS.
Maintenance of operations during construction	Existing processes can operate largely without impact during construction.	Only one biotower can be out of service at a time for media replacement.

Tables 5-1, 5-2 and 5-3 show that on an economic basis, Alternatives 1 and 2 are in the same range. Alternative 1 is more economical on a capital-cost basis, and Alternative 2 is more economical on an annual operating cost basis, and has a lower 20-year life cycle cost. Because the economics are "close", the right alternative for the plant to implement therefore must result from a considered weighing of the non-economic factors presented by each option.

The most critical non-economic consideration in deciding between Alternative 1 and Alternative 2 is the potential requirement for the plant to achieve nitrification (either year-round or seasonal) or total nitrogen removal in the future. As indicated by review of Table 5-4, if the plant is required to remove ammonia (to nitrify) in the future, then Alternative 2 would be the preferred option; however, if the plant is required to remove total nitrogen (to denitrify) in the future, then Alternative 1 would be preferred. At this time, it is unknown which, if either, of these performance requirements will become part of the plant's discharge permit.

However, it is possible to proceed with needed process upgrades now while keeping options open for meeting future permit possibilities. By selecting Alternative 1 now, the plant would implement the lowest capital cost option now, and if implemented correctly, could maintain the flexibility to best address future permit requirements for either ammonia or total nitrogen. The expansion of the activated sludge process described to implement Alternative 1, consisting primarily of new aeration tankage, clarifiers and supporting systems, would be sited and built to accommodate further expansion to meet potential future permit requirements. The biotower structures would be abandoned in place but not demolished; therefore, it would be possible to put back into operation in the future if ammonia removal is required. In addition, the siting of the Alternative 1 facilities would allow for site footprint to be allocated for intermediate clarifiers in the future (east of the biotowers as shown in Alternative 2), if total nitrogen removal is required in the future. In the event that a future nitrogen limit is required, the biotowers could then be demolished and additional aeration tankage could be constructed in this space.

Because of its flexibility to be designed and arranged to be suitable for future adaptation to either ammonia or total nitrogen limits, Alternative 1 is recommended for implementation at this time.

FMC
ENVIRONMENTAL SOLUTIONS

WATER TREATMENT

November 18th, 2013

Kati Bell, Ph.D.
CDM Smith
210 25th Avenue North, Suite 1102
Nashville, TN 37203

Re: VigorOx® WWT II Disinfection Process for the Maxson WWTP

Dear Kati,

Following our July 26th proposal for the Stiles WWTP, we would like to submit for your consideration a similarly structured proposal for the use of the VigorOx® WWTII Disinfection Process at the Maxson WWTP. The pricing approach is based on water quality parameter ranges that are expected to represent most operating conditions expected at the plant.

1. Scope of Supply

Equipment

Two (2) 40,000 gal Storage Tanks for VigorOx WWTII, including all nozzles, level instrumentation, tie-downs.
One (1) VigorOx Feed and Control System, including four (4) chemical feed pumps (two injection points), PLC-based system control panel, color touch-screen HMI, two (2) on-line PAA probes.

Disinfectant

VigorOx® WWTII Peracetic Acid, Delivered Bulk
100% of Plant Requirements during contract period

Services

Equipment Startup
Disinfectant Delivery and Tank Fill Up
Tank Level Monitoring and Delivery Scheduling
Disinfection Process Remote Monitoring
Equipment Preventive Maintenance
Equipment Corrective Maintenance

Process Guarantee

Under the full disinfection solution model, FMC guarantees compliance with the plants NPDES permit pathogen limits: (a) daily maximum and (b) 30-day geometric mean of daily grab samples. The mechanism to assess penalties for non-compliance will be negotiated with the City.

1.2 Commercial Terms

Pricing

TSS Range Bracket	Price per MGD
0 to <15	$89.00
>15 to <30	$153.00
>30 to <96	$253.00
>96	$500.00

- Price includes all items listed under '1.1 Scope of Supply'.
- Invoices will be generated monthly.
- Invoice amount will be calculated at the end of the month, by adding the month's daily totals (MGD * Price) and considering the daily average value for each of the water quality parameters to select the appropriate price tier.
- Flow rate, Color and TSS are to be measured continuously and on-line; instruments to be calibrated periodically by a third party.
- Pricing also assumes influent pathogen count will not exceed $1x10^6$ CFU/100ml.
- Pricing and calculations are based on a minimum contact time of 15 minutes

Contract Duration

- Minimum contract duration: 5 yrs

Evaluation Period

- Understanding that the pricing above is based on limited data, FMC proposes to establish a six month evaluation period in which real plant conditions and disinfectant demand can be properly evaluated. After this six month period, both the City of Memphis and FMC will have the right to renegotiate price or terminate the contract if agreement on pricing cannot be reached.

All other terms and conditions will be negotiated with the City of Memphis.

This pricing is provided for CDM Smith's use in connection to the City of Memphis' Stiles WWTP project only, and we ask that these price ranges are treated as confidential information that should not be disclosed to any third parties, other than CDM Smith's client for this project.

Best regards,

Alberto Garibi
Business Manager, Water Treatment

DRAFT
REPORT

Maxson WWTP Supplemental Pilot & Bench Disinfection Testing Report

City of Memphis, TN

January 2016

CDM Smith

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Executive Summary

The City of Memphis has been evaluating various disinfection alternatives for use at the T.E. Maxson Wastewater Treatment Plant (Maxson) over the past several years. Since the previous pilot work, performed by CDM Smith in 2013, two major changes have occurred at Maxson. First, during the 2013 pilot testing, a portion of the plant treatment process was being bypassed to allow for the construction/installation of the new fine screen facility prior to the primary clarifiers. Second, a major industrial contributor (Cargill) to Maxson closed and was anticipated to result in a significant reduction in overall plant loading. As a result, supplemental pilot testing of peracetic acid (PAA) was performed at Maxson. In addition, supplemental UV related analysis were performed, as was bench testing the utilization of UV and PAA as a combined disinfectant.

This report provides a summary of on-site pilot testing and development of the disinfection kinetics model for establishing design criteria for a PAA disinfection system. The kinetic model allows selection of design doses for a range of contacts times and bacterial inactivation set points. Updated design criteria for a UV system, based on new collimated beam data, were also developed. In addition to the PAA pilot study results, results from bench scale testing of UV/PAA combined testing are also reported.

The key objectives of the additional pilot testing conducted were aimed at supplementing the bench and pilot testing that have previously been conducted at the Maxson WWTP. In order to confirm the results of previous testing, in light of the recent changes at the facility, the following objectives were addressed with respect to meeting limits for *Escherichia coli* (*E. coli*) as outlined in the current draft National Pollutant Discharge Elimination System (NPDES) permit:

- Refine the design criteria for PAA disinfection to meet disinfection limits
  - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times
  - Determine the design dose for average conditions to support calculation of associated operating costs
- Confirm the UV disinfection design dose to support estimates of capital and operating costs

The key objectives of the bench scale UV/PAA disinfection study included:

- Quantify and compare disinfection kinetics among several UV and PAA combinations including:
  - PAA alone, UV alone, UV followed by PAA, PAA followed by UV, simultaneous disinfection with UV and PAA.
- Propose a mechanistic model to describe the efficacy of the combined disinfectant

PAA pilot testing commenced on Monday, May 4th, and continued through Friday, June 5th, 2015; samples were collected and submitted to Environmental Testing and Consulting Laboratory,

located in Memphis, Tennessee. Results and analysis of data are provided in this document. The disinfection kinetics model that was developed allowed CDM Smith to make recommendations on both UV and PAA design criteria and directly compare lifecycle costs for the two disinfection alternatives.

Three disinfection set points were established to reflect average, peak, and minimum conditions at the plant. The basis for these set points are described in Section 3. **Table ES-1** shows the results of the PAA pilot results analysis for each of the disinfection set points in the terms of CT. The required CT can be achieved through numerous combinations of time and PAA dose. A cost optimization was performed to determine the most effective combination of contact time and dose to reduce overall lifecycle costs while constraining the cost of the contact tank to less than $10 million and ensuring that the resulting residual PAA concentration is between 0.4 mg/L and 1.5 mg/L. Based on these design criteria, a sodium bisulfite system would not be required for any of these set points, although an emergency SBS system is recommended and was included in the lifecycle analysis.

Table ES-1: Required PAA CTs and Design Points

Set Point	Flow (MGD)	Required Log Inactivation	CT*
Average Conditions	90	3.92	87.1
Peak Conditions	170	3.82	74.1
Minimum Conditions	50	2.81	22.4

*CT results include a 1.3x safety factor

Several new collimated beam (CB) analyses were performed to determine if disinfection requirements have changed due to changes in plant influent since 2013. A comparison of the recent and historical CB data performed by Trojan Technologies is shown in **Figure ES-1**. These represent the average of the entire dataset from each year. There is no significant difference between the two datasets. The effectiveness of a UV disinfection system relies heavily on the UV transmittance (UVT) of the influent to the system. During the pilot period, the observed average UVT was 16%, which was lower than those observed during the 2013 pilot testing.

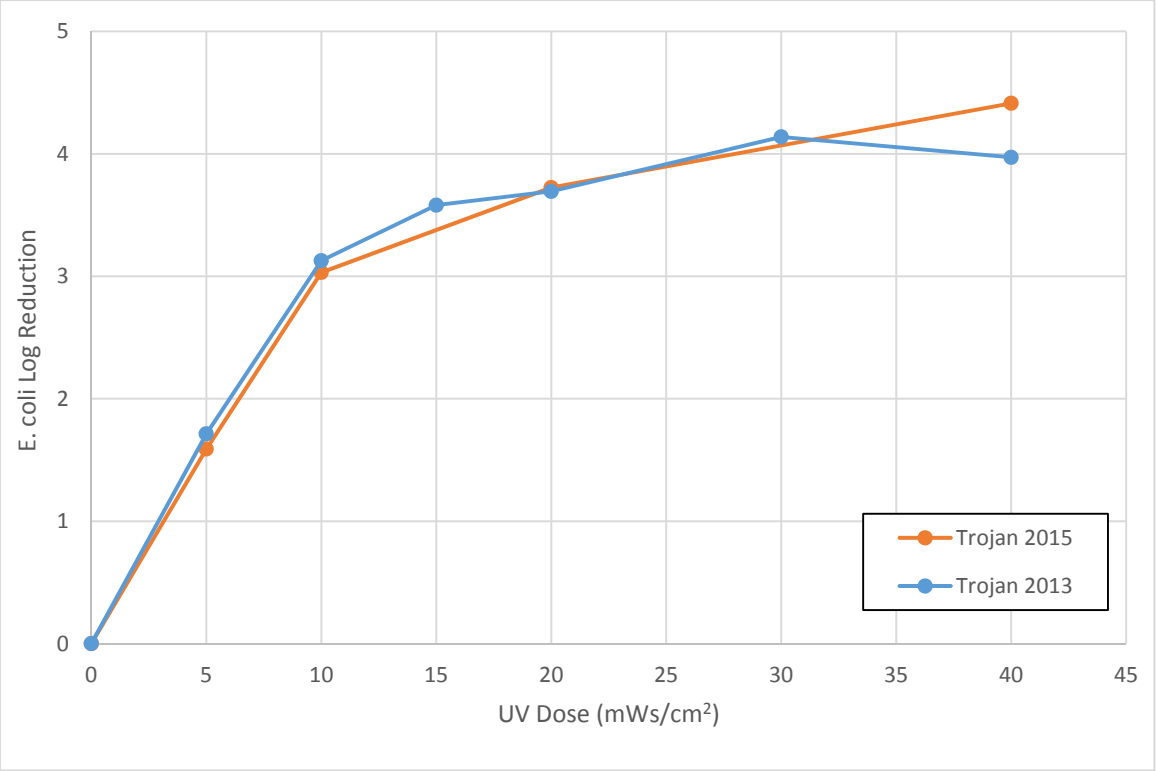


Figure ES-1: Comparison of Recent and Historical Collimated Beam Data

A mechanistic model was developed, based on the results of the combined UV/PAA disinfection bench test, to predict the results of combined disinfection using UV and PAA. Results indicated that the most effective combination of the two is UV followed by PAA. **Figure ES-2** was developed to illustrate the different combinations of UV and PAA that would be required to maintain an effluent concentration of 126 cfu/100 mL of *E. coli.* Although the results are promising, further research is required to accurately describe the effect of combined disinfection, and the economic analysis that was performed based on the results did not indicate significant economic savings through application of a combined disinfection system. The full UV/PAA bench testing report from Trojan Technologies is included as **Appendix A**.

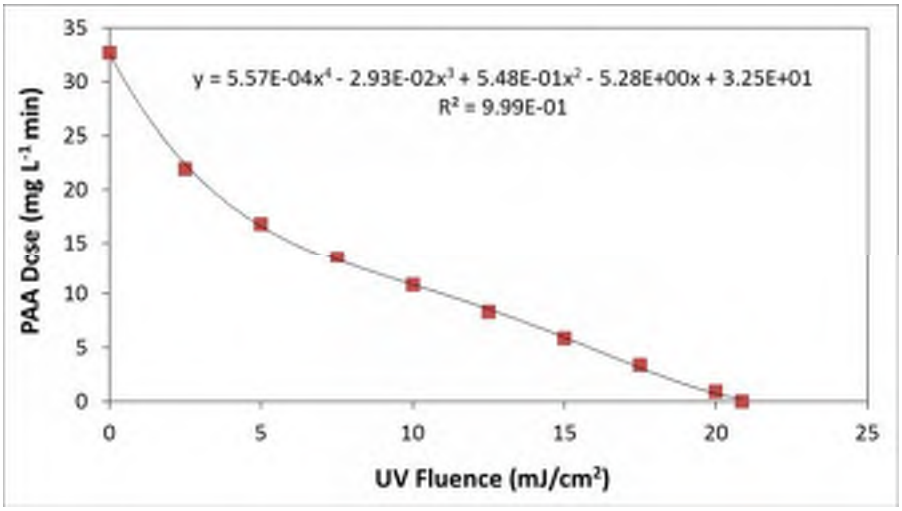
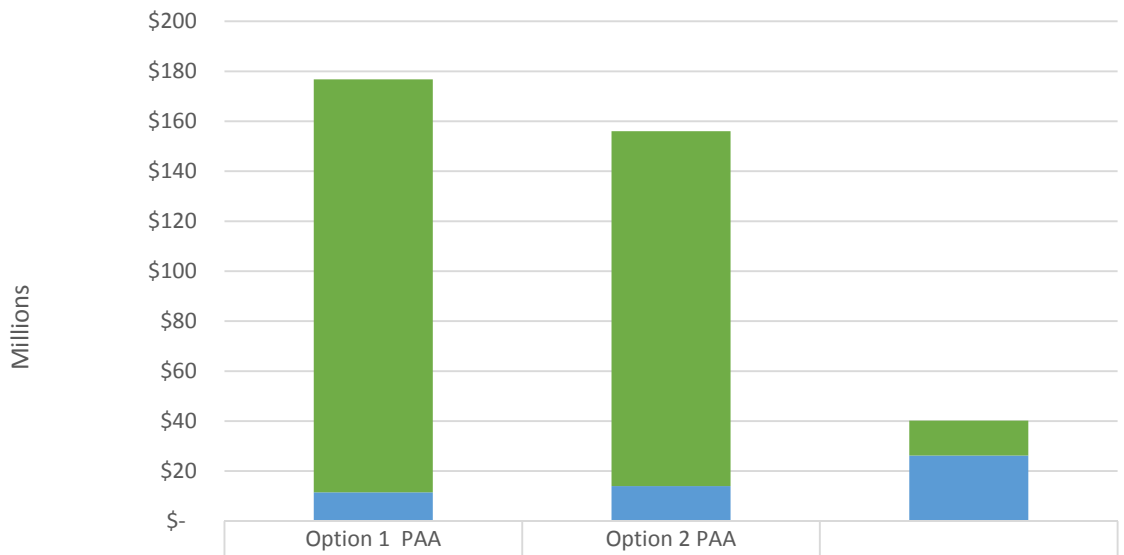


Figure ES-2: Model predicted combinations of PAA dose and UV doses required to achieve an E. coli disinfection target of 126 cfu / 100 mL when applying the sequential UV→PAA treatment process.

Comparative 20 year life cycle costs of three alternative disinfection systems are shown in **Figure ES-3**. The first alternative is a PAA system with a contact tank providing 31 minutes of contact time at average flow, the second system is a PAA system providing 31 minutes of contact team at peak flow, and the third is a UV system designed to treat water at 20% UVT. Providing more contact time at average flow eliminated the need for quenching with sodium bisulfite. Although the lifecycle costs of the UV alternative is lower than that of the two PAA alternatives, the City of Memphis and CDM Smith discussed the impacts caused by the variability of the low UV transmittance seen in the Maxson WWTP effluent. The variability likely stems from the change in processes and raw materials utilized by industrial users within the City's collection system, which may further decrease UVT and adversely affect a UV system. Based upon these discussions it was decided to eliminate UV from the list of disinfection alternatives. Results of the detailed cost analysis and the pilot data indicate that the most cost effective contact tank size to reduce overall lifecycle costs is 489, 000 cubic ft. Design parameters for the PAA system are shown in **Table ES-2**.



	Option 1 PAA 253,000 cubic ft	Option 2 PAA 489,000 cubic ft	20% UVT Design UV System
Total Annual Cost	$165,300,000	$142,000,000	$14,000,000
Total Capital Cost	$11,500,000	$14,000,000	$26,200,000
Lifecycle Costs	$177,000,000	$156,000,000	$40,000,000

Figure ES-3: 20 Year Lifecycle Analysis of Three Disinfection Options

Table ES-2: PAA System Design Parameters

Tank Size = 489, 000 cubic ft				
Set Point	**LI**	**Design CT***	**Contact Time**	**Dose**
		mg/L*min	**min**	**mg/L**
Average Conditions	3.92	87.1	31.0	8.4
Peak Conditions	3.82	74.1	58.5	6.7
Minimum Conditions	2.81	22.4	105.4	4.5

*CT results include a 1.3x safety factor

Section 1

Introduction

1.1 Background

The City of Memphis is comparing the feasibility of installing several different disinfection systems at the T.E. Maxson Wastewater Treatment Plant (Maxson) facility including a standalone PAA system, a UV system, and a combined disinfection system utilizing both UV and PAA. CDM Smith conducted an in depth investigation of all three of these disinfection technologies. The results of the UV investigation and the initial PAA pilot testing have been presented previously, but the results of PAA study presented here. This includes a summary of the on-site pilot testing and the development of the disinfection kinetics model for establishing design criteria for a PAA disinfection system. A summary of the combined UV/PAA testing is also included, and the full report is included as an **Appendix A**.

Historically, PAA has been applied to the food, beverage, medical and pharmaceutical industries; it has been used in Europe at wastewater treatment facilities for over a decade for disinfection. The US Environmental Protection Agency (EPA) has approved three commercially available PAA products for use as a disinfectant to treat wastewater. To date, there are several full-scale facilities that have been permitted with several more under design, and there are a number of pilot studies that have been performed or are ongoing in the United States (US).

1.2 NPDES Permit Requirements

The current NPDES permit, number TN0020729, issued by Tennessee Department of Environment and Conservation (TDEC) authorizes the Maxson WWTP to discharge treated effluent from Outfall 001 to the Mississippi River at Mile 725.0, pursuant to the permit limits and monitoring requirements specified in the permit**.** The facility, as noted in the permit, has a treatment design capacity of 90 million gallons per day (MGD) with a hydraulic capacity of 160 MGD. The effluent limits for parameters relevant to the evaluation of disinfection processes are summarized in **Table 1-1**.

Table 1-1: Disinfection Related Permit Requirements

Parameter	Effluent Discharge
BOD5 or CBOD5	
Monthly average	42 mg/L
Weekly average	63 mg/L
Daily maximum	84 mg/L
pH (s.u.)	6 – 9 s.u.
Total Suspended Solids (mg/L)	
Monthly average	48
Weekly average	72
Daily maximum	96
Turbidity	

Parameter	Effluent Discharge
E. coli	
Monthly average	126 cfu/100 mL
Daily maximum	487 cfu/100 mL
Total Residual Chlorine (or Oxidant)	2.0 mg/L

1.3 Pilot and Bench Study Objectives

In order to develop the disinfection kinetics model for establishing design criteria for a PAA disinfection system, a 30-day side-stream pilot was conducted on site. To determine UV design criteria, samples were taken for collimated beam testing throughout the pilot test period. The goal of this study was to verify previous dose recommendations for effluent discharge to meet permit requirements.

The key pilot study objectives included:

- Refine the design criteria for PAA disinfection to meet disinfection limits
  - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times
  - Determine the design dose for disinfection set points in conjunction with life cycle cost analysis
- Confirm and update the UV disinfection design dose to support estimates of capital and operating costs

The key bench study objectives included:

- Quantify and compare disinfection kinetics among several UV and PAA combinations including:
  - PAA alone, UV alone, UV followed by PAA, PAA followed by UV, simultaneous disinfection with UV and PAA.
  - Propose a mechanistic model to describe combined disinfection

Section 2

Pilot & Bench Study Procedures

2.1 PAA Pilot Study

The pilot study was designed to evaluate PAA disinfection efficacy across a range of doses, conditions, and contact times to support development a kinetic model to predict PAA disinfection efficacy at different concentrations and contact times. Detailed plans and procedures are contained in the Technical Memorandum entitled Additional Testing for Disinfection – Contract 28231 at the T.E. Maxson Wastewater Treatment Plant, which is located in **Appendix B**. For reference, the PAA dosing schedule is shown in **Table 2-1**, and the sampling matrix is shown in **Table 2-2**. Test methods for each parameter are listed in **Table 2-3**.

Table 2-1: PAA Dose Schedule

Dates	Desired/Target PAA Dose (ppm)
May 4-8, June 2	7
May 11-15, June 3	8
May 18- 22, June 4	9
May 26-28	5
May 29, June 1	6
June 5	10

Table 2-2: Sampling Matrix

Parameter	Influent Control Port	Ports 1-5	Effluent Port 6	Frequency	
Residual PAA (mg/L), field meter	--	--	X	4x/day	4 days/week
		X		1x/day	4 days/week
E. coli (MPN/100 mL), ETC Lab	X	--	X	4x/day	4 days/week
	--	X	--	1x/day	4 days/week
pH (SU) , field meter	X	--	X	4x/day	4 days/week
	--	X	--	1x/day	4 days/week
Temperature (°C), field meter	X	--	--	1x/day	4 days/week
COD (mg/L), ETC Lab	X	--	--	1x/day	4 days/week
Apparent and Filtered Color (PtCo), ETC Lab	X	--	--	1x/day	4 days/week
NO2-N (mg/L), ETC Lab	X	--	--	1x/day	4 days/week
Filtered and Unfiltered UVT (%T), ETC Lab	X	--	--	1x/day	4 days/week
Total Suspended Solids (mg/L), ETC Lab	X	--	--	1x/day	4 days/week

Table 2-3: Test Methods

Parameter	Analysis Method
Residual PAA (mg/L), field meter	EPA, Method 330.5
E. coli (cfu/100 mL)	EPA, 9223B
pH (SU), field meter	ASTM D1293 – 12
Temperature (°C), field meter	SM 2550
Carbonaceous Oxygen Demand (COD) (mg/L), ETC Lab	SM 5220D
Apparent and Filtered Color (PtCo)	SM 2120B
NO2-N (mg/L)	EPA 300.0
Filtered and Unfiltered UVT (%T)	SM 5910B
Total Suspended Solids (mg/L)	SM 2540D

Pilot testing commenced on Monday May 4, 2015 and continued through June 5, 2015. Samples were collected Monday through Thursday during this period. The only exception occurred when weather issues prevented sampling during the fourth experiment on May 20th. **Figure 2-1** highlights some key features of the pilot reactor.

Figure 2-1: Key Features of PAA Pilot Reactor: (Left to Right) Influent Port, Flow Meter, and Sample Port

Samples for *E. coli* were collected in 120 mL jars containing sodium thiosulfate to quench the residual PAA and prevent further bacterial inactivation. Samples collected for COD, TSS, Color, Nitrite, and UVT alkalinity, and ammonia were obtained from the influent port four times per week delivered to the Environmental Testing and Consulting Laboratory in Memphis, TN, for testing. In addition, field tests to measure pH and temperature were conducted each day. Temperature was measured at the influent port once per day, and pH was measured at the influent port and port 6 four times per day.

2.2 Collimated Beam

Nine samples were sent to Trojan Technologies for collimated beam analysis during the pilot period. Samples were irradiated under controlled UV dosing and hydraulic conditions, according to industry defined standards. *E. coli* concentrations were measured at different UV dose intervals to determine the specific dose response characteristic for *E. coli* at Maxson WWTP.

2.3 UV/PAA Bench Study

In order to investigate the feasibility and economics of implementing a combined disinfection technology strategy, bench testing was conducted to inform process selection and sizing. UV/PAA bench testing was conducted at Maxson the week of September 21, 2015. Samples of secondary effluent were collected twice daily (7:00 and 13:00) immediately prior to the discharge from the plant and were treated at bench-scale, on site. In this study, secondary effluent samples were collected and treated with UV doses between 2.5 – 40 mJ/cm^2 and PAA CTs of 2.5 – 50 mg·L^{-1}·min. To evaluate different operational scenarios were evaluated including the following five combinations were applied: PAA alone, UV alone, PAA followed by UV, UV followed by PAA, and simultaneous UV and PAA.

Water quality parameters measured include TSS, COD, UVT, color, and BOD_5. PAA residual was measured using a CHEMetrics PAA vacu-vials test kits and a PAA single analyte meter. The IDEXX Colisure method was used to determine the concentration of viable for E. coli. Sample color was measured at 455 nm using a Hach DR5000 spectrophotometer.

PAA residual concentrations were measured over time, and E. coli samples were collected following PAA measurement. Samples were quenched prior to E. coli enumeration using sodium bisulfite. UV testing was conducted using a collimated beam (CB) apparatus following the IUVA testing protocol; UV irradiation was measured using an International Light Technologies (ILT) ILT1700 radiometer with a UV detector. Samples were irradiated in order to achieve UV doses of 2.5, 5, 10, 15, 20 and 40 mJ/cm^2. Calculations of the unweighted doses at each wavelength band were based on existing protocols developed by Trojan.

For the UV+PAA experiment, effluent was first irradiated to UV doses of 10, 15 or 20 mJ/cm^2, then dosed with PAA as described above. For the PAA+UV experiment, effluent was first dosed with PAA as described above. After set durations, portions of the sample were removed, quenched with a stoichiometric amount of sodium bisulfite, and then subjected to UV doses of 10, 15 or 20 mJ/cm^2. For the simultaneous PAA+UV experiment, two different scenarios were investigated. The first involved dosing PAA at the onset of UV irradiation, irradiating for a set duration, and then removing the sample from UV exposure and continuing to stir until a desired PAA contact time was achieved. The second scenario involved first dosing PAA and allowing it to stir for a period prior to subjecting it to UV irradiation.

Section 3

Data Results and Analysis

3.1 PAA Pilot Study Data Results and Analysis

Standard methods for describing PAA disinfection efficacy are still be developed because the application of PAA as a wastewater disinfectant is relatively recent. CDM Smith has historically applied the Hom's model to disinfection datasets. For PAA, it is thought that the "CT" (residual concentration times contact time) approach that is traditionally used for chlorine disinfection may not be fully adequate to assess the effectiveness of PAA disinfection because of differences in chemical half-lives. In Hom's model, "m" is used to account for the shorter half-life of PAA.

Equation (3-1)

$$\log\left(\frac{N}{N_o}\right) = -kC^n t^m$$

Where:

> k = the disinfection rate constant otherwise known as the specific coefficient of lethality and depends on the target organism (here, *E. coli*) and other factors such as bacterial association with total suspended solids (TSS)
> C = the residual PAA concentration, mg/L
> t = contact time, min
> Where $n < m$, t (contact time) is the primary factor affecting inactivation and longer contact times will provide additional disinfection benefit
> Where $n \sim m$, t (contact time) and PAA residual are similar in their effect on inactivation.
> Where $n > m$, chemical residual overrides contact time with respect to disinfection efficacy.
> When $m < 1$, there can be a tailing-off behavior at very long contact times.

Data collected during the pilot study were used to determine the Hom's parameters and to model *E. coli* inactivation at different PAA residuals and contact times. A total of 95 test conditions including PAA residual (C), contact time (t), and *E. coli* inactivation (log(N/NO)) were included in the analysis.

The best fit of Hom's model for *E. coli* disinfection was determined using the Excel Solver; results are shown in **Table 3-1**. The correlation between the predicted and the observed bacterial inactivation are shown in **Figure 3-1**. Although the correlation between the model and the measured data is 81%, there does appear to be some over-prediction at low inactivation and under predication at high inactivation.

Table 3-1: Hom's Model Parameters

Hom's Parameters		
k	n	m
0.86	0.18	0.47

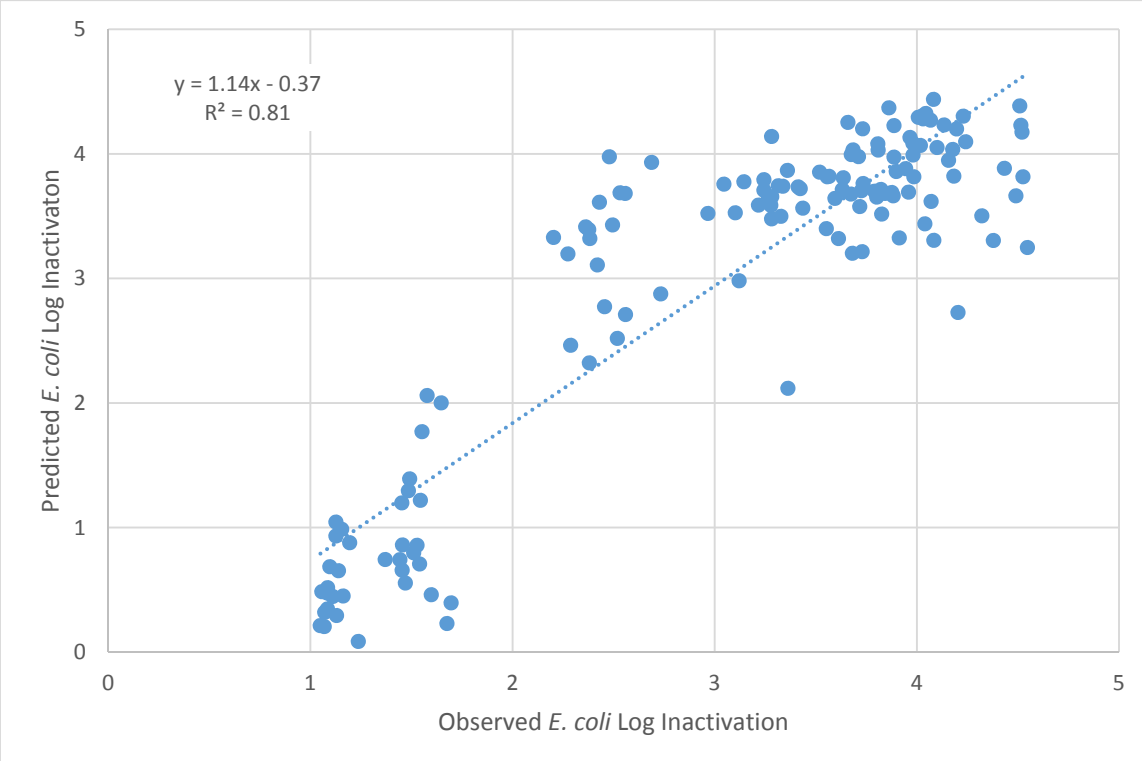


Figure 3-1: Correlation between Measured Log Inactivation and Hom's Model Predicted Inactivation

Because of the spread between the model and the measured data that was observed in the application of Hom's model, the standard CT model was also applied to determine if a better fit could be found. This approach is applied in several steps. In step 1, residual concentration and time are fitted to an exponential decay equation:

Equation (3-2) $$C = (C_0 - D) * e^{-kt}$$

Where:

C = the concentration of PAA at time, t
Co = the applied dose of PAA,
D = the instantaneous demand exerted by the wastewater
k = the specific decay rate of PAA
t = time

Based on this analysis, it was determined that during the pilot period, the average demand exerted by the wastewater was 3.66 mg/L and the specific decay rate was 0.04 per minute. The CT at any time was determined by calculating the integral of the decay equation between 0 and time t.

Equation (3-3) $$CT = \int_0^t (C_o - D) * e^{-kt} = \frac{(C_o - D)}{k} * (1 - e^{-kt})$$

In the next step, the calculated CT from each experiment is correlated to the measured log inactivation. This is shown in **Figure 3-2**. This correlation is slightly stronger and displays less over and under prediction than the Hom's model. However, there is still observable spread between the model and the measured data.

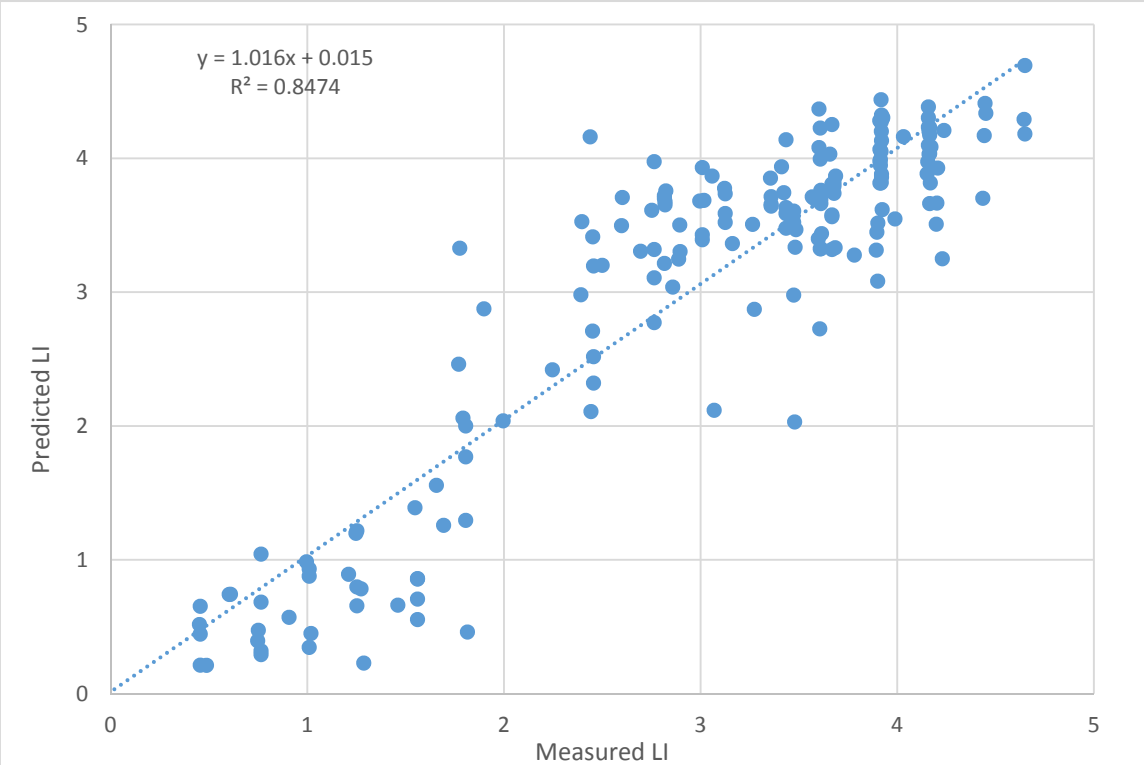


Figure 3-2: Correlation between Measured Log Inactivation and Single Exponential Decay Model Predicted Inactivation

Another predictive model was applied to determine if a stronger correlation could be found. This model also utilizes the integral CT method, but uses a more complex correlation between CT and log inactivation. In this model, the bacterial population is divided into two parts, an easy to inactive portion which represents free floating bacteria, and a hard to inactivate portion, which represents particle associated bacteria. This relationship is descried by the following equation:

Equation (3-4) $$N = N_o * fNd * e^{-k_d * CT} + N_o * fNp * e^{-k_p * CT}$$

Where:

N = the number of viable bacteria, MPN/100 mL
No = the number of bacteria in the wastewater prior to disinfection, MPN/100 mL
fNd = the fraction of the bacterial population that is "easy to inactive"
kd = the specific decay rate of the "easy to inactive" bacteria
fNp = the fraction of the bacterial population that is "hard to inactive"
kd = the specific decay rate of the "hard to inactive" bacteria

The resulting correlation is shown in **Figure 3-3**. The data is best correlated to this model, and the spread between the data and the model is reduced. The PAA dosing recommendations were generated from this model.

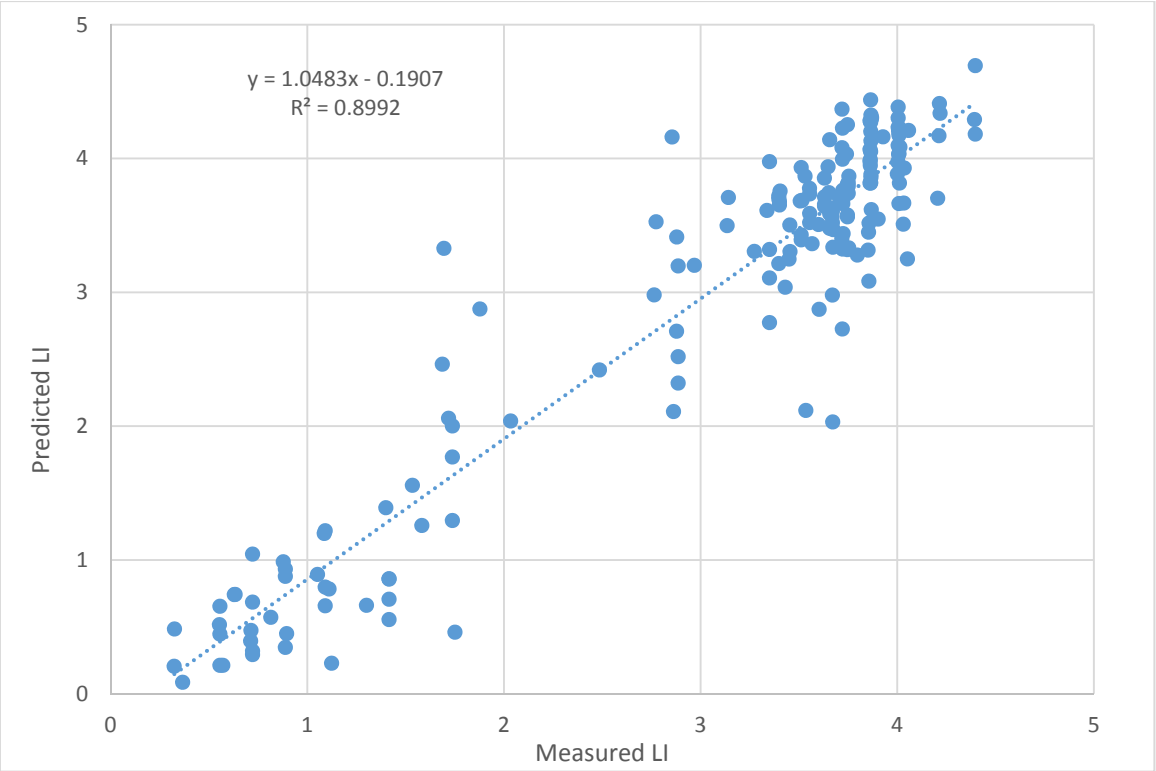


Figure 3-3: Correlation between Measured Log Inactivation and Double Exponential Decay Model Predicted Inactivation

3.2 Collimated Beam Analyses

Several new collimated beam (CB) analyses were performed to determine if disinfection requirements have changed due to changes in plant influent since 2013. A comparison of the recent and historical CB data performed by Trojan Technologies is shown in **Figure 3-4**. These represent the average of the entire dataset from each year. There is no significant difference between the two datasets.

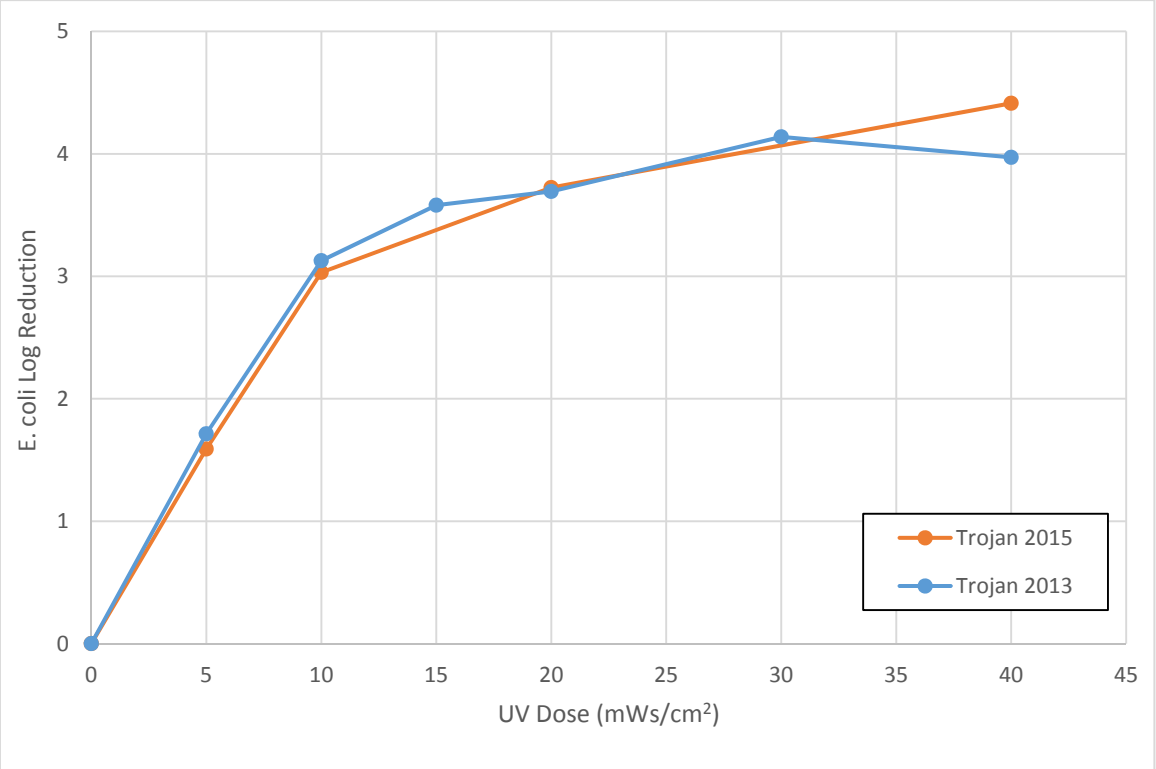


Figure 3-4: Comparison of Recent and Historical Collimated Beam Data

3.3 Combined PAA/UV Disinfection Bench Testing

Data indicated that for combined treatment, the most consistent result and positive results occurred with UV followed by PAA. Based on the analysis of this dataset, a four population mechanistic model to predict both individual and combined disinfection was developed, as described in **Figure 3-5** and Equation 5. In this model, the bacterial population is split into four fractions, each described by a decay coefficient.

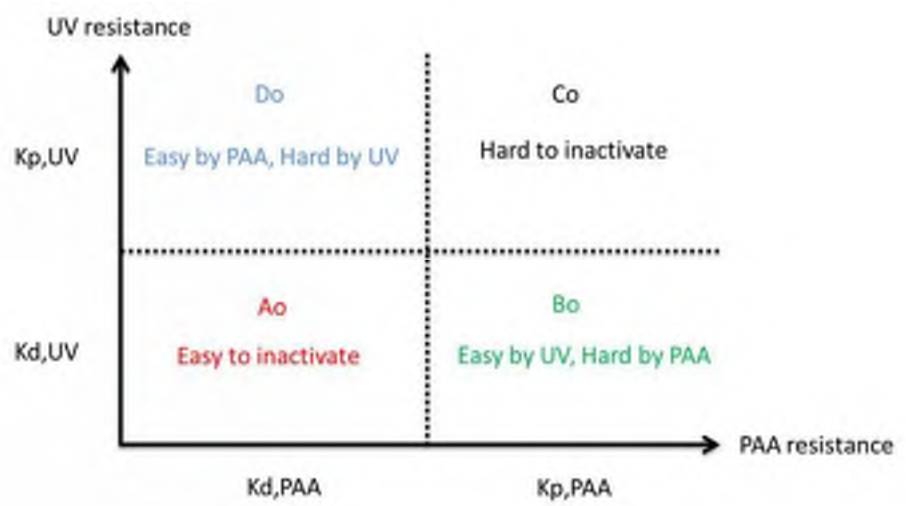


Figure 3-5: Conceptual Description Mechanistic Model to Describe Combined Disinfection

Equation (3-5) $$(N_{total,viable} = A2_{viable} + B2_{viable} + C2_{viable} + D2_{viable}$$

Where:

$N_{total,viable}$ is the total concentration of *E. coli,* after combined disinfection; MPN / 100 mL

$A2_{viable}$ is the concentration of *E. coli* from population A0 after combined disinfection

$B2_{viable}$ is the concentration of *E. coli* from population B0 after combined disinfection

$C2_{viable}$ is the concentration of *E. coli* from population C0 after combined disinfection

$D2_{viable}$ is the concentration of *E. coli* from population D0 after combined disinfection

The model works in two steps. The first step models PAA disinfection (if applicable), and the second set models UV disinfection (if applicable). For example, Equations 6a and 6b are used to calculate the remaining bacteria from the fraction of the population that is easy to kill by both UV and PAA. Similar equations are used to calculate the remaining bacteria from the other populations, and the results are summed to predict the total remaining bacteria in the treated sample.

Equation (6a) $$A_1 = A_o * e^{-k_{d,UV*DOSE}}$$

Equation (6b) $$A_2 = A_1 * e^{-kd,PAA*CT}$$

This model was found to accurately predict both UV alone and PAA alone treatment, as shown in **Figure 3-6**. It was also shown general agreement to data from samples subjected to UV followed by PAA treatment, as shown in **Figure 3-7**.

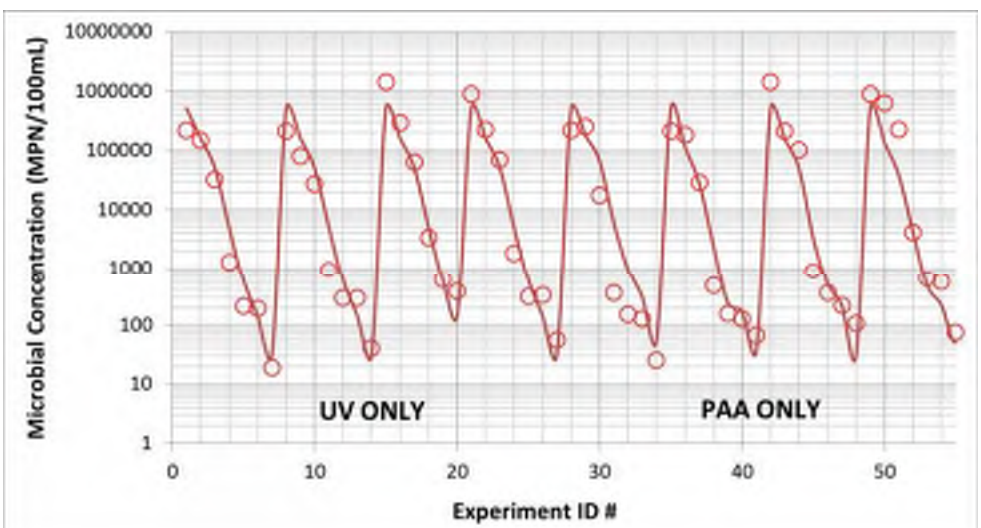


Figure 3-6: Experimental results from inactivation using UV or PAA alone (circles) and predicted values using the mechanistic model.

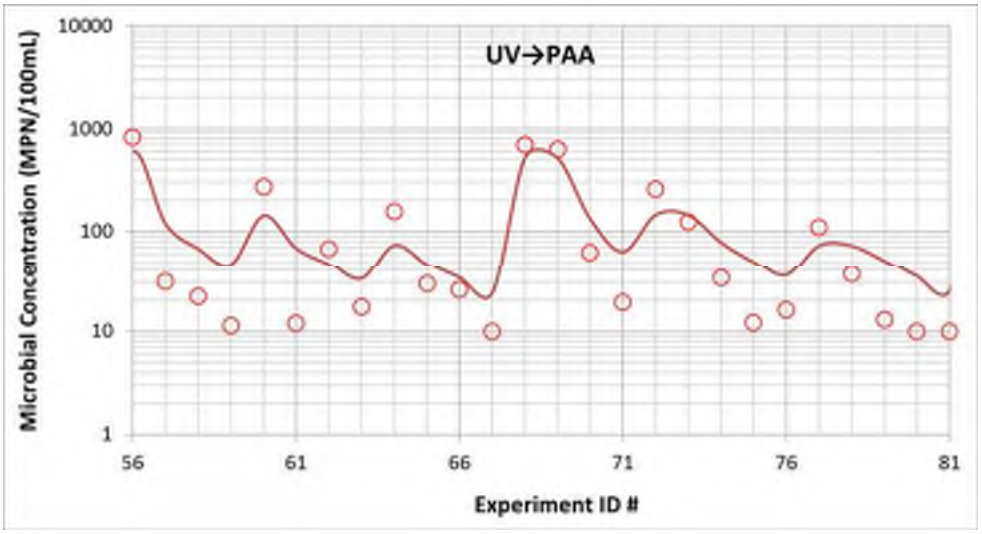


Figure 3-7: Experimental results from inactivation using UV→PAA (circles) and predicted values using mechanistic model.

Based on the mechanistic model, **Figure 3-8** was developed to illustrate the different combinations of UV and PAA that would be required to maintain an effluent concentration of 126 cfu/100 mL of *E. coli*. Although the results are promising, further research is required to accurately describe the effect of combined disinfection, and the economic analysis that was performed based on the results did not indicate significant economic savings through application of a combined disinfection system. The full UV/PAA bench testing report from Trojan Technologies is included as **Appendix A**.

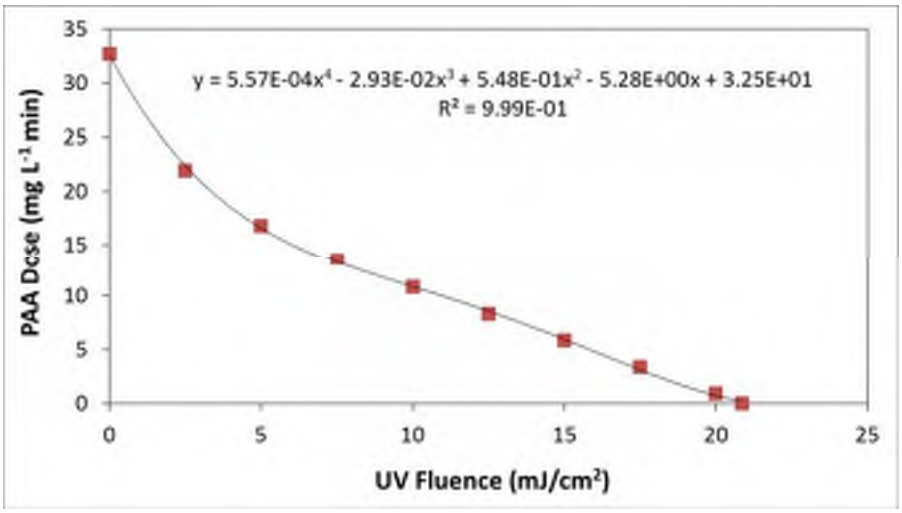


Figure 3-8: Model predicted combinations of PAA dose and UV dose required to achieve a E. coli disinfection target of 126 cfu / 100 mL when applying the sequential UV→PAA treatment process.

Section 4

Conceptual Cost Estimates

The planning level cost estimates developed from the 2013 disinfection alternative testing were revised for the implementation of PAA and UV disinfection systems based on the supplemental pilot results. Costs developed in this preliminary analysis are based on general requirements of each system, including chemical storage requirements, energy costs and auxiliary equipment. These estimates rely on the use of previous estimates and historical data from comparable work, estimating guides, handbooks and costing curves, and are intended for planning purposes and comparing alternatives. For that reason, subtotaled and totaled costs have been rounded to two significant figures. Costs are provided in current (2016) dollars without escalation. The actual cost of any project will depend on actual labor and material costs for competitive bids, project complexity, competitive market condition, actual site conditions, final scope of work, implementation schedule, continuity of personnel and engineering.

It is important to note that in all cases, conservative assumptions regarding equipment redundancy including EPA Class I Reliability guidelines were applied to each system. With more detailed engineering information, the equipment costs and associated contingencies could be reduced. Lifecycle costs were calculated using the following assumptions: project life of 20 years, 4.13 percent interest rate, 3.00 percent inflation rate, and 2.00 percent electric escalation rate above the base inflation rate. The electrical cost rate was estimated at $0.076 per kWh. Maintenance labor costs were estimated at a fully loaded labor rate of $40.00 per hour. The cost of PAA was estimated to be $0.60/lb (delivered).

4.1 UV

The cost of a UV system designed for 35% UVT was estimated during the analysis prepared in 2013, but it is unlikely that it would be adequate based on current water quality conditions, even with improvements made to the secondary treatment process. Therefore, a new cost estimate for a larger UV system designed for 20% UVT was developed with Trojan Technologies. The UV system capital and lifecycle cost breakdown is included in **Appendix C**.

4.2 PAA

4.2.1 PAA Description as Basis of Cost

The PAA disinfection system includes a new contact tank. It is recommended to house chemical feed systems in a protected environment and it has been assumed that a new chemical feed building would be provided. Chemical storage will be provided in tanks located outdoors with appropriate secondary containment; planning level costs have assumed that the storage time for PAA is 14 days. The chemical feed building will be constructed from durable materials that can be easily maintained and will be consistent with the architectural finishes already onsite. This design will meet the hazardous building type criteria for the type and quantity of materials to be stored and the hazardous building type will be designed to meet the required local codes. Personal

safety equipment, emergency showers/eye washes and other necessary equipment will be provided.

A new chemical feed building will be constructed which will contain an electrical room and a mechanical room to house the tepid water skid. The containment areas for chemical feed equipment in the building will be coated to protect the concrete against accidental chemical spills.

A new control system will be put in place to monitor and control the PAA which includes online instrumentation for PAA residual analysis. Signals from the online analyzers will be used to provide automatic control for the PAA and sodium bisulfite feed (if required). All Input/Output (I/O) signals from the disinfection system will be hardwired to a PLC located at the chemical feed building. Additional coordination will be required with the plant staff to provide that the proposed system can be integrated into the existing plant process control system. It is recommended that the City utilize a lease agreement with a PAA supplier, similar to what is being done at the M.C. Stiles WWTP. In this arrangement, the supplier will provide the storage and day tanks, truck unloading and transfer pumps, PAA mixing equipment, on-line PAA analyzers, PAA metering pump skids and all control panels for the entire system.

4.2.2 PAA System Sizing

Required PAA CT was calculated based on three disinfection set points which were determined based on a combined dataset including data measured during the pilot study, data measured during the collimated beam analyses, and data from daily plant operations between 2010 and 2013. Relevant statistic are shown in **Table 4-1**.

Table 4-1 Relevant Influent E. coli Statistics

Statistic	Value
Maximum	5700000
Minimum	13333
Geometric Mean	518730
10 Percentile	152000
20 Percentile	240000
30 Percentile	330778
40 Percentile	455778
50 Percentile	560000
60 Percentile	727000
70 Percentile	926000
80 Percentile	1280000
90 Percentile	1600000

For peak conditions, bacterial concentrations will be reduced from the 90th percentile from the dataset to one half of the daily permit limit of 487 cfu/100 mL. This is equal to a log inactivation of 3.82. For average conditions, the bacterial concentrations will be reduced from the geometric mean from the dataset to one half of the monthly permit limit of 126 cfu/100 mL. This is equal to a log inactivation of 3.92. For minimum conditions, bacterial concentrations will be reduced from the 10th percentile from the dataset to one half of the daily permit limit of 487 cfu/100 mL. This is

equal to a log inactivation of 2.80. The model predicted CT values for these set points are summarized in **Table 4-2**. For conservatism, a safety factor of 1.3 is applied to the CT values for design. This is shown in the CT* column.

Table 4-2 Disinfection Set Points.

Set Point	LI	CT	CT*
Average Conditions	3.92	67	87.1
Peak Conditions	3.82	57	74.1
Minimum Conditions	2.81	17.2	22.4

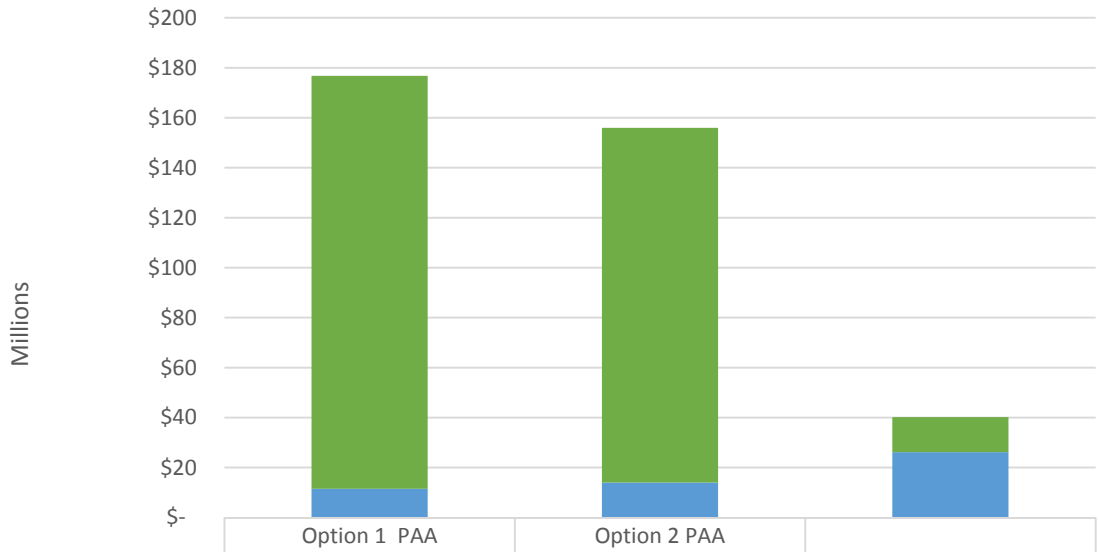
A given CT can be achieved using many combinations of PAA dose and contact time. Lifecycle costs for a PAA system are a function of the contact time at peak flow. The peak flow contact time controls the PAA dose and sodium bisulfite dose (annual costs) at all three design points and the size of the contact tank (capital costs).

Option 1 for the PAA system is based upon a contact tank size in which the contact time at average flow is 30 minutes (16 minutes at peak flow), which is the state mandated minimum. In Option1, a greater PAA dose is required, necessitating a constant sodium bisulfite dose in order to reduce the PAA concentration below the 1.5 mg/L project threshold. This condition was compared to the lifecycle cost for a PAA system in which the contact tank size was optimized to produce the lowest lifecycle cost for a PAA system. The lowest PAA system lifecycle cost occurred when the contact time in the contact tank at peak flow was 31 minutes. At this condition, sodium bisulfite (SBS) is not required. This condition is represented at Option 2. The PAA lifecycle costs are provided in **Appendix C**.

4.3 Cost Summary

Based upon the supplemental testing performed in 2015, the conceptual costs for UV and PAA were revised. Comparative 20 year lifecycle costs for three alternative disinfection systems are illustrated in **Figure 4-1**. The first alternative is a PAA system with a contact tank providing 31 minutes of contact time at average flow, the second is a PAA system providing 31 minutes of contact team at peak flow, and the third is a UV system designed to treat effluent with a 20% UVT. The lifecycle cost estimate performed represents just the disinfection systems and not the rest of the upgrades for the project.

Providing more contact time at average flow for the PAA system eliminated the need for quenching with sodium bisulfite, although the capital costs for a small sodium bisulfite was included for emergency use. Although the lifecycle costs of the UV alternative is lower than that of the two PAA alternatives, the City of Memphis and CDM Smith discussed the impacts caused by the variability of the low UV transmittance seen in the Maxson WWTP effluent. The variability likely stems from the change in processes and raw materials utilized by industrial users within the City's collection system. Based upon these discussions it was decided to eliminate UV from the list of disinfection alternatives. Results of the detailed cost analysis and the supplemental pilot data indicate that the most cost effective contact tank size to reduce overall lifecycle cost is 489,000 cubic ft. As a result, the most cost effective disinfection alternative is PAA - Option 2.



	Option 1 PAA 253,000 cubic ft	Option 2 PAA 489,000 cubic ft	20% UVT Design UV System
Total Annual Cost	$165,300,000	$142,000,000	$14,000,000
Total Capital Cost	$11,500,000	$14,000,000	$26,200,000
Lifecycle Costs	$177,000,000	$156,000,000	$40,000,000

Figure 4-1: Comparative 20 Year Lifecycle Costs

Section 5

Recommendations

Based upon the analysis of the supplemental pilot and bench test results, CDM Smith recommends that PAA be selected as the disinfectant to be utilized at the Maxson WWTP. This recommendation is predicated upon the elimination of UV disinfection because of the influent water quality uncertainty. An economic analysis of combined UV/PAA treatment, based on the additional bench testing, determined that it is not cost effective at this time. Based on the lifecycle analysis of the two PAA options evaluated, it was determined that a 489,000 cubic foot tank providing 31 minutes of contact time at peak flow was the most cost effective design (Option 2) and CDM Smith recommends that the City of Memphis proceed with this design. The associated PAA doses for each disinfection set point are shown in **Table 5-1**. The design elements for this system are described in the conceptual design report (CDR).

Table 5-1 Required PAA Doses to Achieve Disinfection Set Points

	Design CT	Flow	Contact Time	Dose
	mg/L*min	MGD	min	mg/L
Peak Conditions	74.10	170	31	8.36
Average Conditions	87.10	90	59	6.73
Minimum Conditions	22.36	50	105	4.50

Appendix A

Evaluating UV and PAA disinfection strategies for T.E. Maxson Wastewater Treatment Plant

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Evaluating UV and PAA disinfection strategies for T.E. Maxson Wastewater Treatment Plant

Final version – January 21, 2016

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1 DISCLAIMER

This report provides a description of experimental work performed by Trojan Technologies on the disinfection of *E. coli* in secondary settled wastewater obtained from the T.E. Maxson Wastewater Treatment Plant (WWTP) in the City of Memphis (City), Tennessee. It also provides an analysis of data collected from bench-testing of UV and PAA, individually and in combination. While disinfection system sizing and economic evaluations are performed and presented in this report, they do not constitute Trojan's final recommendation on disinfection system sizing and costs.

2 CONFIDENTIALITY

The data, methodologies, data analyses concepts, and discussions are property of Trojan Technologies and should be treated with confidentiality as stipulated by existing Non-Disclosure Agreements between Trojan Technologies and CDM Smith.

3 INTRODUCTION

The Maxson WWTP is located in the southwestern portion of Memphis, Tennessee at 2685 Steam Plant Road. The facility, over the last five years, has treated an average of 72 million gallons per day (MGD) but is currently treating an average of just less than 70 MGD, due to the closing of the Cargill wet corn milling facility. The Maxson WWTP has served the City since its commissioning in 1975. The current liquid treatment process consists of coarse bar screens, grit removal, recently installed fine bar screens, primary clarification, high-rate biotowers, activated sludge and secondary clarification. Biosolids treatment consists of anaerobic digestion and dewatering with the final disposition of solids being land application and a surface disposal site as shown in Figure 1.

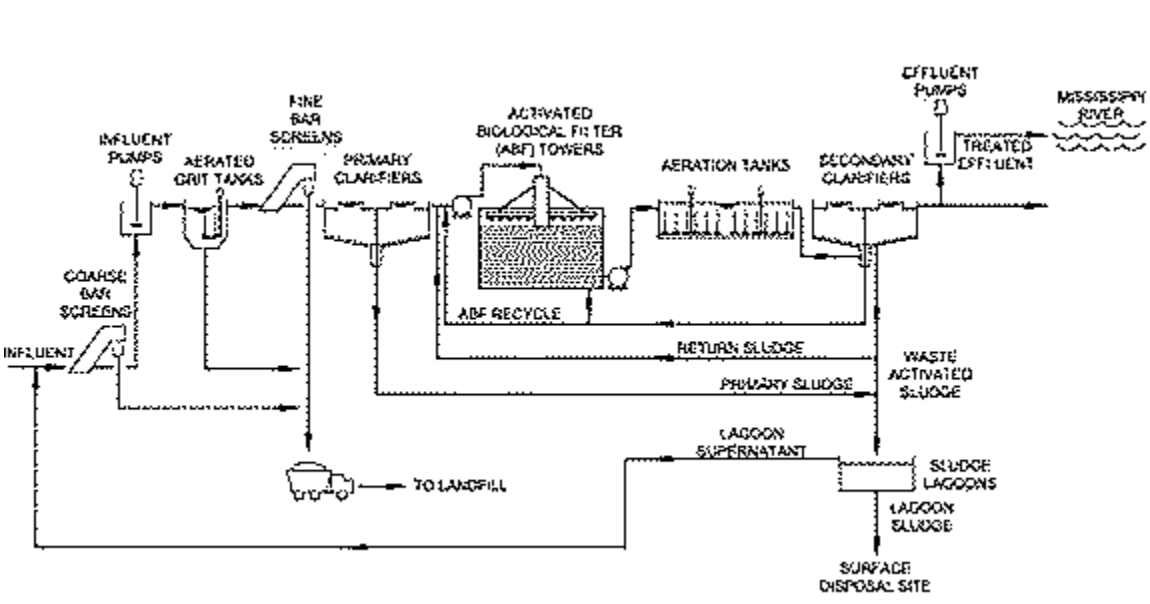

Figure 1: Process flow diagram for the Maxson WWTP.

The facility is currently evaluating the plant processes to determine what changes will be required to meet discharge permit requirements at the design flow of 90 MGD. Proposed changes include expanding the activated sludge process and removing the high-rate biotowers from the flow treatment stream. In addition, the City is planning to provide a new disinfection process. The two methods of disinfection being evaluated are ultraviolet irradiation (UV) and chemical oxidation using peracetic acid (PAA).

UV disinfection is employed throughout the drinking and wastewater treatment industry due to its efficacy for inactivating human pathogens, as well as providing a relatively low lifecycle cost in a small footprint. Inactivation of a pathogen or indicator microorganism occurs when photons of UV light are absorbed and cause damage to an organism's deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), preventing reproduction.

Peroxyacids are a class of chemical disinfectants gaining attention due to the high efficacy at inactivating organisms, low undesirable byproduct formation, and rapid decay in the environment. Peracetic acid is a strong oxidant with a biocidal mode of action via cell membrane damage. Hydroxyl radicals (·OH) and reactive oxygen species released during decomposition reactions are believed to be secondary modes of action (Lubello et al., 2002). Peroxyacids, such as PAA, may also play a role in the disruption of the chemisomotic function of the lipoprotein cyctoplasmic membrane (Santoro et al., 2007, Baldry et al., 1989, Leaper, 1984).

Researchers have reported on the potential benefits of combining of UV and PAA to enhance the disinfection of municipal wastewater (Rajala-Mustonen et al. 1997, Caretti & Lubello 2003, Lubello et al. 2004, Heinonen-Tanksi 2005, Koivunen & Martin & Gehr 2007, Budde & Vineyard 2010, Gonzalez et al. 2012, Block & Tran 2015). However, the exact mechanism for this enhancement is not clear, and there is no general consensus on the mechanisms of disinfection that govern the application of a combined UV and PAA process. It is generally reported that the addition of PAA prior to UV irradiation increases inactivation through an advanced oxidation process (AOP), resulting from the photolysis of the O–O bond in the PAA molecule, generating a hydroxyl radical (·OH) (Caretti and Lubello 2003, Lubello et al. 2002). While investigating the combination of UV and PAA, Lubello et al. (2002) found a PAA concentration between 2 and 8 mg/L or a UV fluence of 120 to 300 mJ/cm^2 were unable to reach the target disinfection levels; however, when a PAA concentration of 2 mg/L was applied immediately before a UV fluence of 192 mJ/cm^2, over 4-log inactivation of total coliform was achieved. However, Gonzalez et al. (2012) reported that when peracetic acid and ultraviolet irradiation were combined, at a low UV fluence (13 mJ/cm^2), there was no synergistic benefit observed, when PAA was added either before or after UV irradiation.

There are other possible synergies between PAA and UV that have not yet been investigated. The addition of PAA to wastewater may increase the UVT% (percent UV transmittance) through oxidation of organic compounds. This would decrease the required UV fluence to reach a target log inactivation of bacteria. PAA may also reduce the concentration of solids which may shield bacteria from UV irradiation. The obvious non-synergistic effect of PAA addition prior to UV is that the bacterial load entering the UV system is reduced. However, none of these effects have been quantified. There is still considerable ambiguity in the current understanding of the mechanisms of UV and PAA treatments.

In this study, the sequential and simultaneous use of UV and PAA disinfectants was investigated. The effluent at the Maxson WWTP is anticipated to be a good candidate for this combination treatment because of its low UVT, high initial *Escherichia coli* (*E. coli*) concentrations (10^5 – 10^6 most probable number (MPN)/100 mL), and high and variable PAA demand and decay. The use of these two processes together may lead to substantial savings by leveraging two disinfection mechanisms (DNA-based for UV and cell membrane-based for PAA) that may also have synergistic effects.

4 MATERIALS AND METHODS

To investigate the feasibility and economics of implementing a combined disinfection technology strategy, bench testing was conducted to inform process selection and sizing. Samples of secondary effluent were collected twice daily (7:00 and 13:00) immediately prior to the discharge from the plant and were treated at bench-scale, on site. Different operational scenarios were evaluated including the following five combinations: PAA alone, UV alone, PAA followed by UV, UV followed by PAA, and simultaneous UV and PAA.

4.1 Analytical Methods

Table 1 provides a summary of the parameters measures and analytical methods employed for the bench-scale treatability study.

Table 1: Summary of analytical methods used.

Parameter	Analytical Method	Instrument
TSS	Standard Method 2504	n/a
COD	Standard Method 5220	n/a
UVT	Standard Method 5910	Hach DR500 at 254 nm
Color	Standard Method 2120	Hach DR500 at 455 nm
BOD5	Standard Method 5210	n/a
PAA concentration	DPD method	CHEMetrics vacu-vials and Single-Analyte-Photometer
E. coli concentration	Standard Method 9223	IDEXX Colisure*

*Although the discharge permit specifies bacterial concentration in colony forming unit (cfu), the EPA approved IDEXX Colisure method, which measures bacterial concentration in most probable number (MPN) was used in the study.

4.2 Bench Test Protocols

In this study, secondary effluent samples were collected and treated with PAA to achieve residual concentration*contact time (CTs) of 2.5 – 50 mg·min/L. PAA tests were conducted in clean glass beakers (500 or 2000 mL), and mixed continuously using a magnetic stirrer (600 rpm). Measurements of PAA residuals were collected over time, and *E. coli* samples were collected following PAA quenching using sodium bisulfite. The four samples collected between September 22 – 24 were each treated with PAA (C_O = 5.0 mg/L) in order to estimate the demand/decay for each sample. These results were then used to estimate the contact times needed to achieve CT doses ranging from 2.5 – 50 mg·min/L for each sample. The demand/decay kinetic parameters were recalculated using the experimental results from each inactivation experiment.

UV testing was conducted using a collimated beam (CB) apparatus, illustrated in Figure 2. UV irradiation was measured using an International Light Technologies (ILT) ILT1700 radiometer with a UV detector calibrated at 253.7 nm (monochromatic output of low-pressure mercury amalgam lamp). Samples were irradiated in order to achieve UV fluences of 2.5, 5, 10, 15, 20 and 40 mJ/cm^2. Calculations of the fluence were based on standardized method for fluence determination presented by Bolton & Linden (2003).

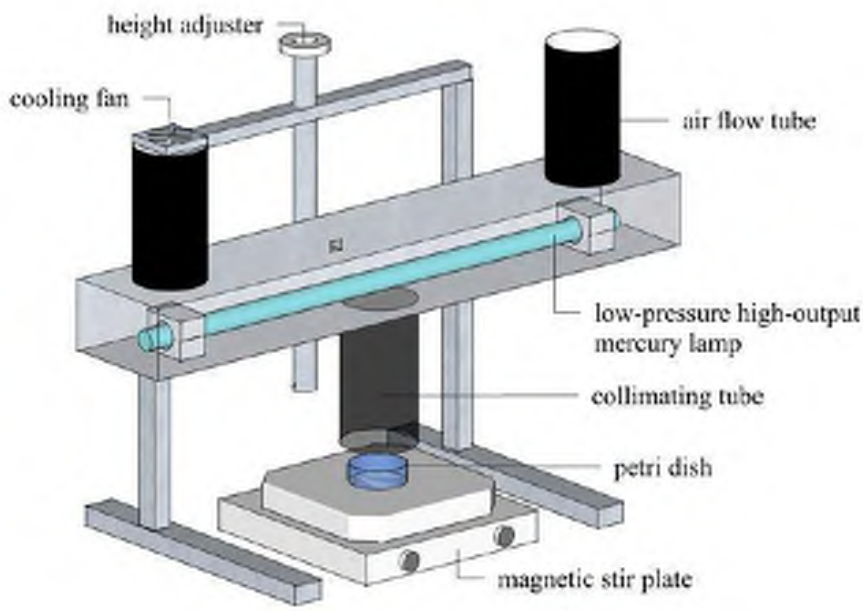

Figure 2: Collimated beam apparatus employed for bench-scale UV testing.

For the UV+PAA experiment, effluent was first irradiated to UV fluences of 10, 15 or 20 mJ/cm^2, then dosed with PAA as described above. For the PAA+UV experiment, effluent was first dosed with PAA as described above. After set durations, portions of the sample were removed, PAA quenched with sodium bisulfite, and then subjected to UV fluences of 10, 15 or 20 mJ/cm^2. For the simultaneous

PAA+UV experiment, two different scenarios were investigated. The first involved dosing PAA at the onset of UV irradiation, irradiating for a set duration, and then removing the sample from UV exposure and continuing to stir until a desired PAA contact time was achieved. The second scenario involved first dosing PAA and allowing it to stir for a period prior to subjecting it to UV irradiation.

The full test plan and experimental matrix is included in Appendix A.

4.3 Data Analyses

4.3.1 PAA Decomposition Kinetics

PAA residuals were fitted to a demand/decay curve using Equation 1. The PAA CT (mg·min/L) was determined by integrating the area under the demand/decay curve and is calculated using Equation 2. An example is shown in Figure 3.

$$C = (C_0 - D)e^{-kt} \qquad \text{[Equation 1]}$$

Where,

C is the concentration of PAA (mg/L) at time t (min)

C_0 is initial concentration of PAA (mg/L)

D is the instantaneous demand of PAA (mg/L)

k is the decay rate constant of PAA (1/min)

t is the contact time (min)

$$CT = \frac{C_0 - D}{k}(1 - e^{-kt}) \qquad \text{[Equation 2]}$$

Where,

CT is the integral PAA dose (concentration * contact time); mg·min/L (Santoro et al., 2015)

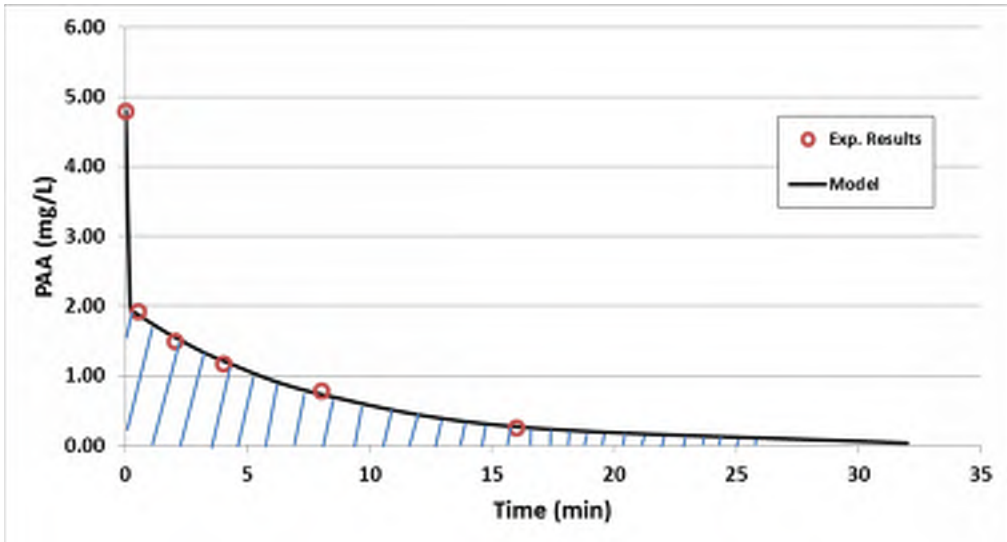

Figure 3: PAA demand/decay curve (black) generated from experimental data using Equation 1. The PAA CT (mg·min/L) is represented as the area under the curve (blue hatchmarks), and is calculated using Equation 2.

4.3.2 PAA and UV Disinfection Kinetics

The models that are used for disinfection for PAA and UV disinfection when used individually are well known such as the Chick-Watson model and the Hom's model. PAA disinfection can be evaluated as a function of residual and contact time. The disinfection kinetics of microorganisms is conventionally modelled by relating the extent of inactivation of the microorganisms to the products of the disinfectant dose and the contact time. For the PAA process the product of dose and contact time is the defined as the CT (mg·min/L) while for UV the product of dose and contact time is the UV fluence (mW*sec/cm^2). That said, there is no published model for evaluating a combined PAA and UV disinfection process and the development of such a model is provided herein.

To develop an disinfection kinetic model, the concentration of viable for *E. coli* can be plotted against either PAA – CT dose or UV fluence and the data fitted using the double exponential inactivation model, described in Equation 3.

$$N = N_d e^{-k_d DOSE^m} + N_p e^{-k_p DOSE} \qquad \text{[Equation 3]}$$

Where,

N is the total concentration of viable *E. coli*; MPN / 100 mL

N_d is the concentration of particle-associated *E. coli*; MPN / 100 mL

N_p is the concentration of dispersed *E. coli*; MPN / 100 mL

k_d is the first order inactivation rate constant for particle-associated *E. coli;* for PAA = L/ mg·min, for UV = cm^2/mJ

k_p is the first order inactivation rate constant for dispersed *E. coli*; for PAA = L/ mg·min, for UV = cm^2/mJ

m is an inactivation kinetic model parameter describing shoulder effects (m = 1 for with UV doses)

DOSE is the dose; for PAA = mg·min/L, for UV = mJ/cm^2

5 RESULTS AND DISCUSSION

The results and discussion are presented in below in five sections: (1) water quality testing (Section 5.1), (2) PAA disinfection testing (Section 5.2), (3) UV disinfection testing (Section 5.3), (4) combined UV and PAA disinfection testing, and (5) modelling the disinfection kinetics of the sequential UV→PAA process. Each section presented results from the experiments conducted as well as sizing calculations for the UV and PAA disinfection processes to meet the plant's disinfection targets.

5.1 General Water Quality

Each of the four samples collected over the 2 day period was analyzed for UVT, color, TSS, COD and BOD. The results of these tests are summarized in Table 2. The water quality was fairly consistent among the samples and was not affected by the flow rate in the plant.

Table 2: Maxson secondary effluent water quality.

Sample ID	Plant Flow (mgd)	UVT (%)	Color (PtCo)	TSS (mg/L)	COD (mg/L)	BOD (mg/L)
Sept. 22 – AM	60.6	19.5	175	16	115	20
Sept. 22 – PM	56.7	20.8	160	14	111	16
Sept. 24 – AM	62.5	20.2	188	16	114	20
Sept. 24 – PM	109.5	20.1	169	17	109	16

5.2 PAA Disinfection Tests

There are several different commercial formulations of PAA available, with differing concentrations of PAA and hydrogen peroxide. For this study, a 22 wt% solution of PAA was used for testing. To provide that this formulation of PAA would be suitable for use, it was compared with a 15 wt% PAA formula, which has been previously investigated at the Maxson WWTP. The demand/decay kinetics, as well as microbial inactivation were investigated, and the results are summarized in Table 3 and Figure 4.

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Table 3: PAA demand/decay (D, *k*) for 15 wt% and 22 wt% PAA solutions.

Sample ID	Demand (D, mg/L)	Decay (*k*, 1/min)
PAA 15 wt%	2.81	0.125
PAA 22 wt%	2.55	0.096

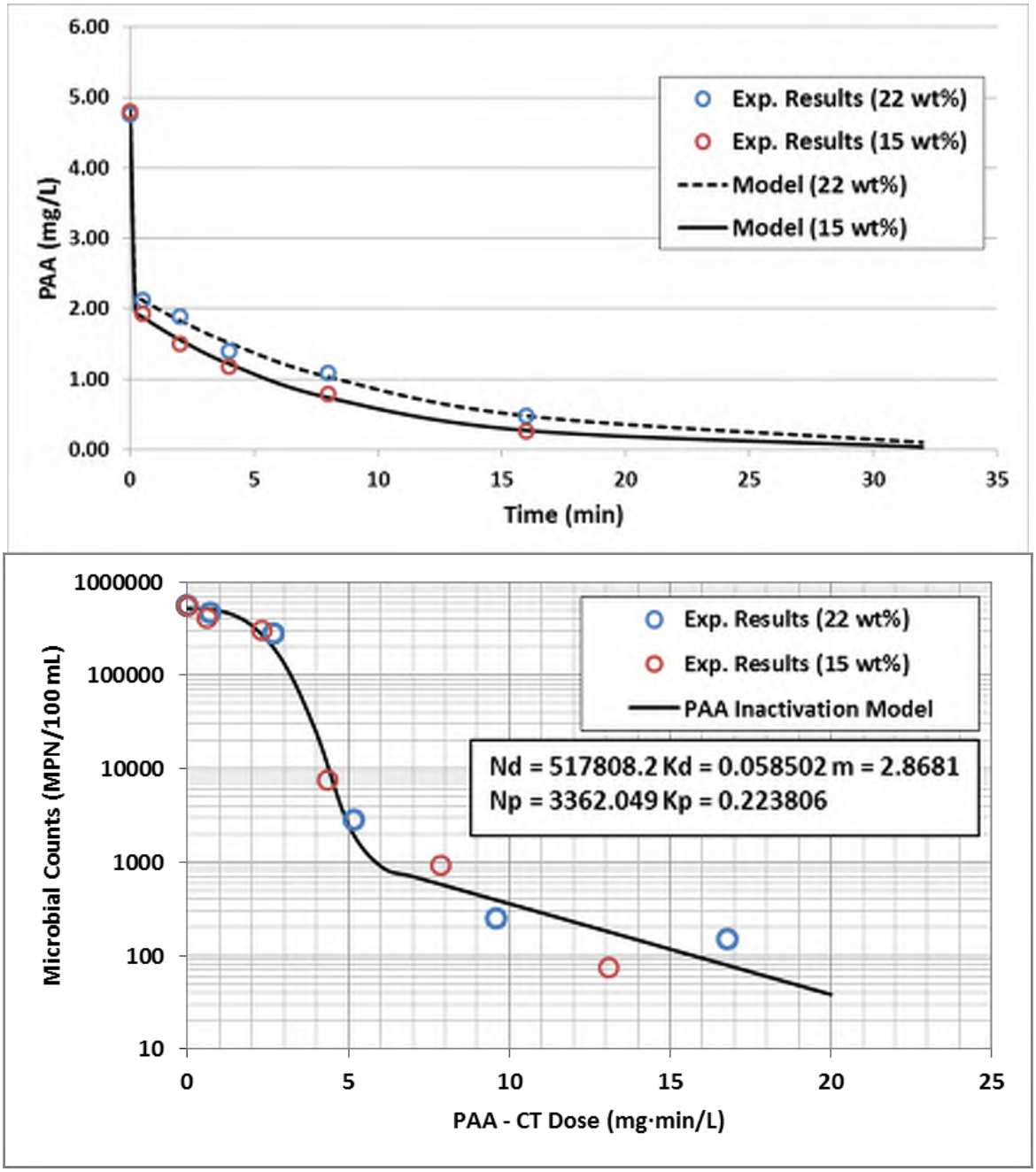

Figure 4: PAA demand/decay for 22% and 15% PAA solutions added to Maxson SE at C_O = 5 mg/L (Top) Data modeled (black lines) from experimental results using Equation 1. Microbial inactivation of Maxson SE treated with 22% and 15% PAA solutions at a C_O = 5 mg/L (Bottom).

There was minimal difference in the demand/decay kinetics when using either 22% or 15% PAA solutions. There was a slightly higher initial demand and decay using the 15% PAA solution, however the difference was minimal. Both the 22% and 15% PAA solutions displayed the same microbial inactivation kinetics, as microbial inactivation plotted against CT dose show the two inactivation curves essentially overlap.

Four samples collected between September 22 – 24 were each treated with PAA in order to achieve CT doses ranged from 2.5 – 50 mg·min/L. The PAA demand/decay results are summarized in Table 4 and Figure 5. Samples collected in the morning had higher PAA demand (ca. 3.5 mg/L) than samples collected in the afternoon (ca. 2.75 mg/L). This is line with the slightly higher BOD_5 measured in those samples. All samples had similar decay rates (ca. 0.060 1/min)..

Table 4: PAA demand/decay parameters (D, *k*) for PAA only disinfection.

Sample ID	Demand (D, mg/L)	Decay (*k*, 1/min)
Sept. 22 – AM	3.58	0.063
Sept. 22 – PM	2.60	0.057
Sept. 24 – AM	3.50	0.056
Sept. 24 – PM	2.91	0.058

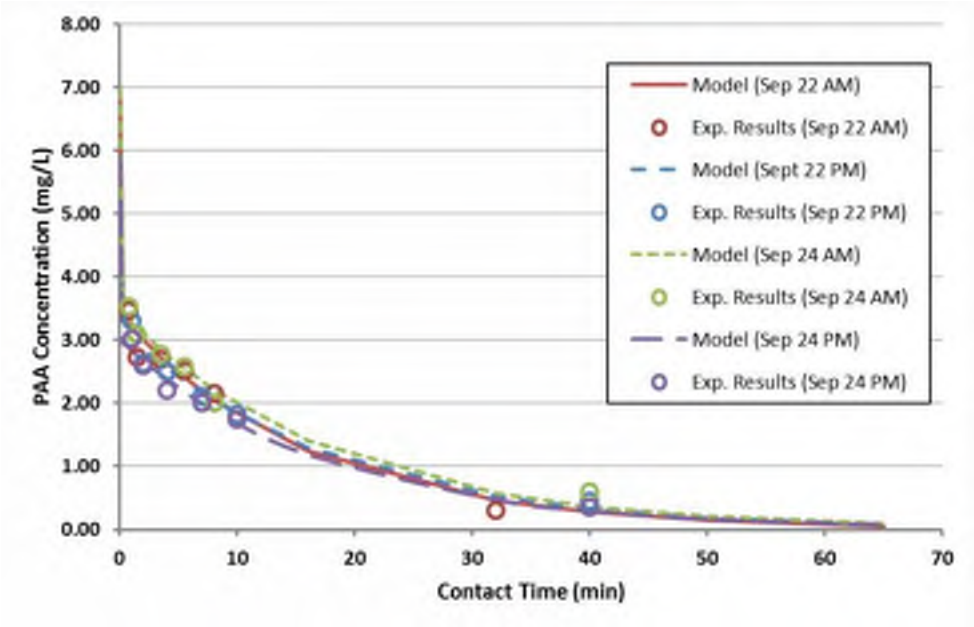

Figure5: PAA demand/decay model plots for Samples collected Sept 22 and Sept 24 (model curves generated from experimental results using Equation 1).

The *E. coli* inactivation kinetics by PAA was calculated for each sample by plotting the viable concentration of *E. coli* on a log scale (y-axis) against the PAA – CT dose (x-axis), and is shown in Figure 6. Two different models were generated from the data. The first inactivation curve (Figure 6 - top) was generated from the all data collected during September 2015. This model was used to predict the CT dose required to meet the plant's disinfection target of 63 MPN / 100 mL (half the 30-day geomean disinfection permit of 126 MPN / 100 mL); CT = 49.2 mg·min/L. The second curve (Figure 6 – bottom) was generated using only samples in which the least amount of inactivation was observed per CT dose. In other words, by selecting data corresponding to the maximum MPN at each CT dose applied, a plot of the most challenging inactivation conditions could be generated. This data was then used to estimate the plant's disinfection target of 244 MPN / 100 mL (half the daily maximum disinfection permit of 487 MPN / 100 mL); CT = 36.0 mg·min/L. Based on these results, it is recommended that a PAA CT dose of ≥ 49.2 mg·min/L be applied in order to meet the plant's disinfection targets.

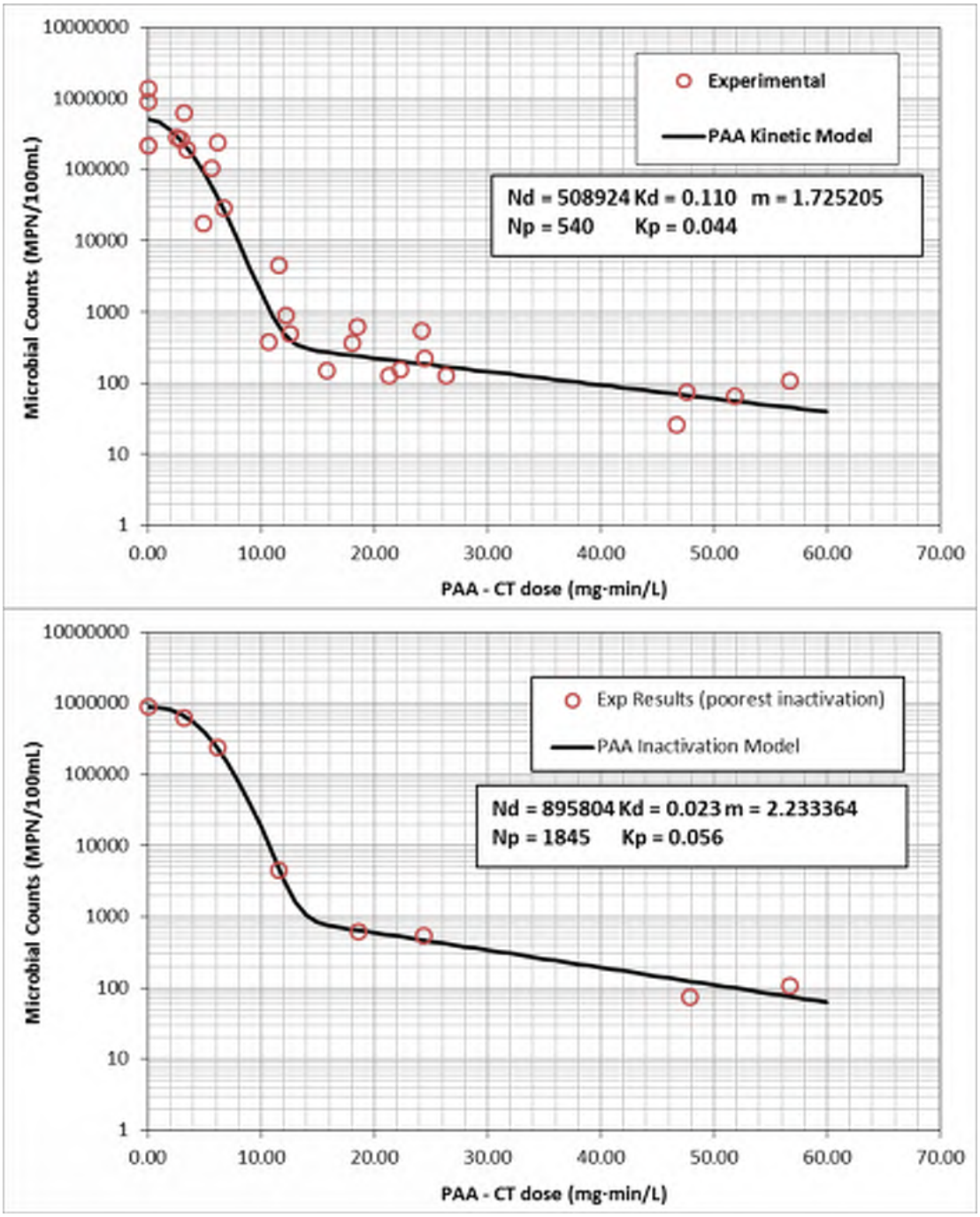

Figure 6: The inactivation of *E. coli* using PAA for Maxson SE samples collected Sept. 22 and Sept. 24 (Top). Inactivation curve for poorest inactivation levels measured on Sept. 22 and Sept. 24 (Bottom).

5.3 UV Disinfection Tests

Collimated beam tests were performed to determine the inactivation of *E. coli* by UV irradiation and to determine the UV fluence for sizing a UV system. Over the last 3 years, Trojan has performed 22 collimated beam tests on multiple samples obtained from the Maxson facility. Water quality ranges from 7 - 34% UVT and 14 - 113 mg/L TSS. To provide a robust and representative sizing of the UV disinfection system, all data from the 22 collimated beams tests have been considered in this analysis.

Figure 7 illustrates data from all the UV collimated beam tests (left) and data representing the poorest inactivation rates (right). Using data in Figure 7 - top, a minimum UV fluence of 20.1 mJ/cm^2 was required to achieve a target of 63 MPN / 100 mL (half the 30-day geomean disinfection permit of 126 MPN / 100 mL). The second curve (Figure 7 – bottom) was generated using only samples in which the least amount of inactivation was observed per UV fluence delivered. In other words, the data was segregated by selecting the maximum MPN at each UV fluence applied thereby providing a plot of the most challenging inactivation conditions. This data was then used to calculate that a minimum UV fluence of 19.2 mJ/cm^2 was required to achieve a target of 244 MPN / 100 mL (half the daily maximum disinfection permit of 487 MPN / 100 mL).

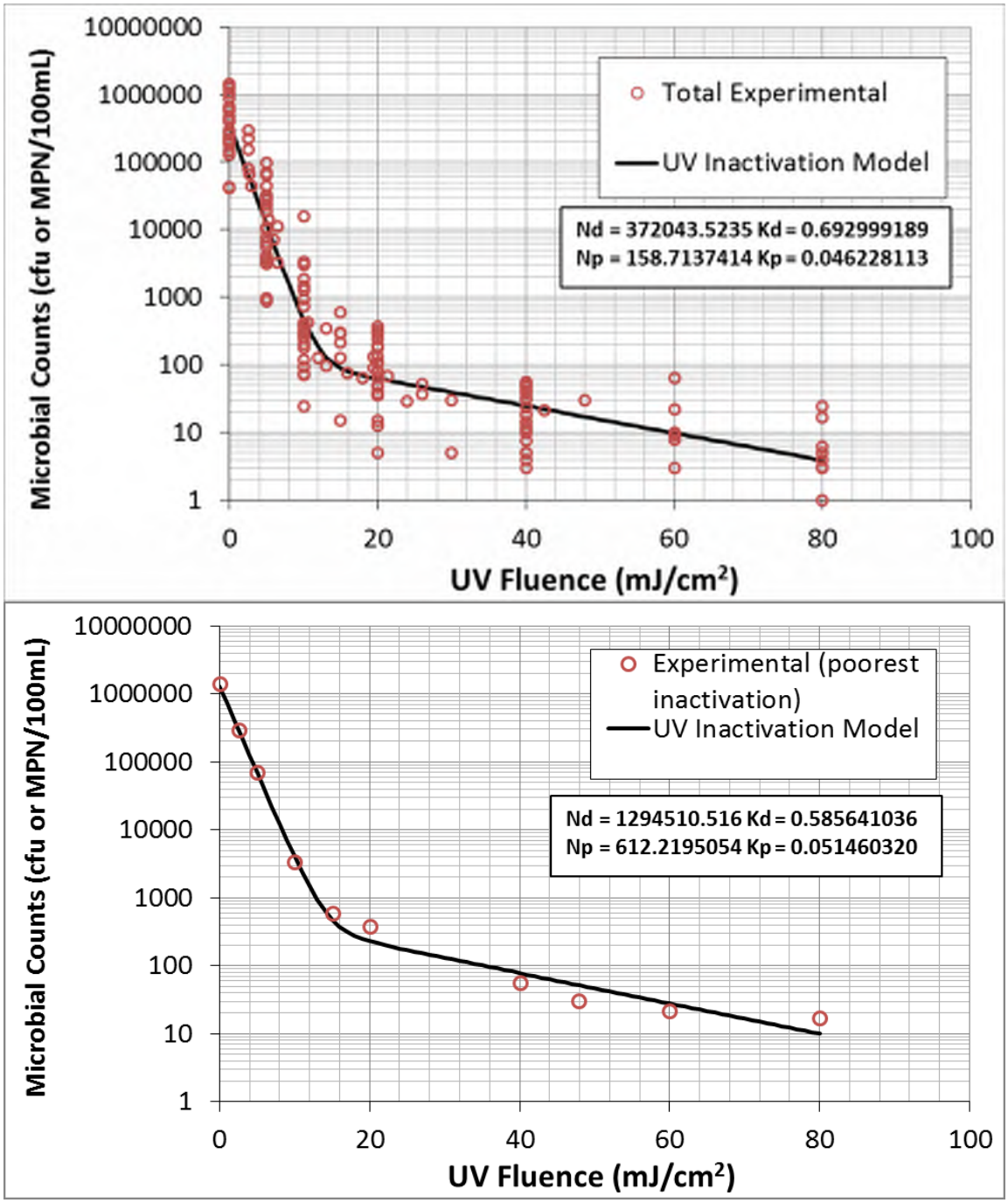

Figure 7: Inactivation of *E. coli* using UV for Maxson SE samples collected 2013 and 2015. Inactivation curves for all data points (top) and poorest inactivation levels (bottom).

5.4 Combined UV and PAA Disinfection Tests

Three distinct scenarios were performed with respect to testing the combined UV and PAA disinfection processes: UV prior to PAA (UV→PAA), PAA prior to UV (PAA→UV), simultaneous UV and PAA (UV+PAA). For the UV→PAA tests, UV fluences of 10, 15, and 20 mJ/cm^2 were applied prior to PAA addition, and PAA CTs ranged from 5-25 mg·min/L. Figures 8 – 10 illustrates the results for viable *E. coli* as a function of PAA CT exposure with different levels of UV fluence applied, prior to PAA treatment.

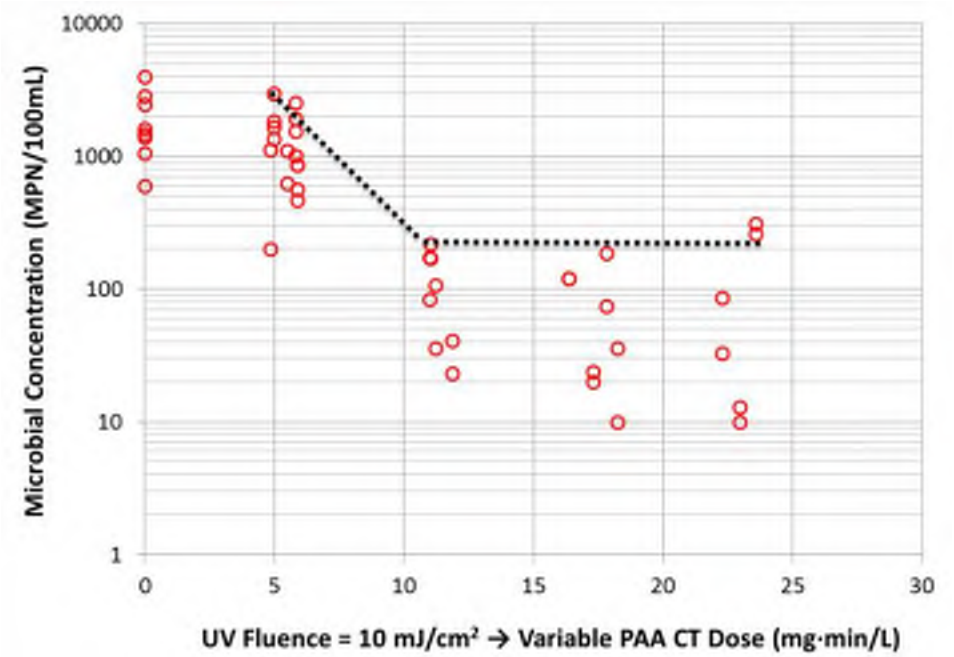

Figure 8: Inactivation of *E. coli* for UV→PAA treatment scenario where PAA treatment is preceded by a UV fluence of 10 mJ/cm^2. Dotted lines are illustrative to show general trend.

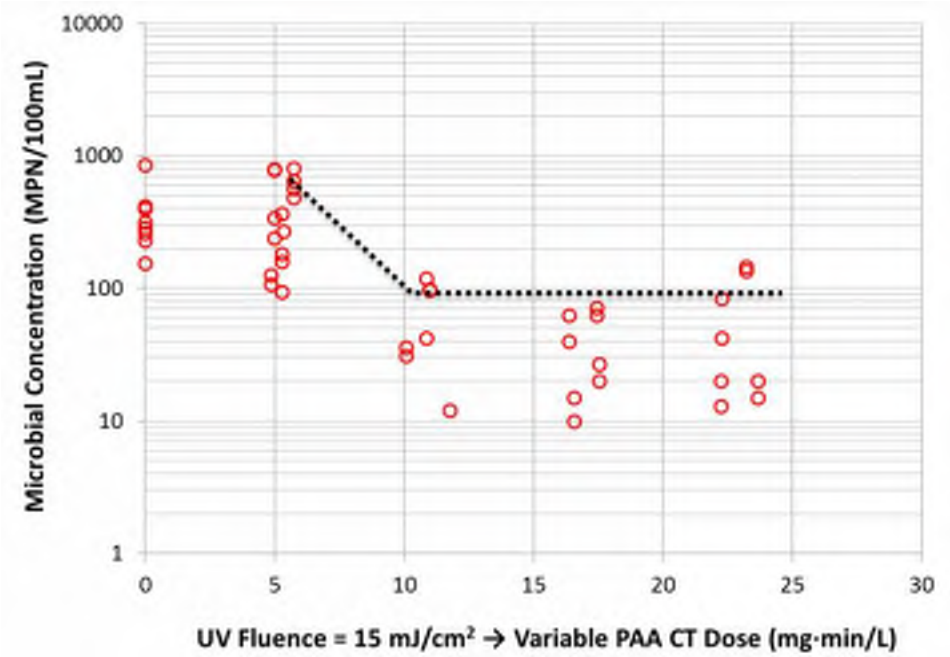

Figure 9: Inactivation of *E. coli* for UV→PAA treatment scenario where PAA treatment is preceded by a UV fluence of 15 mJ/cm^2. Dotted lines are illustrative to show general trend.

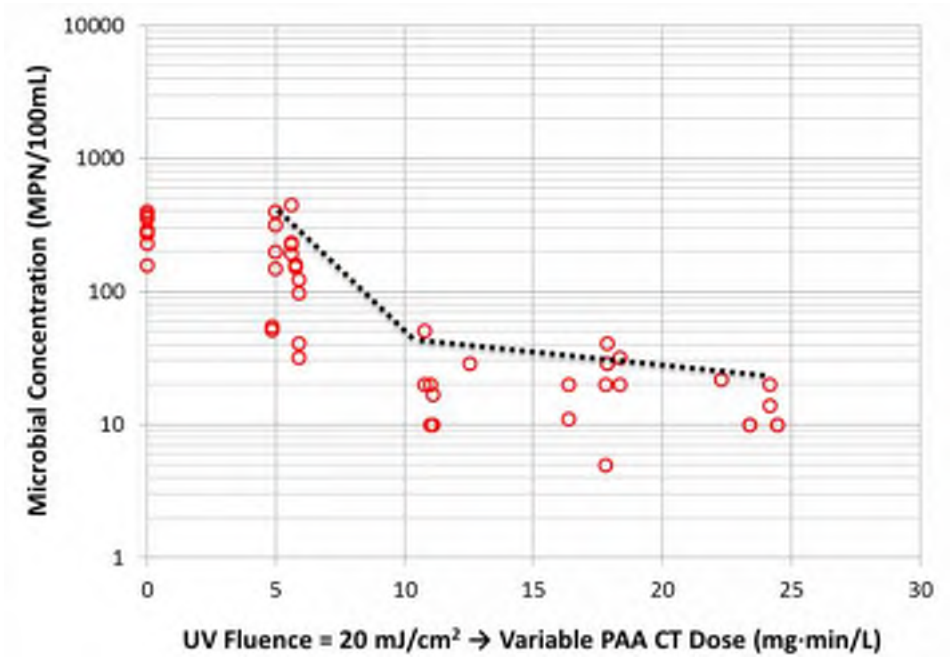

Figure 10: Inactivation of *E. coli* for UV→PAA treatment scenario where PAA treatment is preceded by a UV fluence of 20 mJ/cm^2. Dotted lines are illustrative to show general trend.

The results of this investigation show clear, consistent, and logical trends:

(i) for the initial UV treatment, increasing UV fluences treatment resulted in reduced concentration of viable *E. coli*, and

(ii) for the secondary PAA treatment, increasing PAA CTs resulted in either reduced or constant concentration of viable *E. coli*.

These "trends" are illustrated by the dotted lines in Figures 8 – 10; additionally, this sequence of treatments resulted in both the maximum and geometric mean disinfection targets being met for at least one combination of fluence and CT.

For the PAA→UV tests, PAA CTs that ranged from 10-23 mg·min/L were applied prior to UV fluence rates of 10, 15, and 20 mJ/cm^2. Figures 11 – 13 illustrates the counts of viable *E. coli* as a function of UV fluence with different levels of PAA CT applied prior to UV treatment. The data generally lacks a consistent, logical trend as in some cases there is an increase in viable counts with an increase in treatment level. These "trends" are illustrated by the schematic dotted lines in Figure 11 – 13. Further, this sequence of treatments didn't always result in the geometric mean or maximum disinfection targets being met.

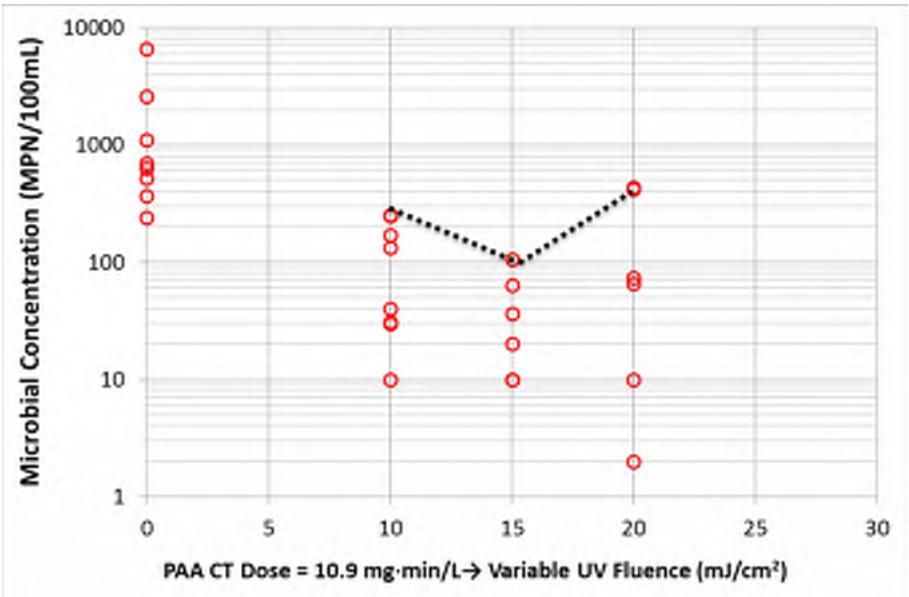

Figure 11: Inactivation of *E. coli* for PAA→UV treatment scenario where UV treatment is preceded by a PAA CT of 10.9 mg·min/L. Dotted lines are illustrative to show general trend.

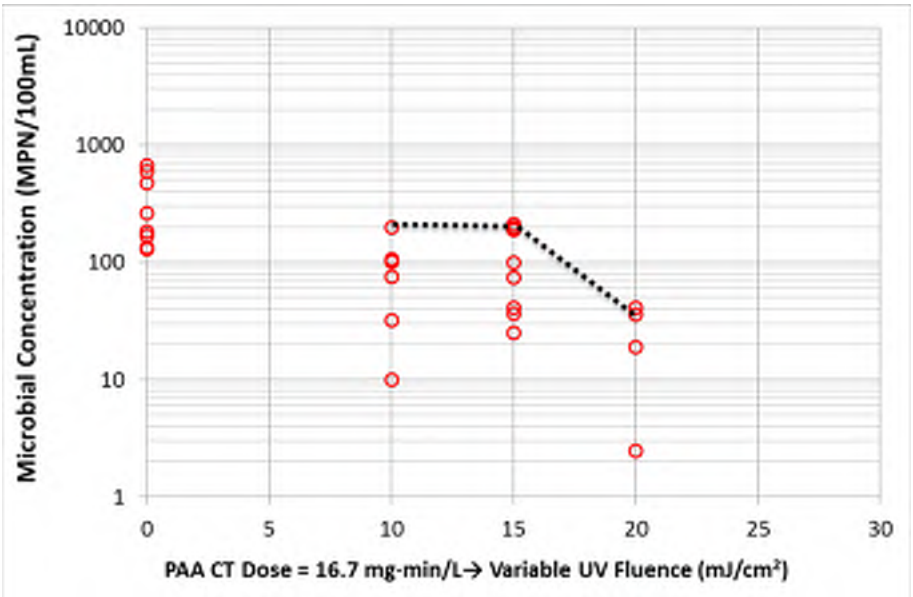

Figure 12: Inactivation of *E. coli* for PAA→UV treatment scenario where UV treatment is preceded by a PAA CT of 16.7 mg·min/L. Dotted lines are illustrative to show general trend.

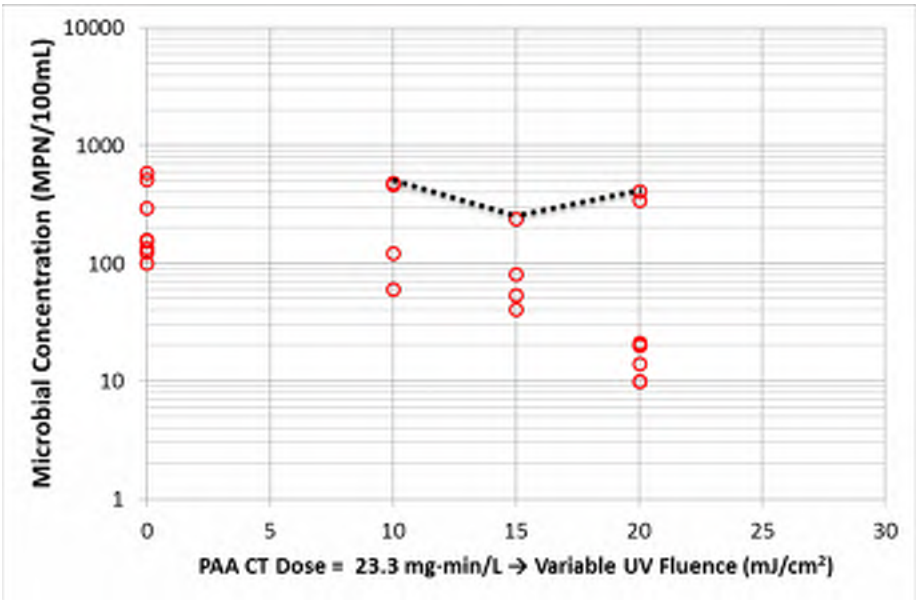

Figure 13: Inactivation of *E. coli* for PAA→UV treatment scenario where UV treatment is preceded by a PAA CT of 23.3 mg·min/L. Dotted lines are illustrative to show general trend.

For the simultaneous UV+PAA tests, UV fluence rates of 10, 15, and 20 mJ/cm^2 were used in conjunction with PAA CTs of 15-30 mg·min/L. Figure 14 – 16 illustrates the results of viable *E. coli* for the simultaneous UV and PAA tests. Data is presented by UV fluence and the respective PAA CT dose applied. In general, the data lacked clear trends; increasing levels of treatments (i.e., higher PAA CTs and UV fluences) did not result in continuously increasing levels of disinfection. Moreover, for reasons not yet evident, the simultaneous treatment scheme could not achieve the geomean or maximum disinfection targets.

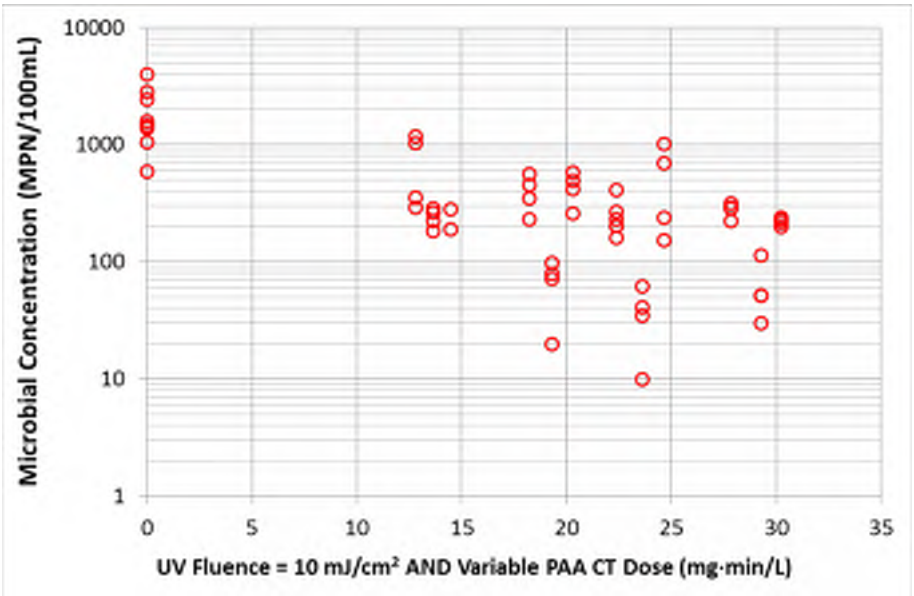

Figure 14: Inactivation of *E. coli* for UV+PAA treatment scenario where data is plotted for fixed UV fluences of 10 mJ/cm^2 and variable PAA CT doses.

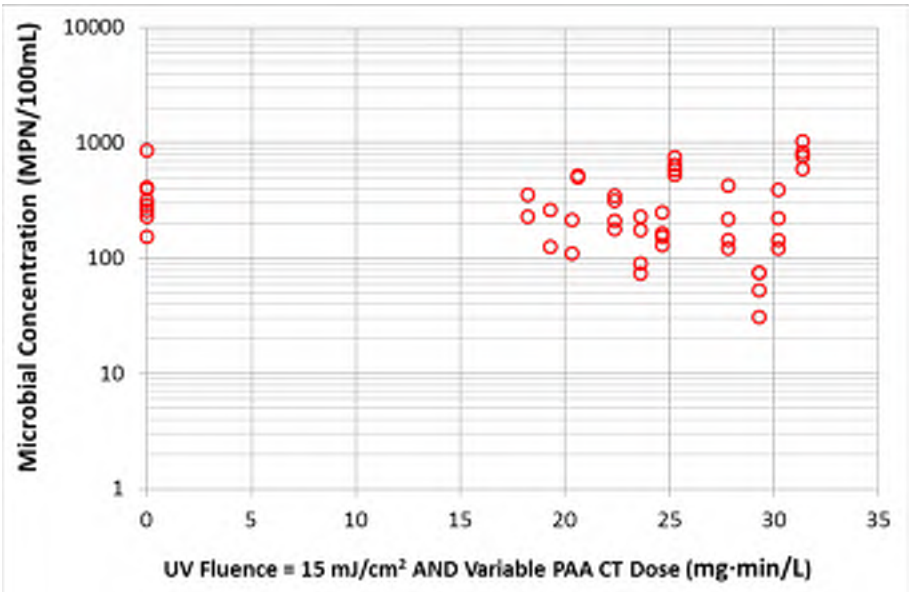

Figure 15: Inactivation of *E. coli* for UV+PAA treatment scenario where data is plotted for fixed UV fluences of 15 mJ/cm^2 and variable PAA CT doses.

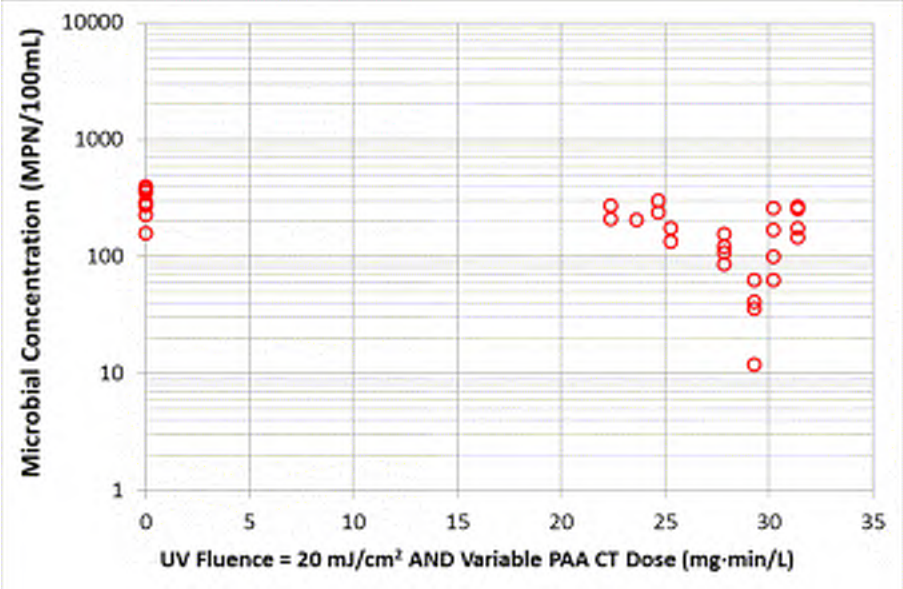

Figure 16: Inactivation of *E. coli* for UV+PAA treatment scenario where data is plotted for fixed UV fluences of 20 mJ/cm^2 and variable PAA CT doses.

5.5 Modeling the sequential UV→PAA

Because the treatment sequence of UV followed by PAA resulted in the most consistent attainment of disinfection targets, this scheme was selected for further analyses including mechanistic modelling and sizing. For the mechanistic modelling, an approach similar to Equation 3 was applied. Equation 3 presents a mechanistic approach where populations of microbes are separated based on their susceptibility to a single disinfectant (UV or PAA) and each population having its own inactivation rate kinetics. For the cases where two disinfectants are applied (UV and PAA) we propose separating the microbes into four populations: (A_0) easy to inactivate by UV and PAA, (B_0) easy to inactivate by UV, hard to inactivate by PAA, (C_0) hard to inactivate by UV, easy to inactivate by PAA, and (D_0) hard to inactivate by UV, hard to inactivate by PAA. Figure 17 provides a conceptual illustration of this mechanistic approach.

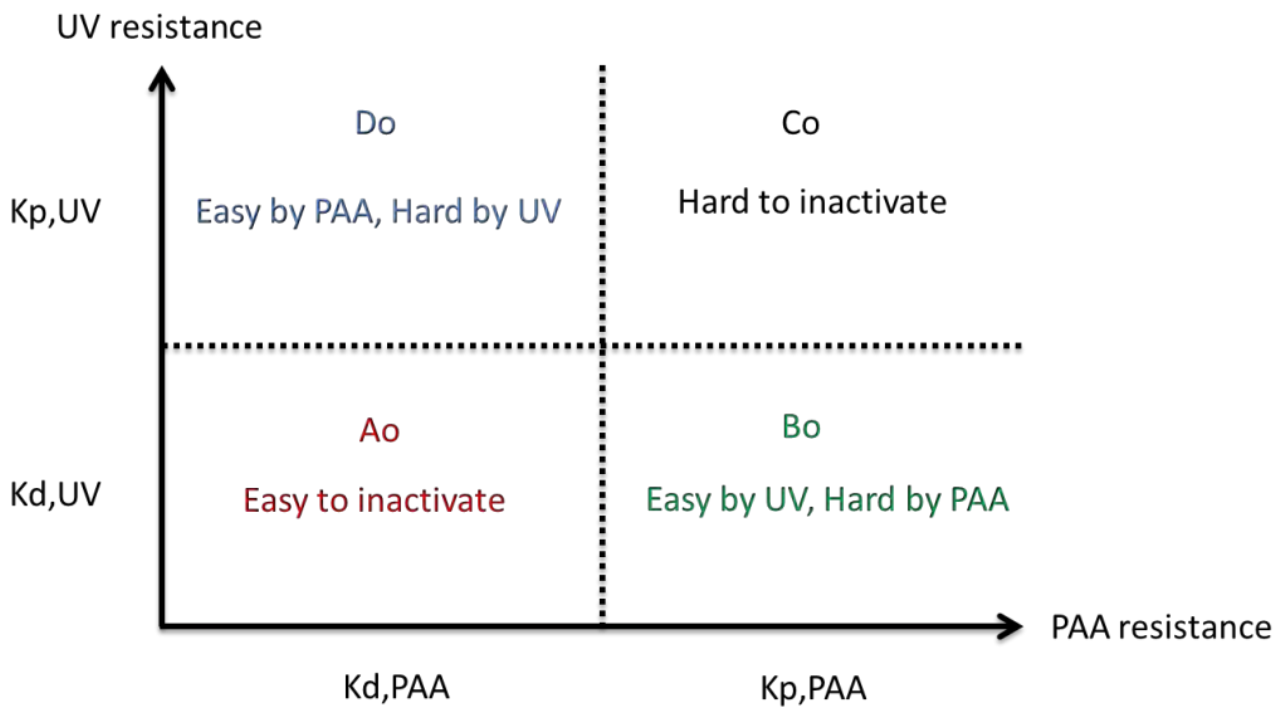

Figure 17: Four population mechanistic approach to model binary disinfection system consisting of UV and PAA disinfectants.

Inactivation mechanisms for this system are represented in Figure 18 and Equation 4 is used to quantify the concentration of viable organisms after disinfection.

$$N_{total,viable\,(UV_{dose},PAA_{dose})} = A2_{viable} + B2_{viable} + C2_{viable} + D2_{viable}$$ [Equation 4]

where,

$N_{total,viable\ (UVdose,PAAdose)}$ is the total concentration of viable *E. coli* remaining after UV and PAA treatment; MPN / 100 mL

$A2_{viable}$ is the concentration of viable organisms from population A_0 remaining after UV and PAA treatment

$B2_{viable}$ is the concentration of viable organisms from population B_0 remaining after UV and PAA treatment mL

$C2_{viable}$ is the concentration of viable organisms from population C_0 remaining after UV and PAA treatment mL

$D2_{viable}$ is the concentration of viable organisms from population D_0 remaining after UV and PAA treatment mL

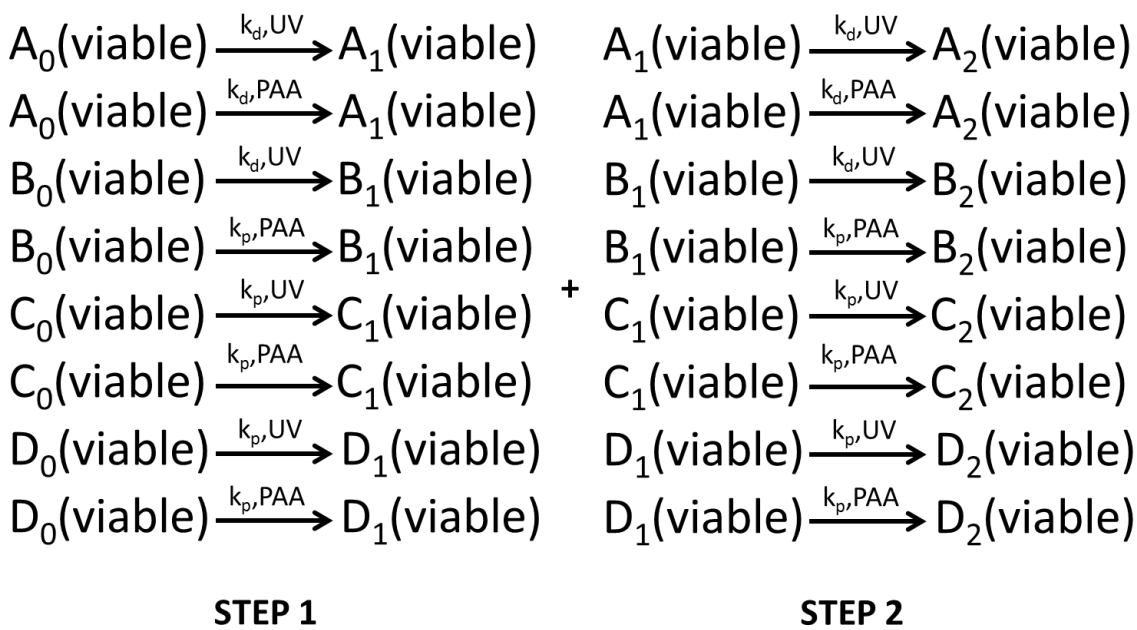

Figure 18: Inactivation mechanisms presenting the inactivation routes and respective first order inactivation rate constants for the proposed four population system with binary disinfectants.

The four population, binary disinfectant model was fitted to the UV only, PAA only, and UV→PAA experimental data to estimate model parameters: A_0, B_0, C_0, D_0, $K_{d,UV}$, $K_{d,PAA}$, $K_{p,UV}$, and $K_{p,PAA}$. The

resulting model is shown with observed results for UV only and PAA only (Figure 19) and for UV→PAA (Figure 20). Figure 21 provides a comparison between actual results and model predicted concentrations of viable *E. coli*. The four population, binary disinfectant model was able to reasonably predict the effect of UV only, PAA only, and UV→PAA disinfection of *E. coli*.

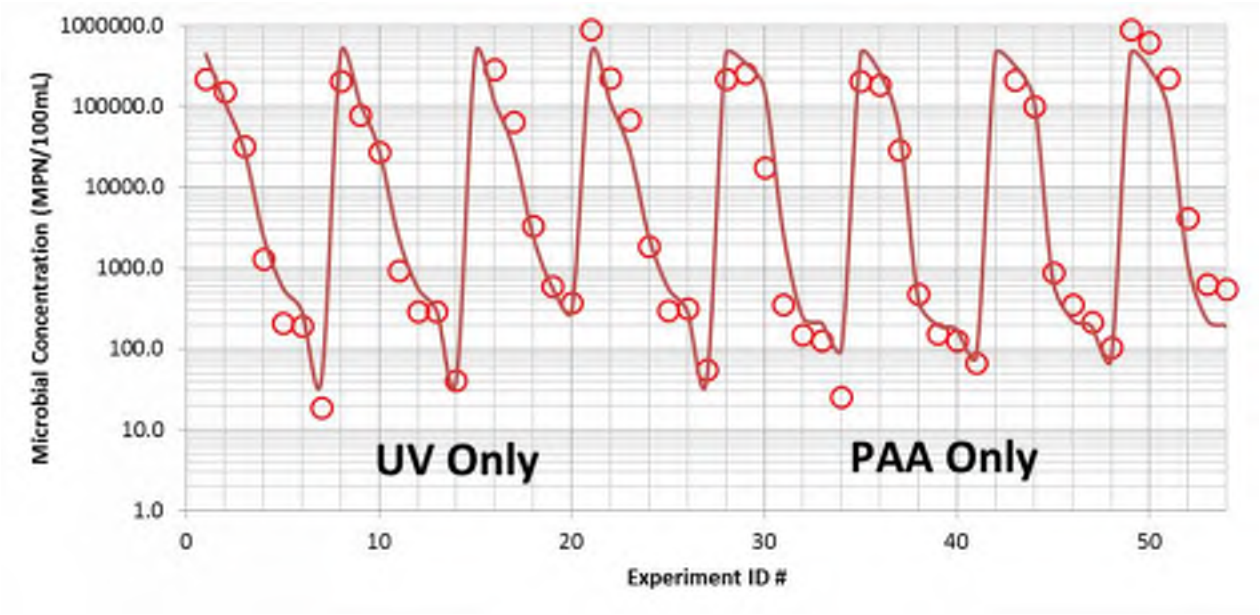

Figure 19: Experimental results from inactivation using UV or PAA alone (circles) and predicted values using the four population, binary disinfectant model.

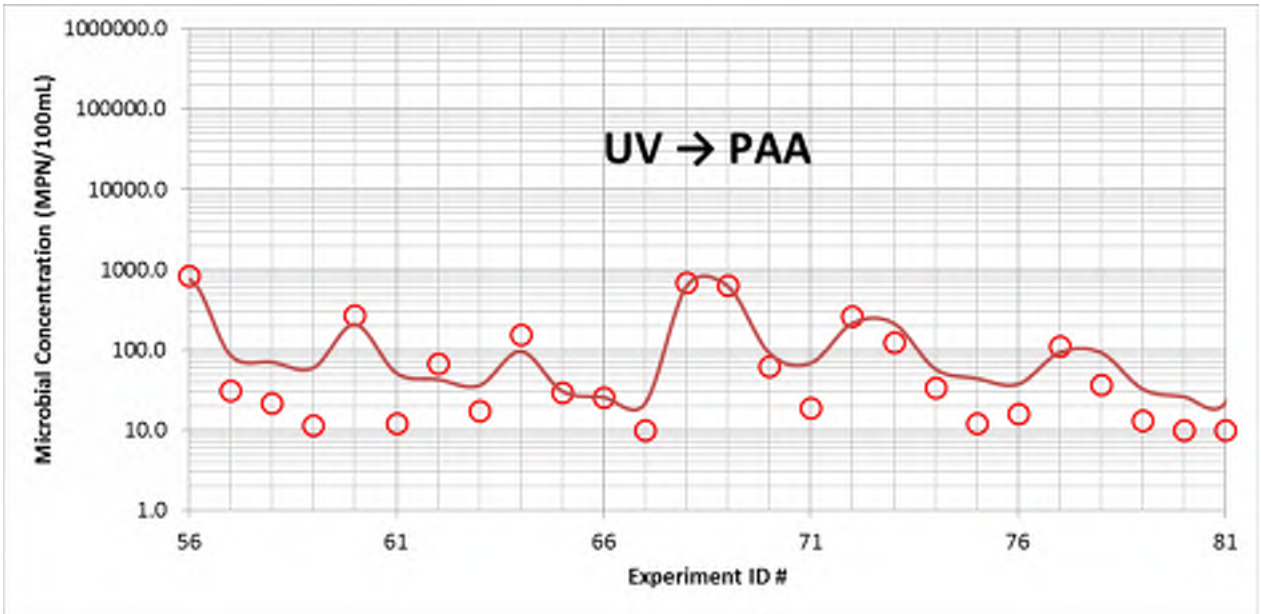

Figure 20: Experimental results from inactivation using UV→PAA (circles) and predicted values using the four population, binary disinfectant model.

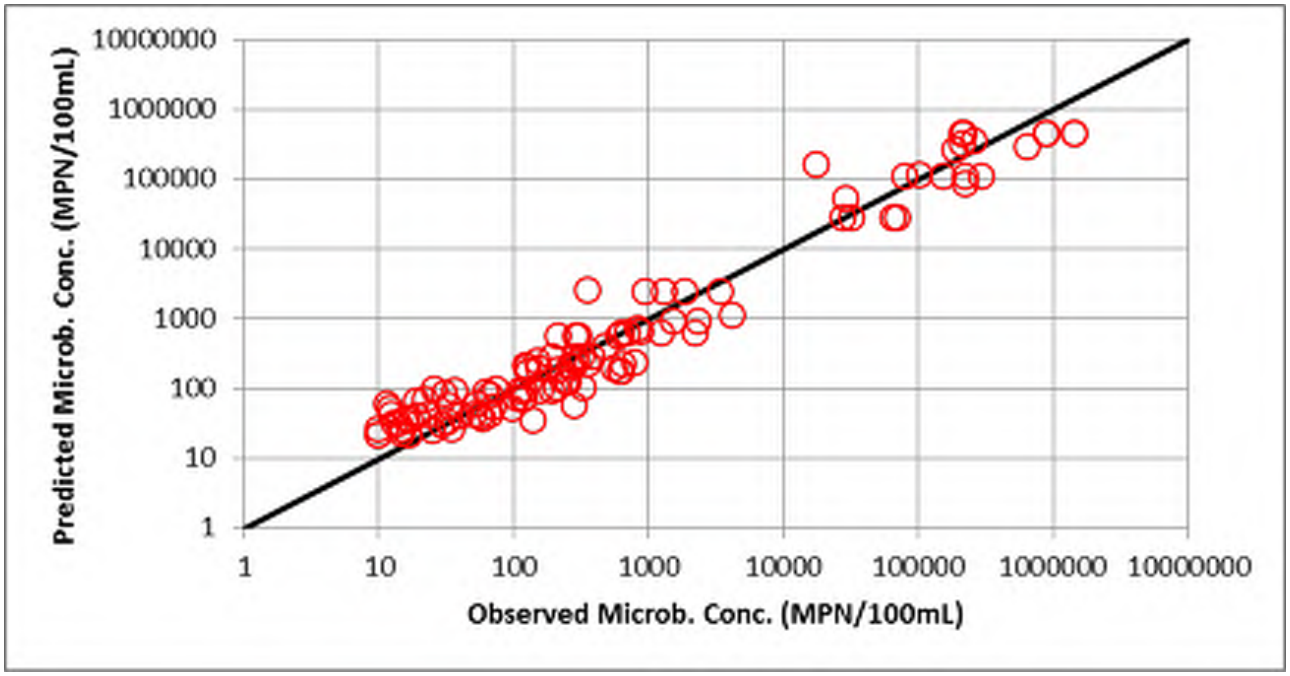

Figure 21: Observed versus model predicted combinations for the UV only, PAA only tests and sequential UV PAA tests. Diagonal line illustrates a perfect fit line.

5.6 Summary of Results

The key results that were determined during this study are summarized here:

- There was no observed difference in the inactivation kinetics of 22% and 15% PAA solutions.
- There was no observed difference in the decomposition kinetics of 22% and 15% PAA solutions.
- A PAA CT dose of 49.2 mg·min/L was required to meet the plant's *E. coli* disinfection target of 63 MPN / 100 mL.
- A UV fluence of 20.1mJ/cm^2 min was required to meet the plant's *E. coli* disinfection target of 63 cfu / 100 mL.
- Of the UV and PAA combined treatment schemes, the UV followed by PAA scheme performed the best in that it consistently met disinfection targets.
- A mechanistic model was developed to predict *E. coli* inactivation by the UV only, PAA only, and UV followed by PAA treatment schemes.
- The mechanistic model was used to determine the combination of UV fluence and PAA CT doses required to meet the plant's *E. coli* disinfection target of 63 MPN / 100 mL.
- The developed correlation can be used to size a combined UV and PAA system as well as perform economic analyses to maximized savings in capital, operating, or net present costs.

6 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the four population, binary model that was developed with estimated parameters, could be used to size the combination of UV fluences and PAA CT doses that would be required to achieve a 30-day geomean disinfection target of 63 MPN/100 mL at full scale. Figure 22 provides a graphical illustration of the combination of disinfectant doses predicted to be required where UV precedes PAA. This plot shows that as the delivered UV fluence is decreased, PAA can be brought online to supplement UV and meet the disinfection target.

It is recommended that this correlation be used to provide disinfection system sizing for a UV + PAA combination system. Although it is currently outside of the scope of work of this effort, it is recommended that the conceptual evaluation of disinfection economics, including operating and capital costs, for the various UV and PAA combinations be developed to support the disinfection system selection process.

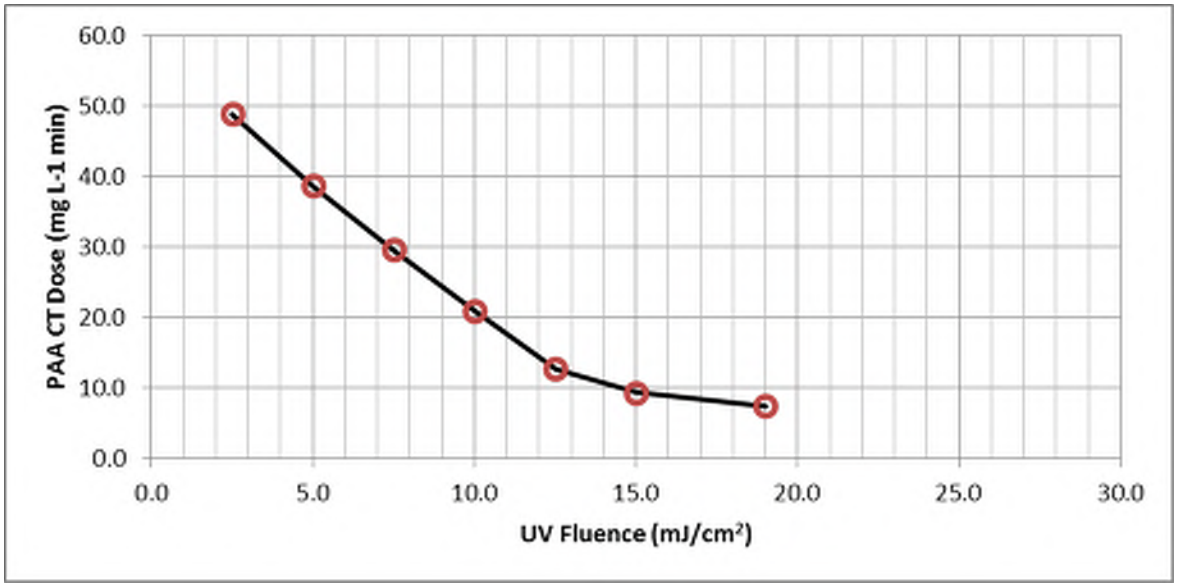

Figure 22: Model predicted combinations of PAA dose and UV fluence required to achieve an *E. coli* disinfection target of 63 cfu / 100 mL when applying the sequential **UV→PAA** treatment process.

7 REFERENCES

Baldry, M. G. C.; French, M. S.; Slater, D. (1991) The Activity of Peracetic Acid on Sewage Indicator Bacteria and Viruses. Water Science & Technology, 24 (2), 353–357.

Block P and Tran M (2015) Wastewater treatment method. Patent US20150005379.

Bolton JR and Linden KG (2003) Standardization of methods for fluence (UV dose) determination in bench-scale UV experiments. Journal of Environmental Engineering, 129: 209–215.

Budde FE and Vineyard MK (2010) Method of improving efficiency of UV photolysis of peracetic acid for disinfection and organic destruction . Patent US20100176066**.**

Caretti C and Lubello C (2003) Wastewater disinfection with PAA and UV combined treatment: a pilot plant study. Water Research. 37: 2365–2371.

Gonzalez A, Gehr R, Vaca M, and Lopez R (2012) Disinfection of an advanced primary effluent with peracetic acid and ultraviolet combined treatment: A continuous-flow pilot plant study. Water Environment Research. 84(3): 247–253.

Koivunen J and Heinonen-Tanski H (2005) Inactivation of enteric microorganisms with chemical disinfectants, UV irradiation and combined chemical/UV treatments. Water Research. 39: 1519–1526.

Leaper, S. (1984) Synergistic Killing of Spores of Bacillus subtilis by Peracetic Acid and Alcohol. Journal of Food Technology, 19, 355–360.

Lubello C, Gori R, Nicese FP, and Ferrini F (2004) Municipal-treated wastewater reuse for plant nurseries irrigation. Water Research. 38: 2939–2947.

Martin N and Gehr R (2007) Reduction of photoreactivation with the combined UV/peracetic acid process or by delayed exposure to visible light. Water Environment Research. 79(9): 991–999.

Rajala-Mustonen RL, Taviola PS, and Heinonen-Tanksi H (1997) Effects of peracetic acid and UV irradiation on the inactivation of coliphages in wastewater. Water Science & Technology. 35(11–12): 237–241.

Santoro, D., Gehr, R., Bartrand, T.A., Liberti, L, Notarnicola, M., Dell'Erba, A., Falsanisi, D., Haas, C.N. (2007) Wastewater Disinfection by Peracetic Acid: Assessment of Models for Tracking Residual Measurements and Inactivation. Water Environment Research. 79 (7): 775–787.

Santoro, D., Crapulli, F., Raisee, M., Raspa, G., Haas, C.N. (2015) Nondeterministic Computational Fluid Dynamics Modeling of *Escherichia coli* Inactivation by Peracetic Acid in Municipal Wastewater Contact Tanks. Environmental Science & Technology. 49: 7265–7275.

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APPENDIX A – TEST PROTOCOL

City of Memphis, TN – Maxson WRRF Site Test Protocol - UV and PAA Disinfection

1) SUMMARY

Two (2) secondary effluent samples will be collected daily from the Maxson WRRF and treated by UV and PAA disinfection. Testing will be conducted over a period of three (3) days during the week of Sept 21st. The experiment test matrix described below will be conducted on each of the 6 water samples.

2) OBJECTIVE

Evaluate various process design scenarios and operating parameters for a combined UV and PAA disinfection system by running batch disinfection studies under different UV and PAA treatment conditions.

3) EXPERIMENT TEST MATRIX

These experiments will include variable PAA and UV dosages, alone and in combination. The detailed experimental plan is outlined as:

a. PAA demand decay test (PAA residuals will be measured at each contact time).
b. E. coli disinfection over a PAA dosage range: 0, 5, 10, 15, 20, and 40 mg/L min.
c. E. coli disinfection over a UV dosage range: 0, 2.5, 5, 10, 20 and 40 mJ/cm^2.
d. E. coli disinfection at UV→PAA dosages: Sample pre-treated by UV at 10, 15 and 20 mJ/cm^2 dosages followed by PAA dosages of 0, 5, 10, 15, 20 mg/L min.
e. E. coli disinfection at PAA→UV dosages: Sample pre-treated by PAA at CT dose of 5, 10, 15 and 20 mg/L min, followed by irradiation using UV fluences of 0, 10, 15, and 20 mJ/cm^2.
f. E. coli disinfection at UV+PAA dosages: Simultaneous addition of PAA and UV at CT doses in the range of 5-10, 10-15, and 15-20 mg/L min and UV doses of 10, 15, and 20 mJ/cm^2.

The complete test matrix is shown in Table 1. Two (2) secondary effluent samples will be collected each day for three (3) days. Samples will be collected in attempt to capture average flow and peak flow

conditions. For example, the first sample would be collected at 7:00 AM and the second around 1:00 PM. Ten (10) liters of secondary effluent will be collected at each time. Two (2) liters of this sample will be sent to Trojan as a backup. Select experiments will be completed in duplicate.

All the samples will be tested using the same test matrix illustrated in Table 1. UV tests will be conducted using the 50 mL volumes in 60 mL petri dishes. PAA tests will be conducted using appropriate size beakers (500 – 2000 mL)

Table 1 – Test matrix for UV/PAA experiments

Test ID #	Treatment process	UV fluence (mJ/cm^2)	PAA CT (mg/L min)	Test Parameters
1	Control	0	0	E.coli
2	PAA alone	0	2.5	PAA residual, E.coli
3	PAA alone	0	5	PAA residual, E.coli
4	PAA alone	0	10	PAA residual, E.coli
5	PAA alone	0	15	PAA residual, E.coli
6	PAA Alone	0	20	PAA Residual, E. coli
7	PAA Alone	0	40	PAA Residual, E. coli
8	UV alone	2.5	0	E.coli
9	UV alone	5	0	E.coli
10	UV alone	10	0	E.coli
11	UV alone	15	0	E.coli
12	UV Alone	20	0	E. coli
13	UV Alone	40	0	E. coli
14	UV+PAA	10	5	PAA residual, E.coli

15	UV+PAA	10	10	PAA residual, E.coli
16	UV+PAA	10	15	PAA residual E.coli
17	UV+PAA	10	20	PAA residual, E.coli
18	UV+PAA	15	5	PAA residual, E.coli
19	UV+PAA	15	10	PAA residual, E.coli
20	UV+PAA	15	15	PAA residual E.coli
21	UV+PAA	15	20	PAA residual, E.coli
22	UV+PAA	20	5	PAA residual, E.coli
23	UV+PAA	20	10	PAA residual, E.coli
24	UV+PAA	20	15	PAA residual, E.coli
25	UV+PAA	20	20	PAA residual, E.coli
26	PAA+UV	10	5	PAA residual, E.coli
27	PAA+UV	15	5	PAA residual, E.coli
28	PAA+UV	20	5	PAA residual, E.coli
29	PAA+UV	10	10	PAA residual, E.coli
30	PAA+UV	15	10	PAA residual, E.coli
31	PAA+UV	20	10	PAA residual, E.coli
32	PAA+UV	10	15	PAA residual, E.coli
33	PAA+UV	15	15	PAA residual, E.coli
34	PAA+UV	20	15	PAA residual, E.coli
35	PAA+UV	10	20	PAA residual, E.coli

36	PAA+UV	15	20	PAA residual, E.coli
37	PAA+UV	20	20	PAA residual, E.coli
38	Simult. PAA+UV	10	5 – 10	PAA residual, E.coli
39	Simult. PAA+UV	10	5 – 10	PAA residual, E.coli
40	Simult. PAA+UV	10	10 – 15	PAA residual, E.coli
41	Simult. PAA+UV	10	15 – 20	PAA residual, E.coli
42	Simult. PAA+UV	15	10 – 15	PAA residual, E.coli
43	Simult. PAA+UV	15	10 – 15	PAA residual, E.coli
44	Simult. PAA+UV	15	15 – 20	PAA residual, E.coli
45	Simult. PAA+UV	20	15 – 20	PAA residual, E.coli
46	Simult. PAA+UV	20	15 – 20	PAA residual, E.coli
47	Simult. PAA+UV	10	5 – 10	PAA residual, E.coli
48	Simult. PAA+UV	10	10 – 15	PAA residual, E.coli
49	Simult. PAA+UV	10	15 – 20	PAA residual, E.coli
50	Simult. PAA+UV	15	10 – 15	PAA residual, E.coli
51	Simult. PAA+UV	15	15 – 20	PAA residual, E.coli
52	Simult. PAA+UV	20	15 – 20	PAA residual, E.coli

The total number of tests per sample is shown in Table 2.

Table 2 – Total numbers of samples and volume

Test	Microbe	PAA	Volume (mL)
Demand &Decay	0	5	500
Controls / Calibration	12	6	600
PAA alone / PAA+UV	50	6	1500
UV alone / UV+PAA	46	12	1200
Simult. PAA+UV	36	15	750
Total number of samples or volume	144	44	4550

4) SCHEDULE AND TEAM MEMBERS

a) This experiment will be conducted during the week of Sept 21, 2015.
   a. Sunday: Arrival in Memphis
   b. Monday: Plant survey and prep work
   c. Tuesday, Wednesday, Thursday: Sample collection and testing days.
      i. 1st sample collected ca. 07:00. Complete test matrix (ca. 5 – 6 hours)
      ii. 2nd sample collected ca. 13:00. Complete test matrix (ca. 5 – 6 hours)
   d. Friday: Buffer day for extra tests if needed

b) On-site Team:
   a. PAA work: Adrian Murray, PhD, Trojan Application Specialist
   b. UV work: Wenjun Sun, PhD, Trojan Application Specialist
   c. Josh Goldman, PhD, CDM Smith, Environmental Engineer

5) METHODS

Analytical Methods

UV collimated beam and PAA measurements will be conducted following the established SOPs developed by Trojan Technologies.

E. coli measurements will be performed by Waypoint Analytical (Memphis, TN) following the Idexx Colisure protocol.

Color and UVT will be measured on-site by CDM. TSS, COD, and BOD will be measured by an external lab, arranged by CDM.

UV irradiation times and PAA contact times provided in the test plan below are estimates based on previous experiments performed by Trojan Technologies on Maxson water samples. The actual UV irradiation and PAA contact times to be used will be determined for each collected sample prior to analysis.

Test procedures

1. Prepare PAA stock solution (1000 mg/L) from 22% PAA, measure the concentration using titration method (see SOP - PAA production and testing) and with CHEMetrics test kit.
2. Prepare a second PAA stock solution (10,000 mg/L) from 22% PAA, and measure the concentration using titration method (see SOP - PAA production and testing) and with CHEMetrics test kit..
3. Prepare sodium bisulfite stock solution (0.01M) from commercial standard.
4. Collect 6 x 100 mL of sample and set aside as controls for E. coli analysis.
   4.1. Suggested dilutions are: 4 log, 3 log.
5. **Conduct PAA demand/decay pre-test.**
   - 5.1 Measure 250 mL of sample and pour into 500 mL beaker.
   - 5.2 Add appropriate volume of PAA stock solution (1000 mg/L) to obtain 4 mg/L PAA in the 250 mL sample. Start timer immediately after addition. The stir rate for PAA reaction is level 10.
   - 5.3 Measure residual PAA (by removing 25 mL and adding to CHEMetrics test kit) at time intervals of:
     - 5.3.1 0.5 min
     - 5.3.2 2 min
     - 5.3.3 4 min
     - 5.3.4 8 min
     - 5.3.5 16 min
   - 5.4 Quench sample with 0.01 M $NaHSO_3$ stock solution (stoichiometric) and discard.
   - 5.5 Measure background PAA reading for the water sample, in triplicate.
   - 5.6 Record actual concentration of PAA added to sample by dosing in the same volume of PAA stock solution into 250 mL DI water, in triplicate.
   - 5.7 Record measured PAA residuals in the file “Decay Demand Analysis for CT Estimates”.
   - 5.8 Repeat steps 5.1-5.7 one more time on the same water sample.
   - 5.9 Repeat steps 5.1 – 5.7 with PAA stock solution (10,000 mg/L)

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6. Conduct PAA / PAA +UV test:

6.1 Measure 1500 mL of sample and pour into 2000 mL beaker.

6.2 Target a PAA residual of approximately 2 mg/L after 30 seconds, based on step 3, calculate the time required to achieve the above CT (to be estimated with a preliminary decay test), keeping in mind that the actual CT would need to be recalculated for the actual residual PAA concentration measured during PAA disinfection experiments.

6.3 Add PAA concentration calculated from step 5.2, start timer immediately after addition.

6.4 Measure residual PAA (by removing 25 mL and adding to CHEMetrics test kit) at required CT (approx.. 1:01, 2:05, 4:19, 6:44, 9:21 and 23:01 min:sec)

6.5 At the following times, the designated volume of sample is withdrawn and a stoichiometric amount of sodium bisulfite stock solution is added to quench the residual (to ensure immediate quenching at the required time).

6.5.1 For time 1:01, collect 100 mL of sample for microbial testing

6.5.2 For times 2:05 – 9:21, collect 300 mL of sample for microbial testing and to be used for PAA+UV testing

6.5.3 For time 23:01, collect 100 mL of sample for microbial testing

6.6 For each 300 mL subsample collected for PAA+UV analysis (times 2:05 – 9:21), subsample 50 mL for microbial testing. Use the remaining 250 mL to prepare 50 mL samples for UV irradiation.

6.6.1 Measure the UV intensity of the collimated beam to use in calculating the irradiation time (based on the spreadsheet developed by Trojan Technologies – see SOP-collimated beam). The stir rate for UV collimated beam should be set at level 10.

6.6.2 Irradiate 50 mL volume from the subsample to a fluence of 10 mJ/cm^2. Retain the 50 mL of sample for E. coli analysis.

6.6.3 To a new 50 mL sample, irradiate to a fluence of 15 mJ/cm^2. Retain the 50 mL of sample for E. coli analysis.

6.6.4 To a new 50 mL sample, irradiate to a fluence of 20 mJ/cm^2. Retain the 50 mL of sample for E. coli analysis.

6.6.5 Repeat 6.6.1 – 6.6.4 for each 300 mL subsample.

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Table 3 - Sample dilutions for E.coli enumeration

Test ID #	UV Fluence (mJ/cm^2)	PAA CT (mg/L min)	Dilution
2	0	2.5	4 log, 3 log
3	0	5	3 log, 2 log
26	10	5	2 log, 1 log
27	15	5	1 log, none
28	20	5	none
4	0	10	2 log, 1 log
29	10	10	1 log, none
30	15	10	none
31	20	10	none
5	0	15	1 log, none
32	10	15	none
33	15	15	none
34	20	15	none
6	0	20	none
35	10	20	none
36	15	20	none
37	20	20	none
7	0	40	none

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7. **Conduct UV+PAA test:**
   7.1 Measure the UV intensity of the collimated beam to use in calculating the irradiation time (based on the spreadsheet developed by Trojan Technologies – see SOP-collimated beam).The stir rate for UV collimated beam should be set at level 10.
   7.2 Irradiate 50 mL volume at the specified fluence, ex. 10 mJ/cm^2,
   7.3 Repeat step 7.2 six more times to obtain 350 mL of irradiated sample.
   7.4 Withdraw 50 mL of sample for E. coli analysis.
   7.5 Spike the leftover UV irradiated composite batch with PAA to obtain a 2 mg/L residual (after 30 seconds), and start timer.
   7.6 Withdraw samples: 25mL for PAA analysis and 50 mL for E. coli (to be quenched with $NaHSO_3$) at 2:05, 4:19, 6:44 and 9:21 min:sec.
   7.7 Repeat steps 7.5 – 7.6 for remaining UV intensities (15 and 20 mJ/cm^2)

Table 4 – Suggested dilutions for E.coli coliform enumeration

Test ID #	UV Fluence (mJ/cm^2)	PAA CT (mg/L min)	Dilutions
10	10	0	2 log, 1 log
14	10	5	1 log, none
15	10	10	none
16	10	15	none
17	10	20	none
11	15	0	1 log, none
18	15	5	none
19	15	10	none
20	15	15	none
21	15	20	none
12	20	0	none
22	20	5	none

23	20	10	none
24	20	15	none
25	20	20	none

8. Conduct UV alone test:

8.1 Repeat step 7.1 to determine the irradiation time required for each target UV dosage (2.5, 5, 40 mJ/cm^2).

8.2 Use 50 mL secondary effluent samples and irradiate using the calculated durations from step 6.1

8.3 Retain the entire 50 mL of sample for E. coli analysis.

8.3 Repeat steps 8.1 – 8.3 for remaining UV fluences.

Table 5 – Suggested sample dilutions for E. coli enumeration

Test ID #	UV Fluence (mJ/cm^2)	Dilutions
8	2.5	4 log, 3 log
9	5	3 log, 2 log
13	40	none

9. Conduct simultaneous UV+PAA:

9.1. A detailed test matrix for this section is provided as an appendix.

9.2. Place 50 mL sample under UV lamp while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously)

9.3. Irradiate sample for 3:32 (ca. 10 mJ/cm^2). Remove sample from UV, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use 10 mL sub-sample to measure PAA residual concentration. Use the remaining 40 mL of sample for E. coli analysis.

9.4. For a new sample, irradiate for 3:32 (ca. 10 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 0:47, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.5. For a new sample, irradiate for 3:32 (ca. 10 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 3:12, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.6. For a new sample, irradiate for 3:32 (ca. 10 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 5:49, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.7. For a new sample, irradiate for 5:18 (ca. 15 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample from UV, and remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.8. For a new sample, irradiate for 5:18 (ca. 15 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 1:26, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.9. For a new sample, irradiate for 5:18 (ca. 15 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 4:03, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.10. For a new sample, irradiate for 7:05 (ca. 20 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample from UV, and remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

9.11. For a new sample, irradiate for 7:05 (ca. 20 mJ/cm^2), while simultaneously adding PAA (spike to 2 mg/L after residual, as calculated previously). Remove sample and let stir additional 2:17, remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10. Conduct simultaneous PAA+UV:

10.1. A detailed test matrix for this section is provided as an appendix.

10.2. Place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 0:47 and then place under UV lamp. Stir for additional 3:32 (ca. 10 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10.3. For a new sample, place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 3:12 and then place under UV lamp. Stir for additional 3:32 (ca. 10 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10.4. For a new sample, place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 5:49 and then place under UV lamp. Stir for additional 3:32 (ca. 10 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10.5. For a new sample, place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 1:26 and then place under UV lamp. Stir for additional 5:18 (ca. 15 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10.6. For a new sample, place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 4:03 and then place under UV lamp. Stir for additional 5:18 (ca. 15 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

10.7. For a new sample, place 50 mL sample on stir plate and add PAA (spike to 2 mg/L after residual, as calculated previously) Stir sample for 2:17 and then place under UV lamp. Stir for additional 7:04 (ca. 20 mJ/cm^2) and then remove from lamp. Remove 10 mL for PAA analysis, and quench remaining sample with $NaHSO_3$. Use the remaining 40 mL of sample for E. coli analysis.

Table 6 – Suggested sample dilutions for E. coli enumeration

Test ID #	UV Fluence (mJ/cm^2) before PAA	PAA CT (mg/L min)	UV Fluence (mJ/cm^2) after PAA	Dilutions
38	10	5 – 10	-	1 log, none
39	10	5 – 10	-	1 log, none
40	10	10 – 15	-	none

41	10	15 – 20	-	none
42	15	10 – 15	-	none
43	15	10 – 15	-	none
44	15	15 – 20	-	none
45	20	15 – 20	-	none
46	20	15 – 20	-	none
47	-	5 – 10	10	1 log, none
48	-	10 – 15	10	none
49	-	15 – 20	10	none
50	-	10 – 15	15	none
51	-	15 – 20	15	none
52	-	15 – 20	20	none

Material

- Collimated beam, Extra lamp for collimated beam, radiometer
- CHEMetrics PAA analyzer
- PAA test kits
- Sample vials for microbial analysis
- UVT detector
- PAA stock solution, provided on site
- Sodium sulfite for quenching
- wash bottle
- Sample bottles for collecting samples
- Cooler for transporting samples
- micropipettes, 0.1 – 1 mL, 10 – 100 µL.
- pipette tips

- autopipetter, plus larger pipettes (10 – 50 mL)
- grad cylinders, 1 x 50 mL, 1 x 500 mL
- 60 mL petri dishes with stir bars
- 500 mL beakers, 2000 mL beakers
- stop watch / timer
- stir plates
- Kim wipes
- labels, markers, tape, pens, etc
- small, brown glass sample bottles to prepare stock solutions of PAA and quench NaHSO3
- Cerium Sulfate
- sodium thiosulfate
- hach sulfate 1 test packetes
- ferroin indicator
- burret for PAA titration
- 50 mL Erlenmeyer flasks

Appendix : *Test matrix for simultaneous UV+PAA and PAA+UV*

Test ID #	Treatment process	UV irradiation time (min)	UV Dosage (mJ/cm^2)	Additional PAA contact time (min)	Total Contact time (min)	Total PAA CT (mg/L min)
38	Simult. UV+PAA	3:32	10	0	3:32	between 5-10
39	Simult. UV+PAA	3:32	10	0:47	4:19	between 5-10
40	Simult. UV+PAA	3:32	10	3:12	6:44	between 10-15
41	Simult. UV+PAA	3:32	10	5:49	9:21	between 15-20
42	Simult. UV+PAA	5:18	15	0	5:18	between 10-15
43	Simult.	5:18	15	1:26	6:44	between

	UV+PAA					10-15
44	Simult. UV+PAA	5:18	15	4:03	9:21	between 15-20
45	Simult. UV+PAA	7:04	20	0	7:04	between 15-20
46	Simult. UV+PAA	7:04	20	2:17	9:21	between 15-20

Sample #	Treatment process	Initial PAA contact time (min)	UV irradiation time (min)	UV Dosage (mJ/cm^2)	Total Contact time (min)	Total PAA CT (mg/L min)
47	Simult. PAA+UV	0:47	3:32	10	4:19	between 5-10
48	Simult. PAA+UV	3:12	3:32	10	6:44	between 10-15
49	Simult. PAA+UV	5:49	3:32	10	9:21	between 15-20
50	Simult. PAA+UV	1:26	5:18	15	6:44	between 10-15
51	Simult. PAA+UV	4:03	5:18	15	9:21	between 15-20
52	Simult. PAA+UV	2:17	7:04	20	9:21	between 15-20

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APPENDIX B – RAW DATA

These tests were performed on Sep 21. The goal was to compare 22% and 15% PAA formulations for inactivation of *E. coli.* Each stock was prepared to 0.1%

Sample ID	PAA product	Contact Time (min)	E-coli (MPN/100 mL)
DDTest-0		0	411000
DDTest-0 Dilution #2		0	700000
DDTest-22-1	22%	1	488000
DDTest-22-1 Dilution #2	22%	1	450000
DDTest-22-4	22%	4	242000
DDTest-22-4 Dilution #2	22%	4	326000
DDTest-22-8	22%	8	2850
DDTest-22-8 Dilution #2	22%	8	2800
DDTest-22-16	22%	16	236
DDTest-22-16 Dilution #2	22%	16	270
DDTest-22-32	22%	32	111
DDTest-22-32 Dilution #2	22%	32	190
DDTest-15-1	15%	1	461000
DDTest-15-1 Dilution #2	15%	1	370000
DDTest-15-4	15%	4	>242000
DDTest-15-4 Dilution #2	15%	4	308000
DDTest-15-8	15%	8	7700
DDTest-15-8 Dilution #2	15%	8	7500
DDTest-15-16	15%	16	770

DDTest-15-16 Dilution #2	15%	16	1120
DDTest-15-32	15%	32	51
DDTest-15-32 Dilution #2	15%	32	100

These tests were performed on Sep 21. The goal was to compare the decomposition of 22% and 15% PAA. Also the effect of dilution to 0.1% and 1% was investigated.

PAA product	Contact Time (min)	PAA concentration (mg/L)
22% diluted to 0.1%	0	4.77
22% diluted to 0.1%	0.2	1.37
22% diluted to 0.1%	0.4	1.36
22% diluted to 0.1%	0.8	1.34
22% diluted to 0.1%	1	1.33
22% diluted to 0.1%	2	1.29
22% diluted to 0.1%	4	1.20
22% diluted to 0.1%	8	1.03
22% diluted to 0.1%	16	0.77
22% diluted to 0.1%	32	0.43
15% diluted to 0.1%	0	4.81
15% diluted to 0.1%	0.2	1.18
15% diluted to 0.1%	0.4	1.17
15% diluted to 0.1%	0.8	1.15
15% diluted to 0.1%	1	1.14
15% diluted to 0.1%	2	1.08
15% diluted to 0.1%	4	0.97

15% diluted to 0.1%	8	0.79
15% diluted to 0.1%	16	0.53
15% diluted to 0.1%	32	0.23
22% diluted to 1%	0	4.77
22% diluted to 1%	0.2	1.33
22% diluted to 1%	0.4	1.32
22% diluted to 1%	0.8	1.30
22% diluted to 1%	1	1.29
22% diluted to 1%	2	1.25
22% diluted to 1%	4	1.17
22% diluted to 1%	8	1.02
22% diluted to 1%	16	0.77
22% diluted to 1%	32	0.44

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The following data is for samples tested with PAA only.

Sample	Contact Time (min)	PAA Residual (mg·min/L)	CT dose (mg·min/L)	Average N_{exp} (MPN/100mL)
Sep. 22, AM Co = 6.97	0.00	-	0	217210
	0.75	3.46	2.48	256685
	1.50	2.72	4.85	17605
	3.50	2.69	10.64	354
	5.50	2.52	15.75	151
	8.00	2.16	21.30	126
	32.00	0.31	46.65	26
Sep. 22, PM Co = 5.79	0.00	-	0.00	210012
	1.00	3.29	3.57	186225
	2.00	2.63	6.93	28819
	4.00	2.49	13.04	481
	8.00	2.1	23.18	155
	10.00	1.82	27.37	129
	40.00	0.45	53.87	67
Sep. 24, AM Co = 6.95	0.00		0.00	1420716
	0.75	3.53	2.84	213519
	1.50	3.08	5.56	102032
	3.50	2.78	12.19	876
	5.50	2.58	18.05	357
	8.00	2.01	24.40	214
	40.00	0.6	56.71	106
Sep. 24, PM Co = 5.91	0.00	-	0.00	889812
	1.00	3.02	3.17	634671
	2.00	2.6	6.15	224841
	4.00	2.2	11.57	4148
	7.00	2	18.53	639
	10.00	1.74	24.29	549
	40.00	0.36	47.81	75

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The following data is for samples tested with UV only.

Sample Date	UV irradiation time (min)	UV dose (mJ/cm^2)	Average N_{exp} (MPN/100mL)
Sep. 22, AM	0.00	0	217210
	1.16	2.5	151327
	2.32	5	32425
	4.64	10	1300
	6.96	15	212
	9.28	20	192
	18.57	40	19
Sep. 22, PM	0.00	0	210012
	1.10	2.5	79635
	2.20	5	27242
	4.40	10	941
	6.60	15	289
	8.79	20	290
	17.59	40	41
Sep. 24, AM	0.00	0	1420716
	1.14	2.5	291240
	2.27	5	64426
	4.55	10	3373
	6.82	15	598
	9.10	20	378
Sep. 24, PM	0.00	0	889812
	1.13	2.5	223162
	2.26	5	69375
	4.53	10	1853
	6.79	15	304
	9.05	20	322
	18.11	40	56

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The following data is for samples tested with UV followed by PAA.

Sample Date	UV irradiation time (min)	UV dose (mJ/cm2)	PAA Contact Time (min)	PAA Residual (mg·min/L)	CT dose (mg·min/L)	Average N_{exp} (MPN/100mL)
Sep. 22, AM Co = 6.86	4.64	10	1.50	3.38	5.49	830
	4.64	10	3.50	2.89	11.86	31
	4.64	10	5.50	2.83	17.28	22
	4.64	10	8.00	1.82	22.95	11
	6.96	15	1.50	3.41	5.35	272
	6.96	15	3.50	3.00	11.76	12
	6.96	15	5.50	2.70	17.45	67
	6.96	15	8.00	2.29	23.66	17
	9.28	20	1.50	3.72	5.76	156
	9.28	20	3.50	3.23	12.51	29
	9.28	20	5.50	2.17	18.32	25
	9.28	20	8.00	2.58	24.47	10
Sep. 22, PM Co = 6.19	4.40	10	1.50	2.96	5.89	696
	4.40	10	1.50	-	5.89	632
	4.40	10	3.50	2.22	11.20	62
	4.40	10	5.50	2.29	18.23	19
	6.60	15	1.50	2.44	5.26	260
	6.60	15	1.50	-	5.26	123
	6.60	15	3.50	2.34	10.07	33
	6.60	15	5.50	2.19	16.55	12
	6.60	15	8.00	1.64	22.23	16
	8.79	20	1.50	2.67	5.88	110

	8.79	20	1.50	-	5.88	36
	8.79	20	3.50	2.63	11.08	13
	8.79	20	5.50	1.93	17.78	10
	8.79	20	8.00	1.71	23.37	10
Sep. 24, AM Co = 7.00	4.55	10	1.50	3.47	4.97	1504
	4.55	10	1.50	-	4.97	2331
	4.55	10	3.50	3.08	10.98	121
	4.55	10	5.50	2.49	16.35	120
	4.55	10	8.00	2.44	22.28	53
	6.82	15	1.50	3.30	4.97	786
	6.82	15	1.50	-	4.97	285
	6.82	15	3.50	3.00	10.98	98
	6.82	15	5.50	2.76	16.35	50
	6.82	15	8.00	2.37	22.28	59
	9.10	20	1.50	3.53	4.97	244
	9.10	20	1.50	-	4.97	252
	9.10	20	3.50	3.17	10.98	14
	9.10	20	5.50	2.66	16.35	15
	9.10	20	8.00	2.34	22.28	15
Sep. 24, PM Co = 5.92	4.53	10	2.00	2.74	5.82	1256
	4.53	10	2.00	-	5.82	2203
	4.53	10	4.00	2.47	11.03	194
	4.53	10	7.00	2.10	17.83	118
	4.53	10	10.00	1.74	23.57	284
	6.79	15	2.00	2.67	5.73	612
	6.79	15	2.00	-	5.73	629

6.79	15	4.00	2.45	10.85	71
6.79	15	7.00	2.11	17.54	23
6.79	15	10.00	1.68	23.20	141
9.05	20	2.00	2.68	5.58	324
9.05	20	2.00	-	5.58	209
9.05	20	4.00	2.45	10.76	32
9.05	20	7.00	2.35	17.84	34
9.05	20	10.00	1.92	24.16	17

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The following data is for samples tested with PAA followed by UV.

Sample Date	PAA Contact Time (min)	PAA Residual (mg·min/L)	CT dose (mg·min/L)	UV irradiation time (min)	UV dose (mJ/cm2)	Average N_{exp} (MPN/100mL)
Sep. 22, AM Co = 6.97	1.50	2.72	4.85	4.64	10	473
	1.50	2.72	4.85	6.96	15	117
	1.50	2.72	4.85	9.28	20	53
	3.50	2.69	10.64	4.64	10	17
	3.50	2.69	10.64	6.96	15	14
	3.50	2.69	10.64	9.28	20	423
	5.50	2.52	15.75	4.64	10	18
	5.50	2.52	15.75	6.96	15	19
	5.50	2.52	15.75	9.28	20	5
	8.00	2.16	21.30	4.64	10	86
	8.00	2.16	21.30	6.96	15	47
	8.00	2.16	21.30	9.28	20	20
Sep. 22, PM Co = 5.79	2.00	2.63	6.04	4.40	10	184
	2.00	2.63	6.04	6.60	15	120
	2.00	2.63	6.04	8.79	20	41
	4.00	2.49	11.43	4.40	10	35
	4.00	2.49	11.43	6.60	15	19
	4.00	2.49	11.43	8.79	20	4
	8.00	2.1	18.45	4.40	10	22
	8.00	2.1	18.45	6.60	15	58
	8.00	2.1	18.45	8.79	20	8
	10.00	1.82	24.38	4.40	10	42

	10.00	1.82	24.38	6.60	15	13
	10.00	1.82	24.38	8.79	20	28
Sep. 24, AM 6.95	1.50	3.08	4.97	4.55	10	477
	1.50	3.08	4.97	4.55	10	326
	1.50	3.08	4.97	6.82	15	148
	1.50	3.08	4.97	9.10	20	140
	3.50	2.78	10.98	4.55	10	181
	3.50	2.78	10.98	4.55	10	207
	3.50	2.78	10.98	6.82	15	81
	3.50	2.78	10.98	9.10	20	69
	5.50	2.58	16.35	4.55	10	142
	5.50	2.58	16.35	6.82	15	192
	5.50	2.58	16.35	6.82	15	206
	5.50	2.58	16.35	9.10	20	28
	8.00	2.01	22.28	4.55	10	473
	8.00	2.01	22.28	6.82	15	139
	8.00	2.01	22.28	9.10	20	372
Sep. 24, PM Co = 5.91	2.00	2.6	5.59	4.53	10	633
	2.00	2.6	5.59	4.53	10	697
	2.00	2.6	5.59	6.79	15	176
	2.00	2.6	5.59	9.05	20	134
	4.00	2.2	10.44	4.53	10	256
	4.00	2.2	10.44	4.53	10	130
	4.00	2.2	10.44	6.79	15	74
	4.00	2.2	10.44	9.05	20	41
	7.00	2	16.51	4.53	10	90

7.00	2	16.51	6.79	15	43
7.00	2	16.51	6.79	15	64
7.00	2	16.51	9.05	20	48
10.00	1.74	21.39	4.53	10	118
10.00	1.74	21.39	6.79	15	131

TROJAN technologies™

The following data is for the simultaneous treatment with UV and PAA.

Sample Date	UV irradiation time (min)	UV dose (mJ/cm2)	PAA Contact Time (min)	PAA Residual (mg·min/L)	CT dose (mg·min/L)	Average N_{exp} (MPN/100mL)
Sep. 22, AM Co = 6.25	4.64	10	4.65	2.79	14.46	234
	4.64	10	7.00	2.48	20.30	494
	4.64	10	9.00	2.31	24.64	192
	4.64	10	12.00	1.72	30.20	216
	6.96	15	7.00	2.14	20.30	154
	6.96	15	9.00	2.26	24.64	198
	6.96	15	12.00	1.93	30.20	296
	9.28	20	9.00	1.85	24.64	272
	9.28	20	12.00	1.82	30.20	212
	4.64	10	7.00	1.81	20.30	360
	4.64	10	9.00	1.46	24.64	851
	4.64	10	12.00	1.96	30.20	230
	6.96	15	9.00	2.01	24.64	148
	6.96	15	12.00	2.00	30.20	134
	9.28	20	12.00	1.35	30.20	80
Sep. 22, PM Co = 6.32	4.40	10	4.65	2.57	13.61	230
	4.40	10	4.65	-	13.61	244
	4.40	10	7.00	2.34	19.30	40
	4.40	10	9.00	2.14	23.61	38
	4.40	10	12.00	1.93	29.27	77
	6.60	15	7.00	2.24	19.30	183
	6.60	15	9.00	1.99	23.61	82

	6.60	15	12.00	1.28	29.27	48
	8.79	20	9.00	2.13	23.61	109
	8.79	20	12.00	1.86	29.27	22
	4.40	10	7.00	2.23	19.30	84
	4.40	10	9.00	1.95	23.61	25
	4.40	10	12.00	1.62	29.27	39
	6.60	15	9.00	2.15	23.61	202
	6.60	15	12.00	1.78	29.27	63
	8.79	20	12.00	1.85	29.27	48
Sep. 24, AM Co = 6.01	4.55	10	4.65	2.41	12.80	325
	4.55	10	4.65	-	12.80	1115
	4.55	10	7.00	2.14	18.21	326
	4.55	10	9.00	2.08	22.35	203
	4.55	10	12.00	1.73	27.81	255
	6.82	15	7.00	2.21	18.21	287
	6.82	15	9.00	2.08	22.35	334
	6.82	15	12.00	1.88	27.81	134
	9.10	20	9.00	1.81	22.35	240
	9.10	20	12.00	1.52	27.81	132
	4.55	10	7.00	2.26	18.21	444
	4.55	10	9.00	2.01	22.35	209
	4.55	10	9.00	1.64	22.35	311
	4.55	10	12.00	-	27.81	305
	6.82	15	9.00	2.05	22.35	195
	6.82	15	12.00	1.55	27.81	307
	9.10	20	12.00	1.56	27.81	103

	4.53	10	4.65	2.74	14.50	271
	4.53	10	4.65	-	14.50	1817
	4.53	10	7.00	2.53	20.60	441
	4.53	10	9.00	2.31	25.23	255
	4.53	10	12.00	2.11	31.34	273
	6.79	15	7.00	2.45	20.60	513
	6.79	15	9.00	2.38	25.23	560
Sep. 24, PM Co = 6.25	6.79	15	12.00	1.93	31.34	895
	9.05	20	9.00	2.14	25.23	154
	9.05	20	12.00	1.92	31.34	262
	4.53	10	7.00	2.39	20.60	414
	4.53	10	9.00	2.15	25.23	977
	4.53	10	9.00	-	25.23	828
	4.53	10	12.00	1.87	31.34	256
	6.79	15	9.00	2.11	25.23	700
	6.79	15	12.00	1.79	31.34	711
	9.05	20	12.00	1.54	31.34	161

Appendix B

Additional Testing for Disinfection – Contract 28231 at the T.E. Maxson Wastewater Treatment Plant

Technical Memorandum

To: *Scott Morgan, P.E.*
Mike Brower, Plant Manager
City of Memphis, Environmental Engineering Department

From: *Kati Bell, Ph.D., PE, BCEE*
Joshua E. Goldman, Ph.D.
Sarah A. Stewart, PE

Date: *April 28, 2015*

Subject: *Additional Testing for Disinfection - Contract 28231*
at the T.E. Maxson Wastewater Treatment Plant

This technical memorandum provides information and guidelines on the operation and sampling protocols for the peracetic acid (PAA) parallel pipe reactor pilot to be conducted at the T.E. Maxson wastewater treatment plant (Maxson WWTP). PAA piloting was previously conducted at the Maxson WWTP in 2013; during the time of the initial pilot testing, construction of the new fine bar screens was nearing completion. Since that time, the facility has observed notable improvements in plant performance. Additionally, there has been a significant change in the plant influent loading due to a reduction in discharges from one of the major industrial users. Considering these factors, coupled with the potential benefits of aligning disinfection technologies between the Maxson WWTP and the Stiles WWTP, it is useful to conduct a brief pilot study to determine whether these changes have impacted the UV and PAA design doses.

Objectives

The key objectives of the additional testing to be conducted are aimed at supplementing the bench and pilot testing that have previously been conducted at the Maxson WWTP. In order to confirm the results of previous testing, in light of the recent changes at the facility, the following objectives will be addressed with the current testing with respect to meeting limits for Eschercia coli (E. coli) as outlined in the current draft National Pollutant Discharge Elimination System (NPDES) permit:

- Confirm the UV disinfection design dose to support estimates of capital and operating costs
- Refine the design criteria for PAA disinfection to meet disinfection limits
    - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times; this information will be used to establish the sizing for a contact basin to support calculation of associated capital costs

- Determine the design dose for average conditions to support calculation of associated operating costs

UV Disinfection

In order to size a UV disinfection system, the disinfection dose must be established. For an existing facility with effluent available, the most accurate dose sizing can be accomplished using site-specific information for the target organism, here *E. coli*, based on its UV dose-response. This data is developed using a collimated beam test, which allows a sample to be exposed to UV irradiation at increasing doses, with measurement of the resulting bacteria concentration at each dose. The data is then analyzed to determine the target organism sensitivity (D_L) by evaluating the log inactivation rate per dose. The D_L is then used along with data on undisinfected effluent bacteria concentrations to establish target inactivation rates for design. The inactivation rates are multiplied by the site-specific D_L, and safety factors that represent the level of variability observed in multiple collimated beam studies to set the design dose. UV disinfection equipment systems are sized based on a bioassay of one or more surrogate organisms. In order to account for potential site-specific water quality effects on the disinfection of the surrogate organism, three collimated beam samples will also be run for MS2 (male-specific [F+] bacteriophage).

In addition to defining the UV dose through collimated beam testing, it is also important to characterize the effluent total suspended solids (TSS) with respect to its potential effects on UV disinfection. While the concentration of suspended solids (total weight measurement) is typically used to evaluate the potential performance of a UV disinfection system, correlations between suspended solids concentrations and UV performance are sometimes inconsistent. Thus, a great deal of research has been conducted on the impact of suspended solids on UV disinfection. Suspended solids cause the observed effects (i.e., decreased disinfection rate and tailing) by interfering with UV disinfection in three ways: (1) by scattering or absorbing light, (2) by shading organisms, and (3) by shielding embedded organisms. In these ways, particles can interfere with UV disinfection as shown in **Figure 1**.

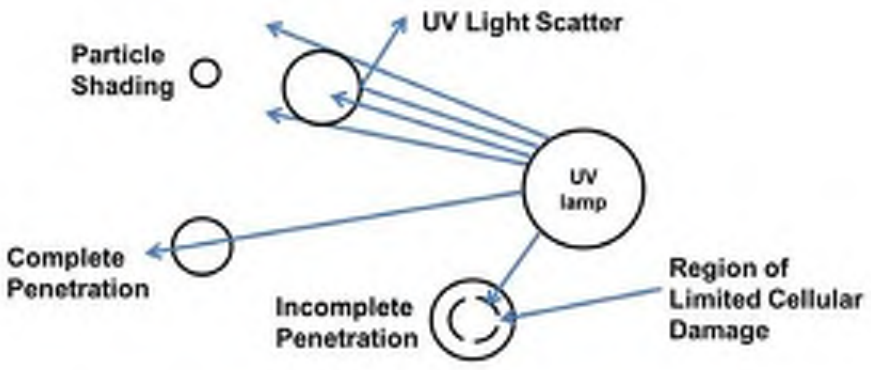


Figure 1. Possible Interactions between UV Light and Wastewater Particles

A number of researchers have concluded that UV light fully penetrates through particles smaller than 10 µm, but not at all through particles larger than 40 µm, even at high UV doses. Thus, 10 – 20 µm is a critical size, or the lower limit size for shielding microorganisms. The extent to which bacteria associate with particles appears to vary widely and is site specific; factors that affect bacterial association with particles include particle size, the nature of the particles, treatment type, and sludge age. Several studies have demonstrated that the protection provided by particles increases with particle size and both the dose and the level of survival at which the dose-response curve begins to tail decreases with a decrease in the size of particles. As a result, when conducting collimated beam studies to confirm design dose for a wastewater UV disinfection project, it is also recommended that a particle size analysis also be conducted. Once particle size distribution data has been collected, a project engineer will need to review the data to determine if the amount of TSS particles in the > 20 micron size fraction is of concern. If there is a significant fraction of > 20 micron particles, the project engineer will need to coordinate with the UV equipment manufacturer to adjust the delivered dose to account for the presence of these large particles.

UV Disinfection Testing Protocol

During this additional testing period, secondary effluent samples will be collected and shipped overnight on ice to an outside laboratory for collimated beam and particle size distribution analysis. Sample kits will be provided by the laboratory. For each collimated beam sample, 1.5 liters of secondary effluent will be collected in pre-cleaned bottles. For particle size distribution analysis (PSD), 500 milliliters of secondary effluent will be collected in pre-cleaned bottles. Two to three drops of bleach (provided in sample kit) will be added to the PSD samples for preservation. This prevents solids characteristics changing prior to analysis.

UV Disinfection Testing Schedule

Samples will be collected three times per week for four weeks for a total of 12 collections; the anticipated sample collection schedule is provided in **Table 1**.

Table 1 Collimated Beam and PSD Sampling Schedule

Date(s)	Samples Collected
May 4th, 11th, 18th ,	Collimated Beam (E. coli and MS2), Particle Size Distribution Analysis
May 5th, 6th, 12th, 13th, 19th, 20th, 25th, 26th, 27th	Collimated Beam (E. coli), Particle Size Distribution Analysis

PAA Disinfection

Unlike chlorine, PAA does not have well documented requirements for design, thus, it is critical to understand the disinfection kinetics associated with this process to provide appropriate design criteria for implementation. The most import factors for design of a PAA system are the contact time and design dose. For chlorine disinfection, a "CT" (residual concentration times contact time) approach has been traditionally used. However, this approach is not adequate in assessing the effectiveness of PAA disinfection because of differences in chemical half-lives. As a result, it is necessary to capture the PAA reaction kinetics and utilize it in a microbial inactivation model to describe the inactivation process taking place. There are a number of models that have been developed to address this effect and among the published models, Hom's model is the most widely used to account for deviations from the Chick-Watson formula:

$$\log\left(\frac{N}{N_0}\right) = -kC^n t^m$$

In Hom's model, *m* is used to account for the shorter half-life of PAA. The model has been validated in several studies, showing that Hom's model is the most appropriate for describing PAA disinfection of secondary wastewater effluent for coliform organisms (Rossi et al., 2007[1]; Azzellino et al., 2011[2]). Data will be collected during the pilot study that will support analysis using this model to make recommendations on the design dose and contact times for possible implementation of PAA at the Maxson WWTP.

[1] Rossi S., Antonelli M., Mezzanotte V., Nurizzo C. (2007). Peracetic acid disinfection: a feasible alternative to wastewater chlorination. *Water Environment Research*, 79 (4): 341-350.

[2] Azzellino A., Antonelli M., Canziani R., Malpei F., Marinetti M., Nurizzo C. (2011). Multivariate modeling of disinfection kinetics: A comparison among three different disinfectants. *Desalination and Water Treatment*, 29 (1/3): 128-139.

PAA Disinfection Testing Protocol

A mobile pilot reactor, supplied by PeroxyChem (**Figures 2** and **3**), will be installed at the Maxson WWTP near the final clarifiers. Test conditions for the pilot reactor are outlined in **Table 2**.

Figures 2 and 3 - Pipe Reactor Photos

Table 2 Testing Conditions

Design Parameter	Condition
Chemical Information	VigorOx® WWT II
	MSDS 79-21-0-27
	15% Peracetic Acid by Weight
Contact Time	20 min
PAA Dose Range	7-12 mg/L (as active ingredient)
Pipe Reactor Flow Rate	~25 gpm through the reactor

PeroxyChem will provide the pipe reactor, the PAA, chemical storage and containment systems, chemical feed pump skid, piping, valves, appurtenances, and tubing for the PAA feed system to the pipe reactor. Layout drawings of the PeroxyChem equipment are included in **Appendix A**. The pilot reactor arrived on site and is being installed the week of April 27th. The supply water to the PAA reactor will be effluent pumped from the final clarifiers to the PAA pilot; the pilot discharge will be routed back to the final clarifiers. Pumping capabilities and piping are provided by Peroxychem. The Material Safety Data Sheet (MSDS) for the PAA used in this pilot test is included in **Appendix B**.

Safety and operational training will be conducted by PeroxyChem for CDM Smith and T.E. Maxson personnel. Operation of the pilot will be performed by CDM Smith personnel during the course of the pilot; however CDM Smith staff will not be onsite 24-hours per day, 7-days per week, thus in the event that an issue arises with the pilot, Maxson WWTP staff will be trained on pilot-shut down procedures.

Pilot System Testing

Following the 2013 pilot study, a PAA dose of 13 mg/L was recommended for use at full scale. Kinetics are more favorable at the pilot scale, and data from the pilot (**Figure 4**) indicate that a dose of 10 mg/L was required to reduce the *E. coli* concentration to 126 colony forming units (cfu)/100 mL. A dose matrix was developed (**Table 3**) based on historical data from the pilot that was conducted in 2013 with the anticipation that recent changes at the facility that have improved effluent water quality may result in a lower required dose.

A bench scale test was performed the week of April 20th to verify the dose ranges identified in the previous pilot early in the pilot schedule. The PAA doses in the dose matrix may be modified during the testing, depending on the bench scale test results, which are anticipated by May 1st.

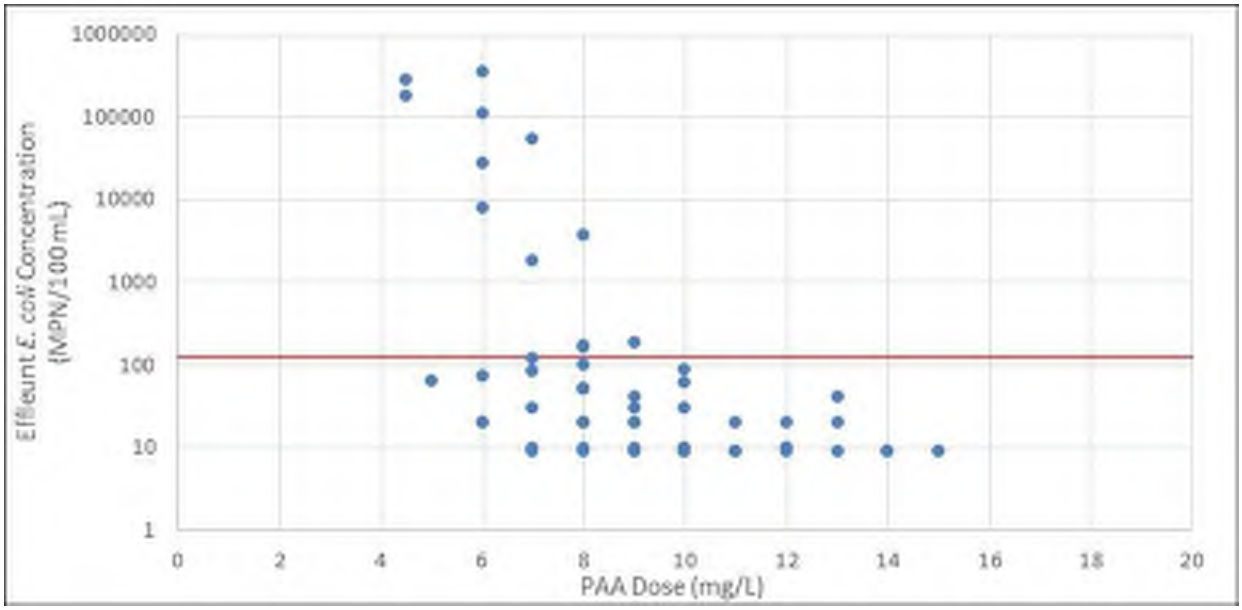


Figure 4 2013 PAA Pilot Data shown with Monthly Geometric Mean Limit of 126 cfu/100 mL

Table 3 Dose Matrix

Week	PAA Dose (mg/L)
1	7
2	8
3	9
4	10
5	11
6	12

Experiments will be conducted four times per day, Monday through Friday. The sampling matrix (**Table 4**) was developed to collect sufficient data for application of the Hom's model, to correlate water quality parameters such as TSS and apparent color with disinfection efficacy.

Table 4 Sampling Plan

Analysis	Measurement Location	Secondary Effluent (Control)	Sample Ports 1,2,3,4,5	Sample Port 6	Total[1]
TSS (mg/L)	ETC Lab	1x Daily		--	30
pH (SU)	Field	4x Daily	1x Daily	4x Daily	390[2]
Unfiltered UVT (%)	ETC Lab	1x Daily		1x Daily	60
Apparent Color (PtCo)	ETC Lab	1x Daily		1x Daily	60
Residual PAA (mg/L)	Field	4x Daily	1x Daily	4x Daily	390
E. coli (MPN/100 mL)	ETC Lab	4x Daily	1x Daily	4x Daily	390
Nitrite (mg/L)	ETC Lab	1x Daily		1x Daily	60

Notes:
1. Totals are based upon a pilot test duration of 6 weeks.
2. Total number of pH, PAA residual, and E. coli residual measurement were calculated as follows: 30 days of testing multiplied by 13 tests per day (4 at control port, 4 at port 6, 1 each at ports 1-5)

CDM Smith/Powers Hill staff will collect the samples identified in **Table 4**. A full kinetic test, in which samples are collected from every port on the reactor, will be performed once per day. The other three tests will include influent and effluent samples only. This scheme allows for multiple kinetic tests at each PAA dose, to provide data for Hom's model while minimizing sampling and analysis costs. Field parameters will be measured immediately and laboratory samples will be delivered on a daily basis to ETC Laboratory for analysis. PAA residual concentration will be measured using a hand held analyzer provided by PeroxyChem, and field pH will be measured using a meter provided by CDM Smith.

Although the dose matrix and sampling plan indicate a six week testing period, the pilot may be completed in four weeks if sufficient data is collected to support development of Hom's model. The

dose matrix is designed to start at a low PAA dose and increase weekly. The pilot schedule may be reduced if the dose resulting in complete inactivation of *E. coli* is reached before the sixth week.

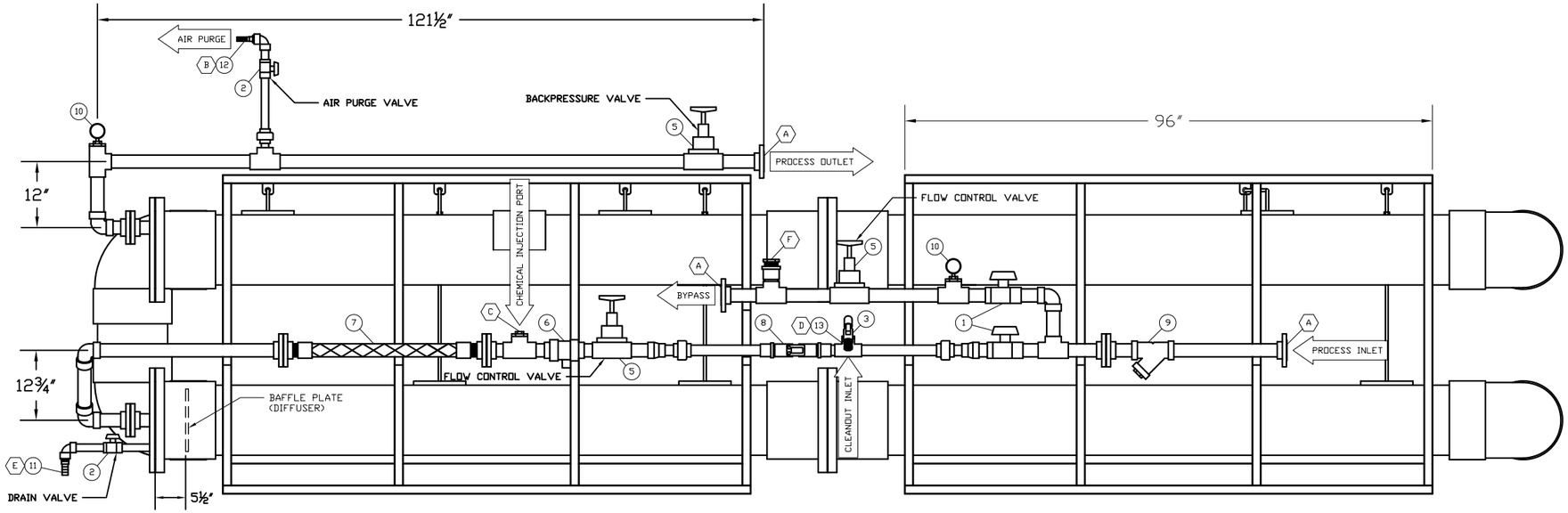
Post Pilot Testing Activities

Following completion of the testing, PeroxyChem will disassemble and remove the pilot reactor, the chemical feed skid, any remaining PAA, and the PAA storage and containment system from the Maxson WWTP.

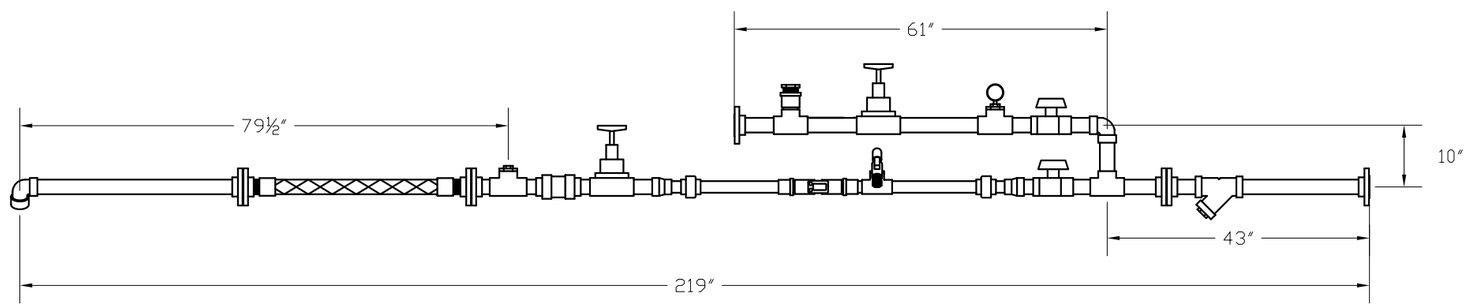
CDM Smith will update the original draft PAA pilot technical memorandum to include findings based on the results collected during this testing. The technical memorandum will summarize pilot data and results, including a recommended design dose and updated costs for both UV and PAA disinfection to meet the discharge permit limits.

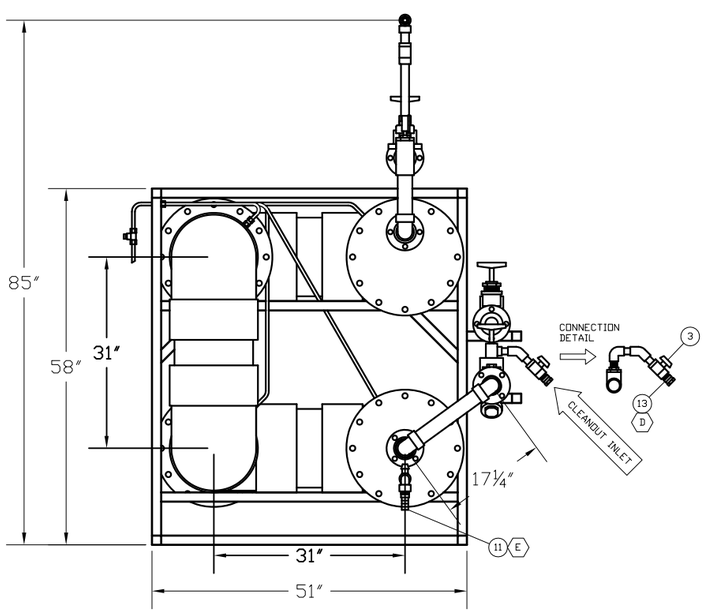
Appendix A

PeroxyChem Equipment Drawings



FRONT ELEVATION





END VIEW

BILL OF MATERIALS

1. BALL VALVE, 2″ SW, PVC, EPDM SEAL (2)
2. BALL VALVE, 1″ SW, PVC, EPDM SEAL (2)
3. BALL VALVE, ¾″ SW, PVC, EPDM SEAL (1)
4. BALL VALVE, ½″ TUBE FITTING, 316 SS, CHEMRAZ BUSHING AND PACKING (5)
5. GLOBE VALVE, 2″ SW, PVC, EPDM PACKING, PP DISC (3)
6. CHECK VALVE, 2″ FNPT, PVC, FLUOROELASTOMER SEAL (1)
7. STATIC MIXER, 12 BLADES, 35″ LONG, 2″ MNPT, PVC (1)
8. TURBINE FLOWMETER/TOTALIZER, 1½″ FNPT, PVC, 316 SS SEAL (1)
9. Y-STRAINER, 1/32″ PERFORATIONS, 2″ SW, PVC, FLUOROELASTOMER SEAL (1)
10. PRESSURE GAUGE, 0-100 PSI, , ¼″ MNPT, 316L SS (3)
11. HOSE ADAPTER, 1″ MNPT x 1″ HOSE ID, BLACK PP (1)
12. HOSE ADAPTER, ¾″ MNPT x ¾″ OD HOSE, 316 SS (1)
13. HOSE CONNECTION, ¾″ MNPT x ¾″ GARDEN HOSE, BRASS (1)

NOTE: DISTANCE FROM CHEMICAL INJECTION PORT TO INLET OF PIPE REACTOR (12″ PIPE) IS 108″ (EXACTLY 9′).

NOZZLE SCHEDULE

A. FLANGE, 2″ 150 LB RF, PVC (3)
B. ¾″ ID HOSE, 316 SS
C. ¼″ FNPT, 316 SS
D. GARDEN HOSE CONNECTION, ¾″, BRASS
E. 1″ ID HOSE, PP
F. PLUG, 2″ MNPT, PVC

MARK		DATE	BY	CHK.

REVISIONS

FMC Corporation
Technical Service Engineering
Box 845, Buffalo, New York 14240

REFERENCE DRAWINGS	FEED_AND_DISCHARGE_PIPING	
BOM_F2404706	FMC_PIPE_REACTOR	
XXXX	SHEET_1_OF_2	
XXXX	XXXX	
XXXX	XXXX	
XXXX	DRAWN: MJM	DATE: 1/13/2014
XXXX	SCALE: XXX	ENGINEER: MJM

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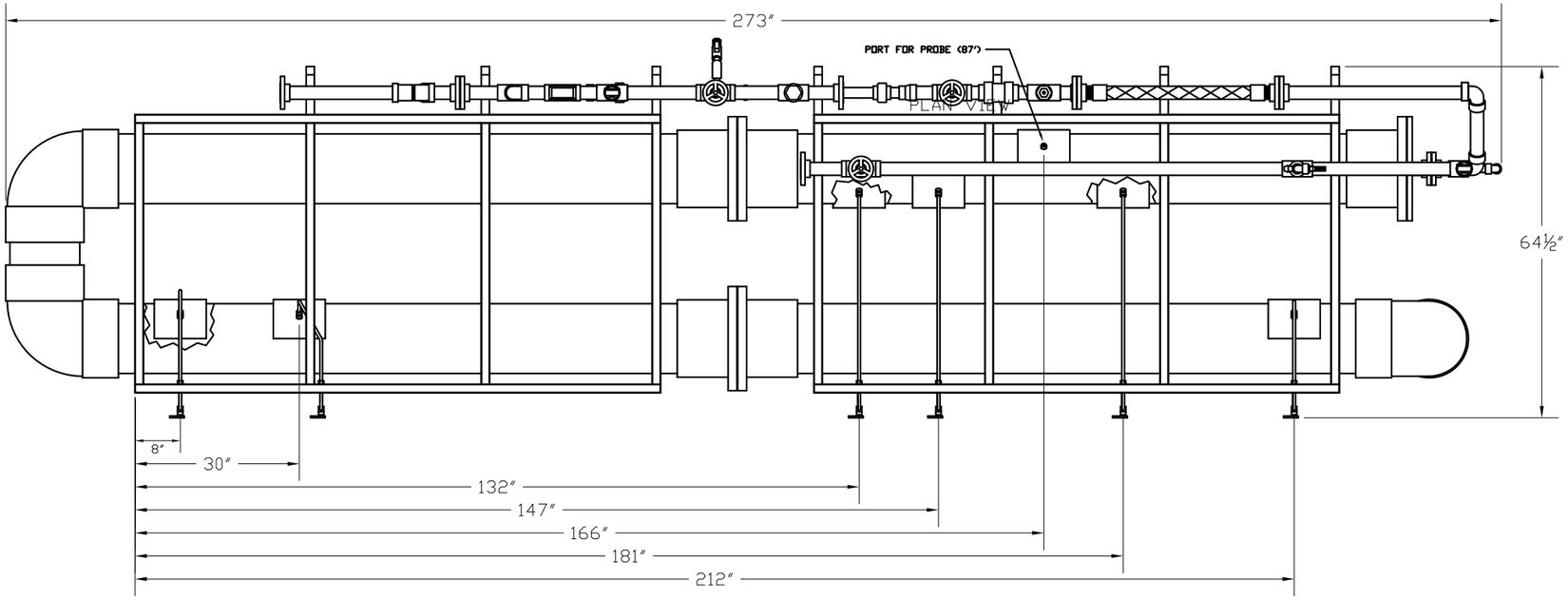
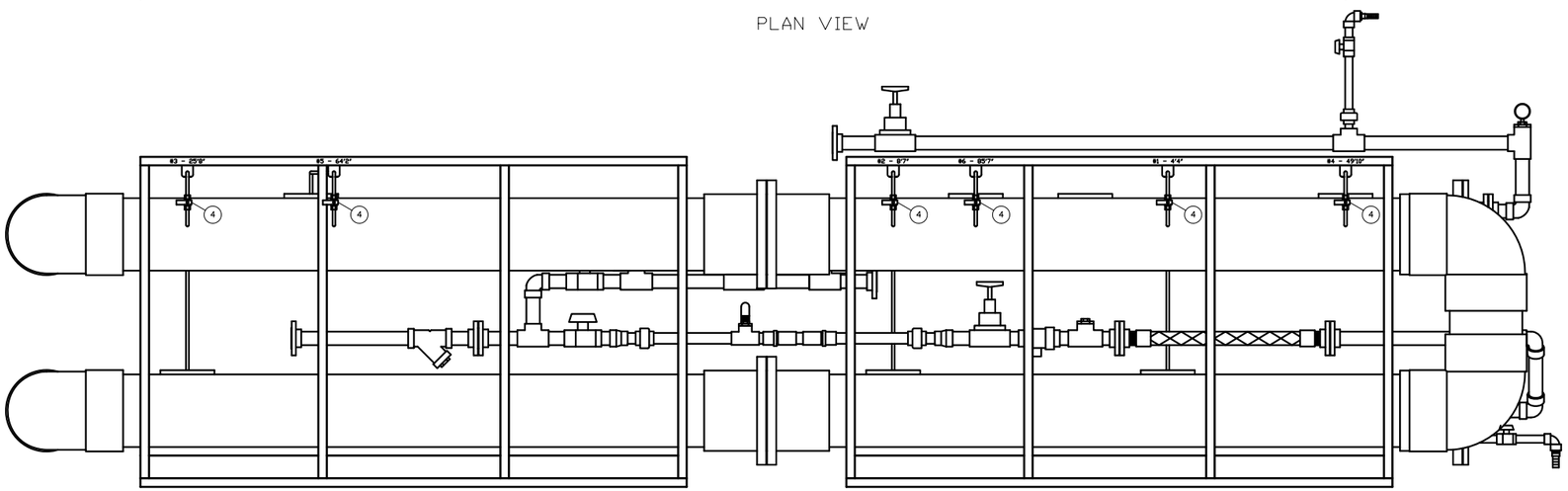
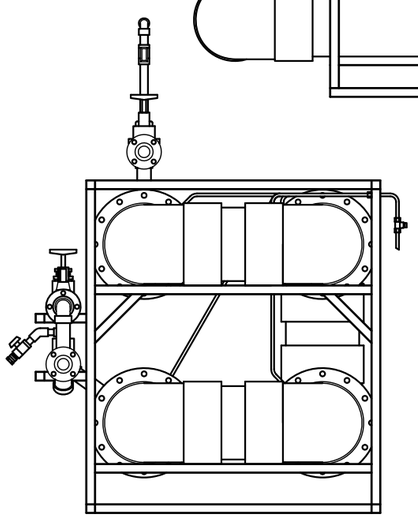


PLAN VIEW

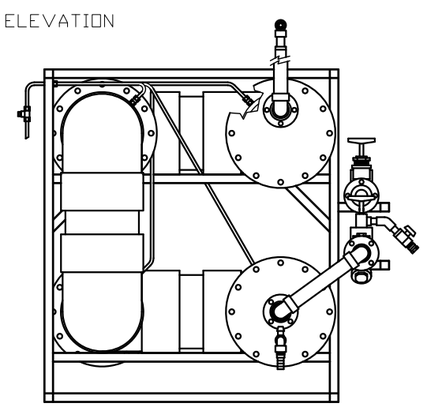


BACK ELEVATION



END VIEW

NOTE: DIMENSIONS ABOVE REPRESENT THE FOOTPRINT OF THE PIPE REACTOR AND LOCATIONS OF SAMPLE PORTS.



END VIEW

MARK		DATE	BY	CHK.

REVISIONS

FMC Corporation
Technical Service Engineering
Box 845, Buffalo, New York 14240

REFERENCE DRAWINGS	FEED_AND_DISCHARGE_PIPING	
BOM_F2404706	FMC_PIPE_REACTOR	
XXXX	SHEET_2_OF_2	
XXXX	XXXX	
XXXX	XXXX	
XXXX	DRAWN: MJM	DATE: 1/13/2014
XXXX	SCALE: XXX	ENGINEER: MJM

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Appendix B

PAA Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

VigorOx® WWT II

MSDS #: 79-21-0-27
Revision date: 2013-02-11
Version 1.01

This MSDS has been prepared to meet U.S. OSHA Hazard Communication Standard 29 CFR 1910.1200
And Canadian Workplace Hazardous Materials Information System (WHMIS) requirements.

1. PRODUCT AND COMPANY IDENTIFICATION

Product Name	**VigorOx® WWT II**
Synonyms	Peroxyacetic Acid Solution; Peracetic Acid Solution; Ethanperoxoic acid
EPA Registration Number	65402-8
Recommended Use:	Wastewater and sewage effluent disinfection; PeroxyChem acquired the EPA product registration from FMC

Manufacturer/Supplier

PeroxyChem LLC
2005 Market Street
Suite 3200
Philadelphia, PA 19103
Phone: +1 267/ 422-2400 (General Information)
E-Mail: sdsinfo@peroxychem.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:
1 800 / 424 9300 (CHEMTREC - U.S.A.)
1 703 / 527 3887 (CHEMTREC - Collect - All Other Countries)
1 303/ 389-1409 (Medical - U.S. - Call Collect)

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Clear liquid with a sharp, pungent, vinegar-like odor
oxidizer
Contact with combustible material may cause fire
Liquid and mist are corrosive
Direct contact can cause irreversible damage to eyes and skin

Potential Health Effects

Eyes	Corrosive to the eyes and may cause severe damage including blindness.
Skin	Corrosive to skin.
Inhalation	Vapor/mist will irritate nose, throat and lungs.
Ingestion	Harmful if swallowed.
Chronic toxicity	Repeated inhalation of the mist may cause inflammation of the upper respiratory tract, chronic bronchitis and etching of the dental enamel.
Environmental Hazard	Very toxic to aquatic organisms.

EPA-HQ-2019-004783 001945

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical name	CAS-No	Weight %
Water	7732-18-5	45
Hydrogen Peroxide	7722-84-1	23
Acetic Acid	64-19-7	16
Peracetic Acid	79-21-0	15
Sulfuric Acid	7664-93-9	1

4. FIRST AID MEASURES

Eye Contact Immediately flush with plenty of water. After initial flushing, remove any contact lenses and continue flushing for at least 15 minutes. Immediate medical attention is required.

Skin Contact Wash off immediately with soap and plenty of water for at least 15 minutes while removing all contaminated clothing and shoes. Immediate medical attention is required.

Inhalation Move to fresh air. If breathing is irregular or stopped, administer artificial respiration. Administer oxygen if breathing is difficult. Call a poison control center or doctor for further treatment advice.

Ingestion Immediate medical attention is required. Rinse mouth. Do NOT induce vomiting. Drink 1 or 2 glasses of water. Never give anything by mouth to an unconscious person. If swallowed, do not induce vomiting - seek medical advice.

Indication of immediate medical attention and special treatment needed, if necessary This product can be corrosive to skin, eyes, and mucous membranes. Consideration should be given to careful endoscopy as stomach or esophageal burns, perforations or strictures may occur. Careful gastric lavage with an endotracheal tube in place should be considered. Observations may be warranted. Treatment is controlled removal of exposure followed by symptomatic and supportive care.

5. FIRE-FIGHTING MEASURES

Flammable properties Substance does not burn but will support combustion.

Flash point 68 °C Closed cup

Suitable Extinguishing Media Water. Cool containers with flooding quantities of water until well after fire is out.

Unsuitable extinguishing media Chemical type extinguishers are not effective with peracetic acid or hydrogen peroxide.

Uniform Fire Code Organic Peroxide: Class 4--Liquid

Explosion data

Sensitivity to Mechanical Impact Not Available
Sensitivity to Static Discharge Not Available

Specific Hazards Arising from the Chemical Decomposes under fire conditions to release oxygen that intensifies the fire.

Protective equipment and precautions for firefighters Wear self-contained breathing apparatus and protective suit. Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.

NFPA	Health Hazards 3	Flammability 1	Stability 2	Special Hazards OX

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Keep people away from and upwind of spill/leak. Avoid contact with the skin and the eyes. Use personal protective equipment. For personal protection see section 8.

Methods for Containment

Control runoff and isolate discharged material for proper disposal. Do not allow material to enter storm or sanitary sewer system

Methods for cleaning up

Combustible materials exposed to hydrogen peroxide should be immediately submerged in or rinsed with large amounts of water to ensure that all hydrogen peroxide is removed. Residual hydrogen peroxide that is allowed to dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in fire.

7. HANDLING AND STORAGE

Handling

Handle product only in closed system or provide appropriate exhaust ventilation.
Drums - Empty as thoroughly as possible. Triple rinse drums before disposal. Avoid contamination; impurities accelerate decomposition. Never return product to original container.
IBCs (Tote) - IBCs should be emptied as thoroughly as possible and recycled without rinsing.

Storage

Keep in a dry, cool and well-ventilated place. Do not store near combustible materials. Keep away from heat and sources of ignition i.e., steam pipes, radiant heaters, hot air vents or welding sparks. Keep at temperatures below 30°C. Containers must be vented. Use first in, first out storage system.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Exposure Guidelines .

Chemical name	ACGIH TLV	OSHA PEL	NIOSH	Mexico
Hydrogen Peroxide 7722-84-1	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	IDLH: 75 ppm TWA: 1 ppm TWA: 1.4 mg/m^3	Mexico: TWA 1 ppm Mexico: TWA 1.5 mg/m^3 Mexico: STEL 2 ppm Mexico: STEL 3 mg/m^3
Sulfuric Acid 7664-93-9	TWA: 0.2 mg/m^3	TWA: 1 mg/m^3	IDLH: 15 mg/m^3 TWA: 1 mg/m^3	Mexico: TWA 1 mg/m^3
Acetic Acid 64-19-7	STEL 15 ppm TWA: 10 ppm	TWA: 10 ppm TWA: 25 mg/m^3	IDLH: 50 ppm TWA: 10 ppm TWA: 25 mg/m^3 STEL: 15 ppm STEL: 37 mg/m^3	Mexico: TWA 10 ppm Mexico: TWA 25 mg/m^3 Mexico: STEL 15 ppm Mexico: STEL 37 mg/m^3
Peracetic Acid 79-21-0	STEL 0.4 ppm			

Chemical name	British Columbia	Quebec	Ontario TWAEV	Alberta
Hydrogen Peroxide 7722-84-1	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3
Acetic Acid 64-19-7	TWA: 10 ppm STEL: 15 ppm	TWA: 10 ppm TWA: 25 mg/m^3 STEL: 15 ppm STEL: 37 mg/m^3	TWA: 10 ppm STEL: 15 ppm	TWA: 10 ppm TWA: 25 mg/m^3 STEL: 15 ppm STEL: 37 mg/m^3
Sulfuric Acid 7664-93-9	TWA: 0.2 mg/m^3	TWA: 1 mg/m^3 STEL: 3 mg/m^3	TWA: 0.2 mg/m^3	TWA: 1 mg/m^3 STEL: 3 mg/m^3

Occupational exposure controls

Engineering measures

Apply technical measures to comply with the occupational exposure limits. When working in confined spaces (tanks, containers, etc.), ensure that there is a supply of air suitable for breathing and wear the recommended equipment.

General information

These recommendations apply to the product as supplied

Respiratory Protection	When workers are facing concentrations above the exposure limit they must use appropriate certified respirators. Wear a positive-pressure supplied-air respirator with full facepiece.
Eye/Face Protection	Chemical resistant goggles must be worn. If splashes are likely to occur, wear: Face-shield.
Skin and Body Protection	Rubber or neoprene footwear. Impervious clothing materials such as rubber, neoprene, nitrile or polyvinyl chloride. Wear liquid proof rubber or neoprene gloves Hydrogen peroxide is an ingredient in this product; completely submerge hydrogen peroxide contaminated clothing or other materials in water prior to drying. Residual hydrogen peroxide, if allowed to dry on combustible materials such as paper, fabrics, leather or wood can cause the material to ignite and result in a fire
Hand Protection	Rubber/latex/neoprene or other suitable chemical resistant gloves. Wash the outside of gloves with soap and water prior to removal. Inspect regularly for leaks. Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. Also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion and the contact time. If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the EC approved gloves
Other Protective Equipment	Ensure that eyewash stations and safety showers are close to the workstation location.
Hygiene measures	When using, do not eat, drink or smoke. Wear suitable gloves and eye/face protection Wash hands before breaks and at the end of workday. Wash hands with water as a precaution Regular cleaning of equipment, work area and clothing is recommended Avoid breathing vapors, mist or gas.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Clear, colorless liquid
Physical State	Liquid
Odor	stinging, Pungent, vinegar-like
pH	< 1 (1% solution = 2-3 @ 25°C)
Melting Point/Range	Not applicable
Freezing Point	-49 °C
Boiling Point/Range	108 °C
Flash point	68 °C Closed cup
Evaporation Rate	>1 (BuAc = 1)
Flammable properties	Substance does not burn but will support combustion
Oxidizing properties	Strong oxidizer
Vapor pressure	20 mm Hg at 25ºC
Specific gravity	1.16 @ 20°C (H20 = 1)
Bulk Density	Not applicable
Water solubility	completely soluble
Decomposition temperature	> 55 °C (SADT)
Autoignition temperature	270 °C

10. STABILITY AND REACTIVITY

Stability	Stable under recommended storage conditions. Decomposes on heating.
Conditions to Avoid	Heat, flames and sparks; Combustibles such as paper and wood; Temperatures above 30°C.
Materials to avoid	Oxidizing agents; Strong reducing agents; Combustible materials; Heavy metals.
Hazardous Decomposition Products	Oxygen which supports combustion.
Hazardous polymerization	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Acute Effects

Eye irritation Severely irritating, corrosive (rabbit)
Skin irritation Severely irritating, corrosive (rabbit)

LD50 Oral LD50 Rat = 50 -500 mg/kg/bw (35% Peracetic acid)
LD50 rat = 1026-1780 mg/kg/bw (15% Peracetic acid)
LD50 rat = 185-3622 mg/kg/bw (2.6-6.11% Peracetic acid)

LD50 Dermal LD50 Rat = 1957 mg/kg/bw (15% Peracetic acid)
LD50 rat = 1147 mg/kg/bw (5% Peracetic acid)
LD50 rat = >2000 mg/kg/bw (Peracetic acid 0.15%-0.89%)

LC50 Inhalation LC50 (4-hr) Rat = 76-189 mg/m^3 (15% Peracetic acid)
LC50 (4-h) rat = 204 mg/m^3 (5% Peracetic acid)

Sensitization Did not cause sensitization on laboratory animals

Chronic toxicity

Chronic toxicity Repeated inhalation of the mist may cause inflammation of the upper respiratory tract, chronic bronchitis and etching of the dental enamel.

Carcinogenicity Did not show carcinogenic effects in animal experiments Topical applications do not produce skin tumors Not recognized as carcinogenic by Research Agencies (IARC, NTP, OSHA, ACGIH)

Chemical name	ACGIH	IARC	NTP	OSHA
Hydrogen Peroxide	A3	Group 3		
Sulfuric Acid	A2	Group 1		X

Legend:

IARC (International Agency for Research on Cancer)
Group 1 - Carcinogenic to Humans
OSHA (Occupational Safety and Health Administration of the US Department of Labor)
X - Present

12. ECOLOGICAL INFORMATION

Ecotoxicity

Peracetic Acid (79-21-0)

Active Ingredient(s)	Duration	Species	Value	Units
Peracetic Acid 15%	96 h LC50	Oncorhynchus mykiss (rainbow trout)	0.53	mg/L
Peracetic Acid 5%	96 h LC50	Bluegill sunfish	1.1	mg/L
Peracetic Acid	33 d NOEC	Brachydanio rerio	0.00225	mg/L
Peracetic Acid 5%	96 h LC50	Oncorhynchus mykiss (rainbow trout)	1.6	mg/L
Peracetic Acid 5%	48 h EC50	Daphnia magna	0.73	mg/L
Peracetic Acid 12.5%	48 h EC50	Mytilus sdulis	0.27	mg/L
Peracetic Acid 15%	21 d NOEC	Daphnia magna	0.05	mg/L
Peracetic Acid 5%	72 h EC50	Selenastrum capricornutum	0.16	mg/L
Peracetic Acid 5%	120 h EC50	Selenastrum capricornutum	0.18	mg/L
Peracetic Acid 5%	72 h NOEC	Selenastrum capricornutum	0.061	mg/L
Peracetic Acid	3 h EC50	Respiration inhibition test (OECD 209)	5.1	mg/L

Persistence and degradability Peracetic acid is completely miscible with water. Aqueous solutions of peracetic acid hydrolyze to acetic acid and hydrogen peroxide. Product is biodegradable

Bioaccumulation Based on its low octanol-water partition coefficient and its rapid degradation in the environment, this product is not bioaccumuable.

Mobility Peracetic acid released in the environment will partition almost exclusively (>99%) to the water compartment. Only a minor part (<1%) will remain in the atmosphere, where it is expected to undergo rapid decomposition with a half life of 22 minutes. The fate of peracetic acid in the environment is mainly determined by its degradation.

Other Adverse Effects None known

13. DISPOSAL CONSIDERATIONS

Waste disposal methods This material, as supplied, is a hazardous waste according to federal regulations (40 CFR 261). It must undergo special treatment, e.g. at suitable disposal site, to comply with local regulations. Dispose of contents/container in accordance with local regulation.

RCRA D Waste Code D001 (ignitable). D002 (corrosive).

Contaminated Packaging Non-returnable containers that held this material should be cleaned by triple-rinsing prior to recycle or disposal. Empty containers should be taken to an approved waste handling site for recycling or disposal.

US EPA Waste Number D002

14. TRANSPORT INFORMATION

DOT

UN/ID no UN3109
Proper Shipping Name ORGANIC PEROXIDE TYPE F, LIQUID (<=17% Peracetic Acid with <=26% Hydrogen Peroxide)

Hazard class	5.2
Subsidiary class	8
Packing Group	II

TDG

UN/ID no	UN3109
Proper Shipping Name	ORGANIC PEROXIDE TYPE F, LIQUID (<=17% Peracetic Acid with <=26% Hydrogen Peroxide)
Hazard class	5.2
Subsidiary class	8
Packing Group	II
Description	UN3109, Organic Peroxide Type F, Liquid (<=17% Peracetic Acid with <=26% Hydrogen Peroxide), 5.2 (8), PG II

ICAO/IATA

UN/ID no	UN3109
Proper Shipping Name	ORGANIC PEROXIDE TYPE F, LIQUID (<=17% Peracetic Acid with <=26% Hydrogen Peroxide)
Hazard class	5.2
Subsidiary Hazard Class	8
Packing Group	II
Special Provisions	Venting of packages is not permitted for air transport.
Description	UN3109, Organic Peroxide Type F, Liquid (<=17% Peracetic Acid with <=26% Hydrogen Peroxide), 5.2 (8), PG II

IMDG/IMO

UN/ID no	UN3109
Proper Shipping Name	ORGANIC PEROXIDE TYPE F, LIQUID (<=17% Peracetic Acid with <=26% Hydrogen Peroxide)
Hazard class	5.2
Subsidiary Hazard Class	8
Packing Group	II
Description	UN3109, Organic Peroxide Type F, Liquid (<=17% Peracetic Acid with <=26% Hydrogen Peroxide), 5.2 (8), PG II

15. REGULATORY INFORMATION

International Inventories

TSCA (United States)	Complies
DSL (Canada)	Complies
NDSL (Canada)	Complies
EINECS/ELINCS (Europe)	Complies
ENCS (Japan)	Complies
China (IECSC)	Complies
KECL (Korea)	Complies
PICCS (Philippines)	Complies
AICS (Australia)	Complies
NZIoC (New Zealand)	Complies

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

SARA 311/312 Hazard Categories

Acute health hazard	Yes
Chronic health hazard	No

Fire hazard	Yes
Sudden release of pressure hazard	No
Reactive Hazard	Yes

CERCLA

Chemical name	Hazardous Substances RQs	Extremely Hazardous Substances RQs
Hydrogen Peroxide		1000 lb
Acetic Acid	5000 lb	
Peracetic Acid		500 lb
Sulfuric Acid	1000 lb	1000 lb

International Regulations

Mexico - Grade Serious risk, Grade 3

Chemical name	Carcinogen Status	Mexico
Hydrogen Peroxide	A3	Mexico: TWA 1 ppm Mexico: TWA 1.5 mg/m^3 Mexico: STEL 2 ppm Mexico: STEL 3 mg/m^3
Acetic Acid		Mexico: TWA 10 ppm Mexico: TWA 25 mg/m^3 Mexico: STEL 15 ppm Mexico: STEL 37 mg/m^3
Sulfuric Acid	A2	Mexico: TWA 1 mg/m^3

CANADA

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

WHMIS Hazard Class

B3 - Combustible liquid
C - Oxidizing materials
E - Corrosive material
D2B - Toxic materials

16. OTHER INFORMATION

HMIS	Health Hazards 3	Flammability 1	Stability 2	Special precautions h

NFPA/HMIS Ratings Legend
Severe = 4; Serious = 3; Moderate = 2; Slight = 1; Minimal = 0

Protection=H (Safety goggles, gloves, apron, the use of supplied air or SCBA respirator is required in lieu of a vapor cartidge respirator)

Revision date: 2013-02-11
Reason for revision: Initial Release.

Disclaimer
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Prepared By:

PeroxyChem
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WATER TREATMENT

End of Safety Data Sheet

Appendix C

Lifecycle Analysis Cost Sheets

PAA Cost Sheet
Peak Contact Time = 31 minutes

Peak Hour Flow	MGD		170
Avg Flow	MGD		90
Influent E. coli - Peak	MPN/100 mL		1,600,000
Target E. coli - Peak	MPN/100 mL		244
Influent E. coli - Average	MPN/100 mL		518,730
Target E. coli	MPN/100 mL		63
LI Peak	--		4
LI Average			4
Contact Time at Peak Flow	min		31
Peak Dose	mg/L		7.7
Peak Residual	mg/L		1.3
Avg Contact Time	min		59
Avg Dose	**mg/L**		7.3
Avg Residual	mg/L		0.4
Tank Size	cf		489,235
Tank Cost	$	$	9,591,263
Present Value PAA Annual Cost	$		142,000,000
PAA Storage and Feed	$	$	4,373,436
Present Value SBS Annual Cost	$	$	-
Total Capital Cost	$	$	13,964,699
Total Annual Cost	$		142,000,000
Lifecycle Costs		$	155,964,699

Annual Costs for Peracetic Acid			
Average treated flow, mgd	90		
Days per year of treatment	365		
PAA dose, mg/L	7.3		
Percent solution PAA, %	15		
Specific density of PAA, lbs/gal	9.7		
Gallons per year, as delivered	1,369,000		
Price per gallon, as delivered	$5.82		$0.60/per lb PAA
Annual chemical costs for PAA		7,968,000.0	
SBS dose, mg/L	-0.9		
Percent solution SBS, %	38		
Specific density of SBS, lbs/gal	11.1		
Gallons per year, as delivered	(56,108)		
Price per gallon, as delivered	$1.55		
Annual chemical costs for SBS		$ (86,968)	
Lifecycle in years	20		
Discount rate	4.13%	*P/A factor =*	
Inflation rate	3.00%	17.87	
Annual Costs for Peracetic Acid		$ 7,880,000	
Present Value of Annual Costs		$ 141,000,000	

PAA Cost Sheet
Peak Contact Time = 16 minutes

Peak Hour Flow	MGD		170
Avg Flow	MGD		90
Influent E. coli - Peak	MPN/100 mL		1,600,000
Target E. coli - Peak	MPN/100 mL		244
Influent E. coli - Average	MPN/100 mL		518,730
Target E. coli	MPN/100 mL		63
LI Peak	--		4
LI Average			4
Contact Time at Peak Flow	min		16
Peak Dose	mg/L		9.8
Peak Residual	mg/L		3.4
Avg Contact Time	min		30
Avg Dose	**mg/L**		8.4
Avg Residual	mg/L		1.6
Tank Size	cf		252,509
Tank Cost	$	$	5,668,563
Present Value PAA Annual Cost	$		167,000,000
PAA Storage and Feed	$	$	4,373,436
SBS Storage and Feed	$	$	1,441,034
Present Value SBS Annual Cost	$	$	86,625
Total Capital Cost	$	$	10,041,999
Total Annual Cost	$		167,086,625
Lifecycle Costs		$	177,128,625

Annual Costs for Peracetic Acid			
Average treated flow, mgd	90		
Days per year of treatment	365		
PAA dose, mg/L	8.4		
Percent solution PAA, %	15		
Specific density of PAA, lbs/gal	9.7		
Gallons per year, as delivered	1,586,000		
Price per gallon, as delivered	$5.82		$0.60/per lb PAA
Annual chemical costs for PAA		9,231,000.0	
SBS dose, mg/L	0.9		
Percent solution SBS, %	38		
Specific density of SBS, lbs/gal	11.1		
Gallons per year, as delivered	56,322		
Price per gallon, as delivered	$1.55		
Annual chemical costs for SBS		$ 87,300	
Lifecycle in years	20		
Discount rate	4.13%	*P/A factor =*	
Inflation rate	3.00%	17.87	
Annual Costs for Peracetic Acid		$ 9,320,000	
Present Value of Annual Costs		$ 167,000,000	

UV System Cost Sheet
20% UVT

Total Capital Costs	UV Equipment Costs	UV Construction Cost
$ 26,200,000	$ 8,705,000	$ 17,500,000

Annual Costs for Maxson WWTP Facility			
Average treated flow (mgd)	90		
Number of Lamps per MGD @ADF	10.7		
Days per year of treatment	365		
UV dose (mJ/cm2) as T1	19		
Number of lamps at average flow	960		
Power input per lamp (watts)	804		Per Trojan
Annual Electric Usage (kW-hr/yr)	6,710,000		
Electricity cost ($/kW-hr)	$0.076		
Annual electricity costs for UV		$ 510,000	
Guaranteed lamp life (hours)	15,000		From Trojan: Lamp warranty = 15,000 hours
Lamp replacement cost	$450		From Trojan: Lamp price = $450
Guaranteed ballast life (years)	10		From Trojan: Lamp driver warranty = 10 years
Ballast replacement cost	$990		From Trojan: Lamp driver price = $990
Annual costs for lamp replacement		$ 250,000	
Annual costs for ballast replacement		$ 48,000	
Lifecycle in years	20		
Discount rate	4.13%	*P/A factor =* 17.87	
Inflation rate	3.00%		
Annual Costs		$ 810,000	
Present Value of Annual Costs		$ 14,000,000	

BLACK & VEATCH
Corporation

3485 Poplar Avenue, Suite 230, Memphis TN 38111, 901-495-2646

B&V Project 183157

MEMPHIS, TENNESSEE
T. E. MAXSON WWTF
BIOSOLIDS LAGOON 5 RENOVATION

OPINION OF
PROBABLE CONSTRUCTION COST
May 28, 2015

SUMMARY

General Requirements	$1,783,900
Sitework	$22,298,422
Subtotal	**$24,082,322**
Contingency 25%	$6,020,581
Total Probable Construction Cost	$30,102,903

BLACK & VEATCH

Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
GENERAL REQUIREMENTS				
Mobilization		Lump Sum		356,800
Supervision		Lump Sum		891,900
Temporary facilities		Lump Sum		267,600
Temporary utilities		Lump Sum		178,400
Equipment rental & misc.		Lump Sum		89,200
Total - General Requirements				$1,783,900
SITEWORK				
Site restoration		Lump Sum		10,000
Clearing and grubbing	3,500	sq yd	1.50	5,250
Erosion control		Lump Sum		50,000
Earthwork				
Excavation	486,000	cu yd	5.00	2,430,000
Embankments & fill	352,000	cu yd	3.00	1,056,000
Wasting (on site)	134,000	cu yd	5.00	670,000
Dewatering (20 deep wells, pumps, piping)		Lump Sum		975,000
Finish grade outside lagoons	46,600	sq yd	1.25	58,250
Seeding	46,600	sq yd	0.75	34,950
Surfacings				
Asphalt pavement	20,500	sq yd	70.00	1,435,000
Fencing				
Chain link fencing	5,400	lin ft	50.00	270,000
Maintenance gates, double leaf	3	each	2,100.00	6,300
Sludge removal	31,450	dry ton	255.00	8,019,750
Riprap	120	sq yd	50.00	6,000
Yard pipe				
36"				
L5B/L5C Connection	250	lin ft	177.00	44,250
L5A/L5B Connection	250	lin ft	177.00	44,250
L5C Effluent	170	lin ft	177.00	30,090
L5B Effluent	180	lin ft	177.00	31,860
L5A Effluent	185	lin ft	177.00	32,745
L5 Effluent	1,235	lin ft	177.00	218,595
24"				
L5 influent header	1,295	lin ft	122.00	157,990
L5C Influent	70	lin ft	122.00	8,540
L5B Influent	70	lin ft	122.00	8,540
L5A Influent	155	lin ft	122.00	18,910
Decant	1,460	lin ft	122.00	178,120
Biogas	3,300	lin ft	122.00	402,600
Drainage Ditch Culvert	80	lin ft	122.00	9,760
16" Biogas	2,590	lin ft	76.50	198,135
16" Storm Drain	300	lin ft	76.50	22,950
12" Biogas new header	800	lin ft	50.00	40,000
12 " Perfc Included in liner cost				

BLACK & VEATCH

Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Plug Valves				
36"	7	each	38,000.00	266,000
24"	3	each	18,000.00	54,000
12"	12	each	3,000.00	36,000
Structures				
Condensate Sump				
Structure				
36" SDR 17 HDPE pump wet well	3	each	3,500.00	10,500
Equipment				
Section 11161 - Submersible Condensate Pump, CP-22, 22' RTH @ 20 gpm, 1/2 hp	3	each	2,000.00	6,000
Mechanical				
4" HDPE pipe	6	lin ft	40.00	240
4" BFV	1	each	900.00	900
1 1/2" HDPE piping w/valves		Lump Sum		150
Connection to 16" gas line	1	each	1,000.00	1,000
Lagoon 5A				
Ringwall, Concrete, cast in place	2,640	lin ft	95.00	250,800
Ringwall, H pile	2,640	lin ft	50.00	132,000
Geomembrane liner, 60 mil		Lump Sum		422,500
Geomembrane cover, 100 mil		Lump Sum		401,000
Embed		Lump Sum		131,000
Weight System		Lump Sum		11,000
Pipe penetration pad				
36" Effluent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
24" Influent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
36" L5A/L5B Connection				
Concrete, cast in place				
Slab on grade (2)	1	CY	700.00	350
Pipe cradle	28	CY	700.00	19,600
Liner connection to pad (2)				
1/4" x 3" 316 SS continous plate	40	lin ft	30.00	1,200
3/8" 316 SS expans. anchors, 8" ctrs.	60	each	20.00	1,200
Pipe boot cover	2	each	400.00	800
Lagoon Cover Sump				
Structure				
32" SDR 17 HDPE pump wet well, 2'-6" dp	8	each	800.00	6,400
Ballast plates, SS		Lump Sum		1,800
Connect sump to HDPE cover		Lump Sum		1,200
Equipment				
Self Priming Centrifugal Pump	8	each	7,500.00	60,000
Concrete, cast in place				
Slab on grade (8)	11	CY	700.00	7,350
Enclosure	8	each	3,500.00	28,000
Mechanical				
Ballast pipe modification at sump		Lump Sum		1,500
1 1/2" HDPE piping w/valves		Lump Sum		500

BLACK & VEATCH

Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovation
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Vent Stack				
Earthwork				
Structural excavation	21	cu yd	15.00	315
Compacted fill	15	cu yd	35.00	525
Granular fill	1	cu yd	36.00	36
Concrete cast in place				
Slab on grade	1	cu yd	700.00	700
Columns	1	cu yd	700.00	700
Metals				
Structural steel for vent support	750	pounds	5.00	3,750
Anchor bolts, 3/4" x 1' - 6"	16	each	25.00	400
Mechanical				
Vent stack				
12" HDPE	21	lin ft	50.00	1,050
12" Fitting	1	each	550.00	550
Valves				
12" BFV	4	each	3,000.00	12,000
Connection to existing pipe		Lump Sum		10,000
Decant Structure				
Earthwork				
Structural excavation	41	cu yd	15.00	615
Compacted fill	31	cu yd	35.00	1,085
Granular fill	2	cu yd	36.00	72
Concrete cast in place				
Slab on grade	4	cu yd	700.00	2,800
Walls	8	cu yd	700.00	5,600
Suspended slab	3	cu yd	700.00	2,100
Fill	1	cu yd	250.00	250
Metals				
Handrail	52	lin ft	120.00	6,240
Alum access hatch, 2'-6"	1	each	450.00	450
Mechanical				
Slide gate, 48" x 24"	1	each	7,000.00	7,000
Pipe connection to structure		Lump Sum		1,200
Cover				
1/2" 316 SS expans. anchors, 6" ctrs.	60	each	15.00	900
3/8" x 3" 316 SS continous pl w/gasket	30	lin ft	25.00	750
Liner				
1/4" x 3" 316 SS continous pl w/gasket	30	lin ft	20.00	600
3/8" 316 SS expans. anchors, 1' ctrs.	30	each	15.00	450

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Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Lagoon 5B				
Ringwall, Concrete, cast in place	3,100	lin ft	95.00	294,500
Ringwall, H pile	3,100	lin ft	50.00	155,000
Geomembrane liner, 60 mil		Lump Sum		500,500
Geomembrane cover, 100 mil		Lump Sum		452,000
Embed		Lump Sum		157,500
Weight System		Lump Sum		11,500
Pipe penetration pad				
36" Effluent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
24" Influent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
36" L5A/L5B Connection				
Concrete, cast in place				
Slab on grade (4)	4	CY	700.00	2,800
Pipe cradle	42	CY	700.00	29,400
Liner connection to pad (4)				
1/4" x 3" 316 SS continous plate	80	lin ft	20.00	1,600
3/8" 316 SS expans. anchors, 8" ctrs.	120	each	15.00	1,800
Pipe boot cover	4	each	350.00	1,400
Lagoon Cover Sump				
Structure				
32" SDR 17 HDPE pump wet well, 2'-6" dp	8	each	800.00	6,400
Ballast plates, SS		Lump Sum		1,800
Connect sump to HDPE cover		Lump Sum		1,200
Equipment				
Self Priming Centrifugal Pump	8	each	7,500.00	60,000
Concrete, cast in place				
Slab on grade (8)	11	CY	700.00	7,350
Enclosure	8	each	3,500.00	28,000
Mechanical				
Ballast pipe modification at sump		Lump Sum		1,500
1 1/2" HDPE piping w/valves		Lump Sum		500
Vent Stack				
Earthwork				
Structural excavation	21	cu yd	15.00	315
Compacted fill	15	cu yd	35.00	525
Granular fill	1	cu yd	36.00	36
Concrete cast in place				
Slab on grade	1	cu yd	700.00	700
Columns	1	cu yd	700.00	700
Metals				
Structural steel for vent support	750	pounds	5.00	3,750
Anchor bolts, 3/4" x 1'-6"	16	each	25.00	400
Mechanical				
Vent stack				
12" HDPE	21	lin ft	50.00	1,050
12" Fitting	1	each	550.00	550
Valves				
12" BFV	4	each	3,000.00	12,000
Connection to existing pipe		Lump Sum		10,000

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Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Decant Structure				
Earthwork				
Structural excavation	41	cu yd	15.00	615
Compacted fill	31	cu yd	35.00	1,085
Granular fill	2	cu yd	36.00	72
Concrete cast in place				
Slab on grade	4	cu yd	700.00	2,800
Walls	8	cu yd	700.00	5,600
Suspended slab	3	cu yd	700.00	2,100
Fill	1	cu yd	250.00	250
Metals				
Handrail	52	lin ft	120.00	6,240
Alum access hatch, 2'-6"	1	each	450.00	450
Mechanical				
Slide gate, 48" x 24"	1	each	7,000.00	7,000
Pipe connection to structure		Lump Sum		1,200
Cover				
1/2" 316 SS expans. anchors, 6" ctrs.	60	each	15.00	900
3/8" x 3" 316 SS continous pl w/gasket	30	lin ft	25.00	750
Liner				
1/4" x 3" 316 SS continous pl w/gasket	30	lin ft	20.00	600
3/8" 316 SS expans. anchors, 1' ctrs.	30	each	15.00	450

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Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Lagoon 5C				
Ringwall, Concrete, cast in place	3,100	lin ft	95.00	294,500
Ringwall, H pile	3,100	lin ft	50.00	155,000
Geomembrane liner, 60 mil		Lump Sum		500,500
Geomembrane cover, 100 mil		Lump Sum		452,000
Embed		Lump Sum		157,500
Weight System		Lump Sum		11,500
Pipe penetration pad				
36" Effluent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
24" Influent				
Concrete, cast in place				
Slab on grade	1	CY	700.00	350
Pipe cradle	7	CY	700.00	4,620
Liner connection to pad				
1/4" x 3" 316 SS continous plate	20	lin ft	30.00	600
3/8" 316 SS expans. anchors, 8" ctrs.	30	each	20.00	600
Pipe boot cover	1	each	400.00	400
36" L5B/L5C Connection				
Concrete, cast in place				
Slab on grade (2)	2	CY	700.00	1,400
Pipe cradle	42	CY	700.00	29,400
Liner connection to pad (2)	21			
1/4" x 3" 316 SS continous plate	40	lin ft	20.00	800
3/8" 316 SS expans. anchors, 8" ctrs.	60	each	15.00	900
Pipe boot cover	2	each	350.00	700
Lagoon Cover Sump				
Structure				
32" SDR 17 HDPE pump wet well, 2'-6" dp	8	each	800.00	6,400
Ballast plates, SS		Lump Sum		1,800
Connect sump to HDPE cover		Lump Sum		1,200
Equipment				
Self Priming Centrifugal Pump	8	each	7,500.00	60,000
Concrete, cast in place				
Slab on grade (8)	11	CY	700.00	7,350
Enclosure	8	each	3,500.00	28,000
Mechanical				
Ballast pipe modification at sump		Lump Sum		1,500
1 1/2" HDPE piping w/valves		Lump Sum		500
Vent Stack				
Earthwork				
Structural excavation	21	cu yd	15.00	315
Compacted fill	15	cu yd	35.00	525
Granular fill	1	cu yd	36.00	36
Concrete cast in place				
Slab on grade	1	cu yd	700.00	700
Columns	1	cu yd	700.00	700
Metals				
Structural steel for vent support	750	pounds	5.00	3,750
Anchor bolts, 3/4" x 1' - 6"	16	each	25.00	400
Mechanical				
Vent stack				
12" HDPE	21	lin ft	50.00	1,050
12" Fitting	1	each	550.00	550
Valves				
12" BFV	4	each	3,000.00	12,000
Connection to existing pipe		Lump Sum		10,000

BLACK & VEATCH

Memphis, Tennessee
T. E. Maxson WWTF
Biosolids Lagoon 5 Renovaton
Probable Construction Cost
May 28, 2015

Item Description	Quantity	Unit	Unit Cost $	Total Cost $
Decant Structure				
Earthwork				
Structural excavation	41	cu yd	8.00	328
Compacted fill	31	cu yd	35.00	1,085
Granular fill	2	cu yd	36.00	72
Concrete cast in place				
Slab on grade	4	cu yd	700.00	2,800
Walls	8	cu yd	700.00	5,600
Suspended slab	3	cu yd	700.00	2,100
Fill	1	cu yd	250.00	250
Metals				
Handrail	52	lin ft	120.00	6,240
Alum access hatch, 2'-6"	1	each	450.00	450
Mechanical				
Slide gate, 48" x 24"	1	each	7,000.00	7,000
Pipe connection to structure		Lump Sum		1,200
Liner				
1/4" x 3" 316 SS continous pl w/gasket	30	lin ft	20.00	600
3/8" 316 SS expans. anchors, 1' ctrs.	30	each	15.00	450
Electrical and I&C				
Direct Buried Ductbank				
2-2" with 3 4/0 & #1 Ground and 3 #16 shield	5,520	lin ft	50.00	276,000
480/120 transformer	6	each	2,000.00	12,000
Temperature probe and transmitter	3	each	1,500.00	4,500
Breaker	1	each	1,500.00	1,500
Support Rack	17	each	2,000.00	34,000
Total - Sitework				$22,298,422

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DESIGN MEMORANDUM

City of Memphis, Tennessee
T. E. Maxson WWTP
Lagoon 5 Improvements

B&V Project 183157
March 16, 2015
Revised March 23, 2015

To: Scott Morgan, City of Memphis

From: Kevin Nelson

I. GENERAL

The project consists of the design and preparation of drawings and specifications for improvements to the existing sludge lagoon No. 5. The improvements at the lagoons include earthwork, excavation, berm, liner and floating HDPE covers for the lagoons 5A, 5B, and 5C, and sludge piping, gas piping, stormwater dewatering pumps, yard lighting, paving, and fencing. Modifications to the gas blowers and the gas flare will be designed by others.

The T.E. Maxson WWTP is located in the southwest corner of the Memphis metropolitan area near the confluence of the Mississippi River and an oxbow tributary known as McKellar Lake. The lagoon site is located approximately one mile east of the T.E. Maxson WWTP bordered on the west by the secondary sludge dewatering facilities and the land application area and on the east by Fuller State Park.

II. PROCESS DESIGN CRITERIA

The following data, provided to Black & Veatch by City staff, was used to estimate the gas production within the lagoons. The estimated gas produced in each lagoon under various operating scenarios is identified in Figure 1.

Table 1: Process Design Criteria

Condition	**Current - 72 mgd ADF**	**Future - 90 mgd ADF**
Process Configuration	PC+Biotower+High Rate AS	PC+ High Rate AS
Notes	From Plant Data	Includes Cargill
Solids production, Average Day Flow (ADF) loading (lbs/day)	368,000	600,000
Solids production, max month loading (lbs/day)	742,000	670,000
Dry tons produced/MGD ADF flow	2.56	3.36

III. LAGOON 5A, 5B, and 5C MODIFICATIONS

The existing and proposed lagoon solids and gas systems are shown on the enclosed Figure 2 and Figure 3 and described in this section. Existing Sludge Lagoon 5 will be subdivided into three lagoons designated 5A, 5B, and 5C (north to south). The western sections of Sludge Lagoons 3 and 4 will remain unchanged with no modifications other than paved roadways.

Lagoons 5A, 5B, and 5C will process a mixture of primary and secondary sludge pumped from Lagoon 1. Normal operation will be for Lagoon 5A, 5B, and 5C to operate in series (5A to 5B to 5C). However, piping and valving will allow for the lagoons to be operated in parallel or will allow any of the basins to be taken out of service. If any Lagoon 5 cell is taken out of service, the remaining Lagoon 5 cells could then be operated in parallel.

All new plug valves will be furnished with Buna-N only facing material.

The contractor will be responsible for removing, dewatering, and hauling the sludge in existing Lagoon 5 to a disposal area onsite. The location for placing the sludge will be determined by the City. The City will determine the volume and solids content prior to final issue of the bid documents. The residual removal will be bid on a unit price basis, based on dry ton quantities.

The soil underlying the existing lagoon will be excavated to the new lagoon bottom elevation. This excavated material will be used to construct the new lagoon berms. Excess excavated material, that is not suitable for berm construction, will be disposed of on site at a location to be determined by the City. The soil underlying the lagoon berms has been analyzed in accordance with the 2012 International Building Code seismic requirements. This analysis indicated that the underlying soils are prone to liquefaction during a seismic event. Liquefaction of the underlying soils could result in slope stability failures of the Lagoon 5 berms. The City will request a variance from the 2012 IBC related to the potential liquefaction of the soil underlying the berms due to the extremely high cost to improve the ground below the large area covered by Lagoon 5. The existing lagoons upstream of Lagoon 5 were not designed or constructed to 2012 IBC requirements. If the upstream lagoons fail, digested sludge could not be conveyed to

Lagoon 5.

Due to the depth of the lagoons (5A, 5B, and 5C) and the high groundwater in the area, it is anticipated that dewatering will be required during the excavation of the lagoons and during liner and cover installation. The groundwater levels appear to be influenced to some extent by the elevation of the Mississippi River. The excavation and installation of liners and covers should, as much as possible, take place during the period between June and December when Mississippi River water levels are typically at their lowest.

A. LAGOON 5A

If Lagoon 5A is taken out of service, the remaining lagoons could then be operated in parallel. Lagoon 5A will have the following characteristics:

Volume (gallons)	72,510,000
Elevation of top of berm	228.5
Elevation of bottom of lagoon	188
Sludge surface maximum elevation	225.5
Width of top of lagoon at berm (ft)	461
Length of top of lagoon at berm (ft)	881
Width of bottom of lagoon (ft)	217
Length of bottom of lagoon (ft)	625
Slope of inside berm (horizontal to vertical)	3:1
Slope of outside berm (horizontal to vertical)	3:1

A combination of primary and secondary sludge will be added to the east end of Lagoon 5A by a new 24-inch pipeline from Pumping Station L1A/2B. Sludge will normally flow from the east end of Lagoon 5A to the west end. Sludge will then normally flow by gravity from the west end of Lagoon 5A into the west end of Lagoon 5B through one of two new 36-inch HDPE pipelines. One pipeline will slope from near the bottom of Lagoon 5A to near the top of Lagoon 5B where a plug valve will be located. The other will slope from near mid-depth to near the top of Lagoon 5B where a plug valve will be located. The plug valves will be located at an elevation where the adjacent lagoons could be lowered to just below the valve for ease of maintenance.

A ferrous chloride addition point (36-inch tee) will be installed on the 36-inch

connections between Lagoon 5A and 5B. It is anticipated that the City will be pumping ferrous chloride from a future storage tank located along the lower road along the west side of Lagoon 5. Roadways (other than the lower road west of Lagoon 5) do not have to be sized for large trucks delivering ferrous chloride.

There will be a single influent pipe discharging at the center of the east side of the lagoon (near the top of the lagoon). A single withdrawal pipeline will be located at the center of the west end of the lagoon (near the bottom of the lagoon). From the withdrawal pipeline, the sludge will flow by gravity to either existing Lagoon 3 or existing Lagoon 4. A new 36-inch HDPE pipeline will be required from Lagoon 5A to the existing 30-inch HDPE pipeline to existing Lagoon 3 and existing Lagoon 4.

A new decant structure with downward acting stainless steel slide gate will be constructed in the northwest corner of Lagoon 5A. The slide gate will allow for approximately a two foot variation in the overflow elevation (225.5 to 223.5). A new 24-inch HDPE pipeline will connect from the decant structure to the existing decant ditch west of existing Lagoon 5. The pipe should be set as high as possible and should be laid horizontally to the west side of the roadway where it will discharge onto a grouted riprap spillway and flow down to the existing ditch. This ditch drains to the existing decant structure located west of the lagoon dewatering facility. From there, the decant drains through an existing 24-inch pipeline to the existing 96-inch plant influent interceptor located north of Lagoon 1.

Lagoon 5A will be equipped with a 60 mil HDPE bottom liner and a 100 mil HDPE floating cover. The cover and liner will be anchored to a concrete ringwall supported on H piling. Cover and liner material will be specified to have a 20 year warranty. Specifications will include an alternative for 3 year maintenance on the cover.
The cover will be designed such that rainfall drains to a series of drainage sumps near the perimeter the lagoon. Drainage weights (HDPE pipe filled with non-setting cementitious slurry) will be aligned to provide drainage paths to the sumps. Drainage weights will be attached to the cover with HDPE straps and HDPE end pockts to help prevent movement of the weights. Self-priming pumps in a heated enclosure (480 volt) will be located off of the cover. The pumps will take suction from the drainage sumps and will pump the liquid under the cover. The pumps will be sized to accommodate a 24 hour 25 year storm event that produces 7 inches of rain over a 72 hour period. The sump pumps support slab will be located at the same elevation as the top of the ringwall to provide the maximum net

positive suction head. Sampling ports constructed of 12-inch diameter HDPE pipe (with a flanged and gasketed cover) will be installed in the cover of the lagoon. Three sample ports shall be provided on each lagoon, evenly spaced along the centerline of the lagoon.

The lagoon will be provided with two walkways on the side slopes for access to the floating cover. The walkways will be 4'-0" wide 40 mil textured HDPE roughened walkway strip from the ringwall to the toe of the slope to provide a toehold as personnel walk up and down the slope. A rope tied at the top of the berm will be supplied at each walkway to help walking up the slope. A walkway surface constructed of 40 mil textured HDPE material will be installed along the anticipated walkways to the sampling ports located on the flat portion of the cover.

Gas generated in the Lagoon will be collected by perforated HDPE pipes located around the outside of the lagoon. The perforated pipes will be located near the top portion of the berm between the liner and the cover. The liner and cover will be bolted (with stainless steel bolts) to a cast-in-place concrete ringwall around the lagoon. The ringwall will be supported on a pile system. As gas is generated, it will flow between the cover and the liner to the perforated pipes. The perforated pipes will be connected to a buried 16-inch HDPE pipe on the north side of Lagoon 5A and a buried 24-inch HDPE pipe on the south side of Lagoon 5A. These pipes will be connected to a buried 24-inch HDPE pipe on the east end of the lagoon which will connect with the existing 24-inch HDPE pipe to the existing blower building located near the southeast corner of Lagoon 2C. Gas generated in this lagoon will be pumped to the new or existing flare or transferred to TVA. Emergency vents with butterfly valves will be provided along the berm for venting of gas in case of failure of the gas extraction system (blower failure, power failure, blocked piping, etc).

A new 8 foot high fence will be installed around Lagoons 5A, 5B and 5C. The fence will be provided with double swing gates for vehicle access. Gates will be provided near the northwest corner of Lagoon 5A and the southwest corner of Lagoon 5C.

A 25 foot wide roadway along the north, south, east and west sides of the lagoon will be constructed and paved with asphalt. Stormwater drainage from the paved surface will be directed away from the lagoon covers as much as practical. Asphalt surfacing will extend from the roadway to the concrete ringwall.

B. LAGOON 5B

Lagoon 5B will normally process a mixture of primary and secondary sludge which will flow by gravity from Lagoon 5A. Normal operation will be for Lagoon 5A, 5B, and 5C to operate in series (5A to 5B to 5C). However, piping and valving will allow for the lagoons to be operated in parallel or will allow any of the basins to be taken out of service. If Lagoon 5B is taken out of service, the remaining lagoons could then be operated in parallel. Valving will also allow for sludge to be pumped from Lagoon 1 to Lagoon 5B. Lagoon 5B will have the following characteristics:

Volume (gallons)	88,690,000
Elevation of top of berm	228.0
Elevation of bottom of lagoon	188
Sludge surface maximum elevation	225.0
Width of top of lagoon at berm (ft)	457
Length of top of lagoon at berm (ft)	1,044
Width of bottom of lagoon (ft)	213
Length of bottom of lagoon (ft)	805
Slope of berm (horizontal to vertical)	3:1
Slope of outside berm (horizontal to vertical)	3:1

A combination of primary and secondary sludge will normally flow by gravity from the west end of Lagoon 5A into the west end of Lagoon 5B through two new 36-inch HDPE pipelines. One pipeline will slope from near the bottom of Lagoon 5A to near the top of Lagoon 5B where a plug valve will be located. The other will slope from mid-depth in Lagoon 5A to near the top of Lagoon 5B where a plug valve will be located. The plug valves will be located at an elevation where the adjacent lagoons could be lowered to just below the valve for ease of maintenance. Sludge will flow by gravity from the west end of Lagoon 5B to the east end where it will flow by gravity to the east end of Lagoon 5C through two new 36-inch HDPE pipelines. One pipeline will slope from near the bottom of Lagoon 5B to near the top of Lagoon 5C where a plug valve will be located. The other will slope from near mid-depth of Lagoon 5B to near the top of Lagoon 5C where a plug valve will be located. The plug valves will be located at an elevation where the adjacent lagoons could be lowered to just below the valve for ease of maintenance.

Ferrous chloride addition points (24-inch tee) will be installed on the 24-inch influent line to Lagoon 5B and on the 36-inch connections (36-inch tee) between Lagoon 5B and 5C. There will be a single influent pipe discharging at the center of the east side of the lagoon (near the top of the lagoon). A single withdrawal pipeline will be located at the center of the west end of the lagoon (near the bottom of the lagoon). From the withdrawal pipeline, the sludge will flow by gravity to either existing Lagoon 3 or existing Lagoon 4. A new 36-inch HDPE pipeline will be required from Lagoon 5B to Lagoon 5A which connects to the existing 30-inch HDPE pipeline to existing Lagoon 3 and Lagoon 4.

A new decant structure with a downward acting stainless steel slide gate will be constructed in the northeast corner of Lagoon 5B. The slide gate will allow for approximately a two foot variation in the overflow elevation (225.0 to 223.0). A new 24-inch HDPE pipeline will connect from the decant structure to the existing decant ditch west of existing Lagoon 5. The pipe should be set as high as possible and should be laid horizontally to the west side of the roadway where it will discharge onto a grouted riprap spillway and flow down to the existing ditch. This ditch drains to the existing decant structure located west of the secondary dewatering facility. From there, the decant drains through an existing 24-inch pipeline to the existing 96-inch plant influent interceptor located north of Lagoon 1.

Lagoon 5B will be equipped with a 60 mil HDPE bottom liner and a 100 mil HDPE floating cover. The cover and liner will be anchored to a concrete ringwall supported on H piling. Cover and liner material will be specified to have a 20 year warranty. Specifications will include an alternative for 3 year maintenance on the cover.
The cover will be designed such that rainfall drains to a series of drainage sumps near the perimeter the lagoon. Drainage weights (HDPE pipe filled with non-setting cementitious slurry) will be aligned to provide drainage paths to the sumps. Drainage weights will be attached to the cover with HDPE straps to help prevent movement of the weights. Self-priming pumps in a heated enclosure (480 volt) will be located off of the cover. The pumps will take suction from the drainage sumps and will pump the liquid under the cover. The pumps will be sized to accommodate a 24 hour 25 year storm event that produces 7 inches of rain over a 72 hour period. The sump pumps support slab will be located at the same elevation as the top of the ringwall to provide the maximum net positive suction head. Sampling ports constructed of 12-inch diameter HDPE pipe (with a flanged and gasketed cover) will be installed in the cover of the lagoon. Three sample

ports shall be provided on each lagoon, evenly spaced along the centerline of the lagoon.

The lagoon will be provided with two walkways on the side slopes for access to the floating cover. The walkways will be 4'-0" wide 40 mil textured HDPE roughened walkway strip from the ringwall to the toe of the slope to provide a toehold as personnel walk up and down the slope. A rope tied at the top of the berm will be supplied at each walkway to help walking up the slope. A walkway surface constructed of 40 mil textured HDPE material will be installed along the anticipated walkways to the sampling ports located on the flat portion of the cover.

Gas generated in the Lagoon will be collected by perforated HDPE pipes located around the outside of the lagoon. The perforated pipes will be located near the top portion of the berm between the liner and the cover. The liner and cover will be bolted (with stainless steel bolts) to a cast-in-place concrete ringwall around the lagoon. The ringwall will be supported on piles. As gas is generated, it will flow between the cover and the liner to the perforated pipes. The perforated pipes will be connected to buried 24-inch HDPE pipes on the north and south sides of Lagoon 5B. These pipes will be connected to a buried 24-inch HDPE pipe on the east end of the lagoon which will connect with the existing 24-inch HDPE pipe at Lagoon 5A which connects to the existing blower building located near the southeast corner of Lagoon 2C. Gas generated in this lagoon will be pumped to the new or existing flare or transferred to TVA. Emergency vents with butterfly valves will be provided along the berm for venting of gas in case of failure of the gas extraction system (blower failure, power failure, blocked piping, etc).

A 25 foot wide roadway along the north, south, east and west sides of the lagoon will be constructed and paved with asphalt. Stormwater drainage from the paved surface will be directed away from the lagoon covers as much as is practical. Asphalt surfacing will extend from the roadway to the concrete ringwall.

C. LAGOON 5C

Lagoon 5C will normally process a mixture of primary and secondary sludge which will flow by gravity from Lagoon 5B. Normal operation will be for Lagoon 5A, 5B, and 5C to operate in series (5A to 5B to 5C). However, piping and valving will allow for the lagoons to be operated in parallel or will allow any of the basins to be taken out of service. If Lagoon 5C is taken out of service, the remaining lagoons could then be operated in parallel. Valving will also allow for sludge to be pumped from Lagoon 1 to Lagoon 5C. Lagoon 5C will have the following characteristics:

Volume (gallons)	89,100,000
Elevation of top of berm	227.5
Elevation of bottom of lagoon	188
Sludge surface maximum elevation	224.5
Width of top of lagoon at berm (ft)	461
Length of top of lagoon at berm (ft)	1,044
Width of bottom of lagoon (ft)	218
Length of bottom of lagoon (ft)	810
Slope of berm (horizontal to vertical)	3:1
Slope of outside berm (horizontal to vertical)	3:1

A combination of primary and secondary sludge will normally flow by gravity from the east end of Lagoon 5B into the east end of Lagoon 5C through two new 36-inch HDPE pipelines. One pipeline will slope from near the bottom of Lagoon 5B to near the top of Lagoon 5C where a plug valve will be located. The other will slope from mid-depth in Lagoon 5B to near the top of Lagoon 5C where a plug valve will be located. The plug valves will be located at an elevation where the adjacent lagoons could be lowered to just below the valve for ease of maintenance. Sludge will flow by gravity from the east end of Lagoon 5C to the west end.

A ferrous chloride addition point (24-inch tee) will be installed on the 24-inch influent line to Lagoon 5C.

There will be a single influent pipe discharging at the center of the east side of the lagoon (near the top of the lagoon). A single withdrawal pipeline will be located at the center of

the west end of the lagoon (near the bottom of the lagoon). From the withdrawal pipeline, the sludge will flow by gravity to either existing Lagoon 3 or existing Lagoon 4. A new 36-inch HDPE pipeline will be required from Lagoon 5C to the 36-inch line at Lagoon 5B and connected to the existing 30-inch HDPE sludge pipeline to existing Lagoon 3 and existing Lagoon 4.

A new decant structure with a downward acting stainless steel slide gate will be constructed in the northwest corner of Lagoon 5C. The slide gate will allow for approximately a two foot variation in the overflow elevation (224.5 to 222.5). A new 24-inch HDPE pipeline will connect from the decant structure to the existing decant ditch west of existing Lagoon 5. The pipe should be set as high as possible and should be laid horizontally to the west side of the roadway where it will discharge onto a grouted riprap spillway and flow down to the existing ditch. This ditch drains to the existing decant structure located west of the lagoon dewatering facility. From there, the decant drains through an existing 24-inch pipeline to the existing 96-inch plant influent interceptor located north of Lagoon 1.

Lagoon 5C will be equipped with a 60 mil HDPE bottom liner and a 100 mil HDPE floating cover. The cover and liner will be anchored to a concrete ringwall supported on H piling. Cover and liner material will be specified to have a 20 year warranty. Specifications will include an alternative for 3 year maintenance on the cover
The cover will be designed such that rainfall drains to a series of drainage sumps near the perimeter the lagoon. Drainage weights (HDPE pipe filled with non-setting cementitious slurry) will be aligned so that the center of the cover is depressed in relation to the outside. Drainage weights (HDPE pipe filled with non-setting cementitious slurry) will be aligned to provide drainage paths to the sumps. Self-priming pumps in a heated enclosure (480 volt) will be located off of the cover. The pumps will take suction from the drainage sumps and will pump the liquid under the cover. The pumps will be sized to accommodate a 24 hour 25 year storm event that produces 7 inches of rain over a 72 hour period. The sump pumps support slab will be located at the same elevation as the top of the ringwall to provide the maximum net positive suction head. Sampling ports constructed of 12-inch diameter HDPE pipe (with a flanged and gasketed cover) will be installed in the cover of the lagoon. Three sample ports shall be provided on each lagoon, evenly spaced along the centerline of the lagoon.

The lagoon will be provided with two walkways on the side slopes for access to the

floating cover. The walkways will be 4'-0" wide 40 mil textured HDPE roughened walkway strip from the ringwall to the toe of the slope to provide a toehold as personnel walk up and down the slope. A rope tied at the top of the berm will be supplied at each walkway to help walking up the slope. A walkway surface constructed of 40 mil textured HDPE material will be installed along the anticipated walkways to the sampling ports located on the flat portion of the cover.

Gas generated in the Lagoon will be collected by perforated HDPE pipes located around the outside of the lagoon. The perforated pipes will be located near the top portion of the berm between the liner and the cover. The liner and cover will be bolted (with stainless steel bolts) to a cast-in-place concrete ringwall around the lagoon. The ringwall will be supported on piles. As gas is generated, it will flow between the cover and the liner to the perforated pipes. The perforated pipes will be connected to a buried 24-inch HDPE pipe on the north side of Lagoon 5C and a buried 16-inch HDPE pipe on the south side of Lagoon 5C. These pipes will be connected to a buried 24-inch HDPE pipe on the east end of the lagoon which will connect with the existing 24-inch HDPE pipe at Lagoon 5B which connects to the existing blower building located near the southeast corner of Lagoon 2C. Gas generated in this lagoon will be pumped to the new or existing flare or transferred to TVA. Emergency vents with butterfly valves will be provided along the berm for venting of gas in case of failure of the gas extraction system (blower failure, power failure, blocked piping, etc).

A 25 foot wide roadway along the north, south, east, and west sides of the lagoon will be constructed and paved with asphalt. Stormwater drainage from the paved surface will be directed away from the lagoon covers as much as is practical. Pavement will extend from the roadway to the concrete ringwall.

D. MISCELLANEOUS LAGOON DESIGN REQUIREMENTS

Subcontractors that will perform the liner and cover installation will be prequalified.

All buried piping will be provided with City of Memphis bedding.

All pipes penetrating the lagoon berms will be provided with cleanout ports on the outside of the berms. All influent and effluent piping inside of the lagoons will be securely tied down to prevent floatation.

E. LAGOON VOLUME SUMMARY AND HYDRAULICS

Lagoon volumes are controlled by the amount of surface area available, the height of the berms, depth of excavation, slope of berms, and existing surface elevations. The volumes and hydraulic elevations given in this section are preliminary based on approximate data available at the time of the preparation of the design memorandum.

Lagoon	Storage Volume (gallons)
1 (Existing*)	78,000,000
2A (Maximum)	7,000,000
2B (Maximum)	13,300,000
2C (Maximum)	46,000,000
3 (Existing*)	23,842,000
4 (Existing*)	22,220,000
5A	72,510,000
5B	88,690,000
5C	89,100,000
Total	440,662,000

* Volumes of existing lagoons furnished by City staff.

IV. LAGOONS 3 AND 4

Sludge will normally flow from Lagoon 5C through a 36-inch pipeline to either existing Lagoon 3 or existing Lagoon 4 through the existing 30-inch pipeline. Lagoons 5A and 5B will be connected to the same 36-inch line from Lagoon 5C to the Lagoons 3 and 4 connection.

A 12-foot wide roadway along west side of the Lagoons 3 and 4 and the south side of Lagoon 4 will be constructed and paved with asphalt. The roadway width may be reduced to 10 feet as required to avoid existing control panels. Stormwater drainage from the paved surface will be directed offsite.

V. GAS COLLECTION AND DISPOSAL

Gas will be collected and conveyed from Lagoons 5A, 5B, and 5C as described in Section III and illustrated in Figure 3.

The existing gas conveyance piping to Blower Building No. 1 is not adequately sized to convey the gas generated during summer high loading conditions in Lagoons 1, 2A, and 2B. This has resulted in manually venting gas from Lagoon 2B on several occasions. A parallel 12 inch to 16 inch HDPE gas conveyance header will be installed north of Lagoon 1 to Blower Building No. 1 to provide additional conveyance capacity.

It is anticipated that up to 4,000 SCFM of the gas generated at the lagoons will be utilized by TVA. Modifications to the existing blower equipment, modifications to the existing flare or the addition of a new flare, gas treatment equipment, and the gas connection to the TVA facility will be designed by others.

VI. DRAINAGE IMPROVEMENTS

The 24-inch corrugated metal pipe culvert beneath the access road along the west side of the 110 acre site will be replaced with a new 24-inch reinforced concrete culvert pipe at the same invert elevation.

VII. ELECTRICAL/CONTROLS

Three phase power will be distributed to the new cover dewatering pumping stations and new condensate pumps throughout the Lagoon 5 complex. Power will be obtained from a 100 amp breaker in the existing 480V MCC located in the electrical room of Blower Building No. 2.

Two receptacle stations for use with portable sump pumps (250V and 120V) will be provided on each of the east-west berms for a total of eight stations. Each station will consist of a tap box, single phase 480V-120/240V transformer, GFI breakers, 250 Volt outdoor receptacle, and 120 volt weatherproof convenience receptacle.

Controls for the cover dewatering pumping systems will be provided by the pump manufacturer and will be similar to the existing cover on Lagoon 1 (automatic float type

controls at each pump with overload/timing protection). Controls for the condensate pumps will be provided by the pump manufacturer.

One temperature probe/temperature transmitter with local readout will be provided for each lagoon cell. The temperature probes shall be located near the center of each lagoon. The signals from the transmitters will be routed to PLC 5 in Blower Building No. 2.

Site lighting shall be provided around the perimeter of each lagoon.

VIII. PERMITS AND REVIEWS

The following permits will be required for the lagoon improvements:

Tennessee Department of Environment & Conservation Construction Permit
Tennessee Department of Environment & Conservation Stormwater Permit

IX. BUILDING CODES

The following building codes are to be followed on this project:

2012 International Building Code with Local Amendments
2008 National Electrical Code with Local Amendments
2009 International Mechanical Code with Local Amendments
2009 International Gas Code with Local Amendments
2009 International Plumbing Code with Local Amendments
2009 International Energy Conservation Code with Local Amendments

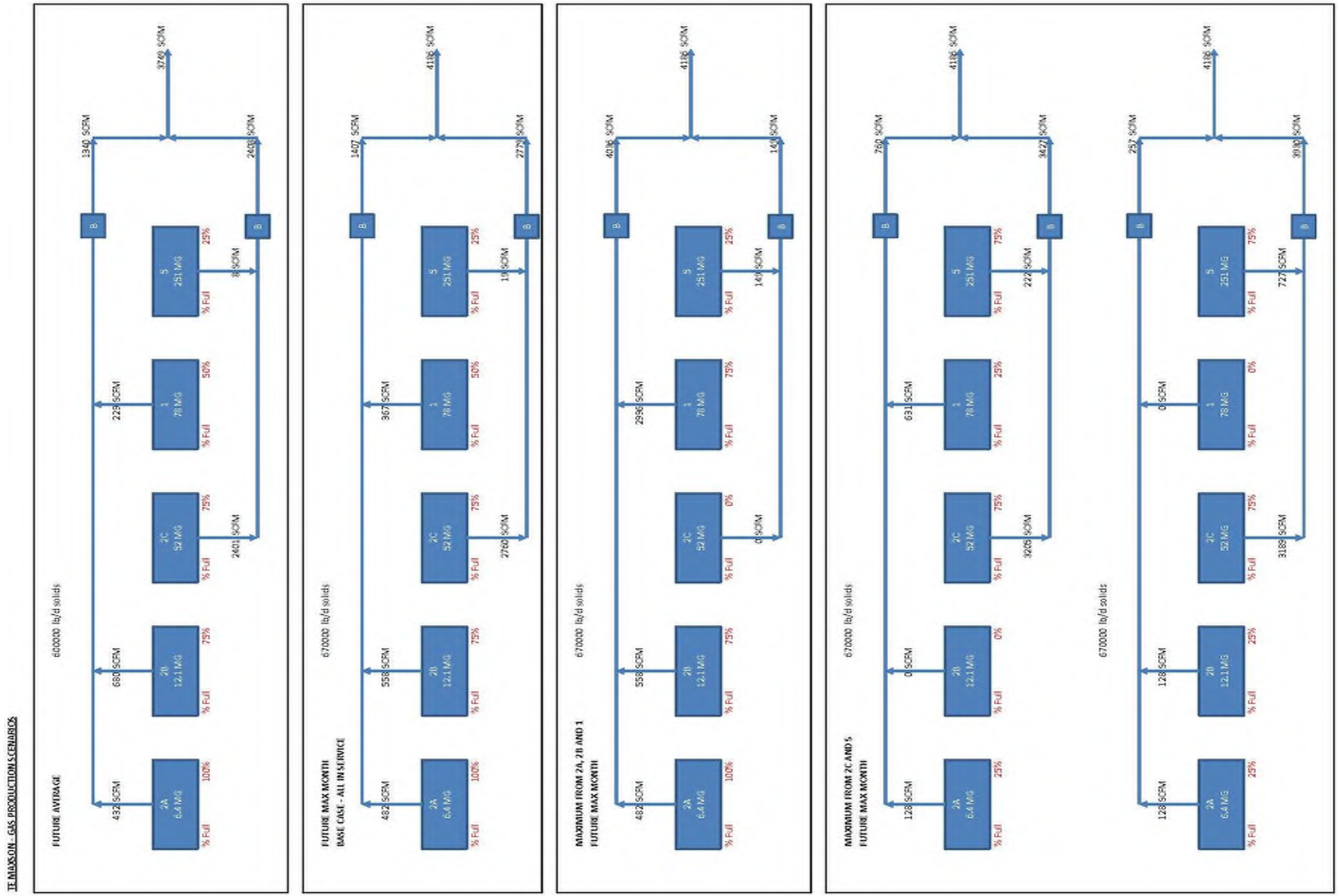
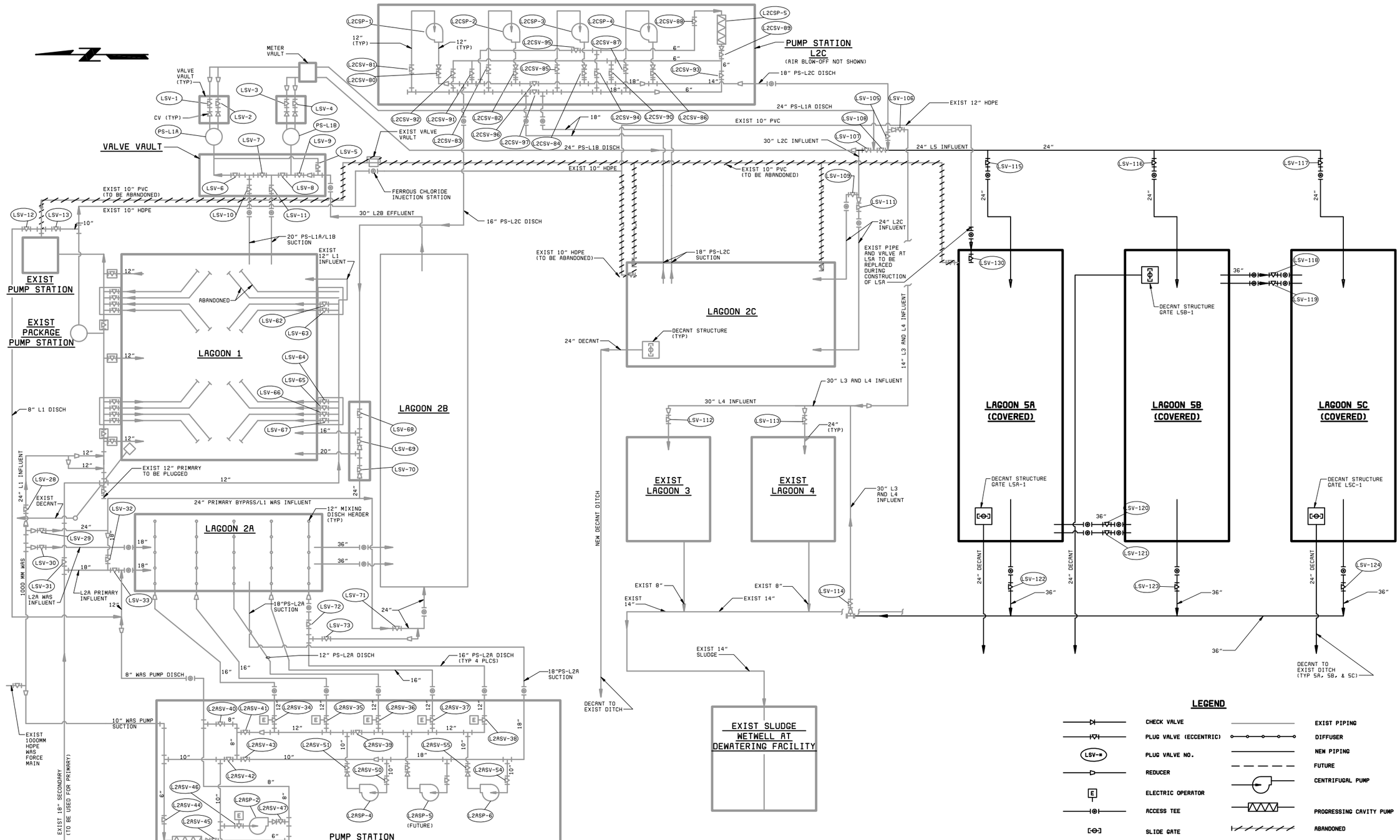


Figure 1: Estimated Gas Production



BLACK & VEATCH
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Saint Louis, Missouri
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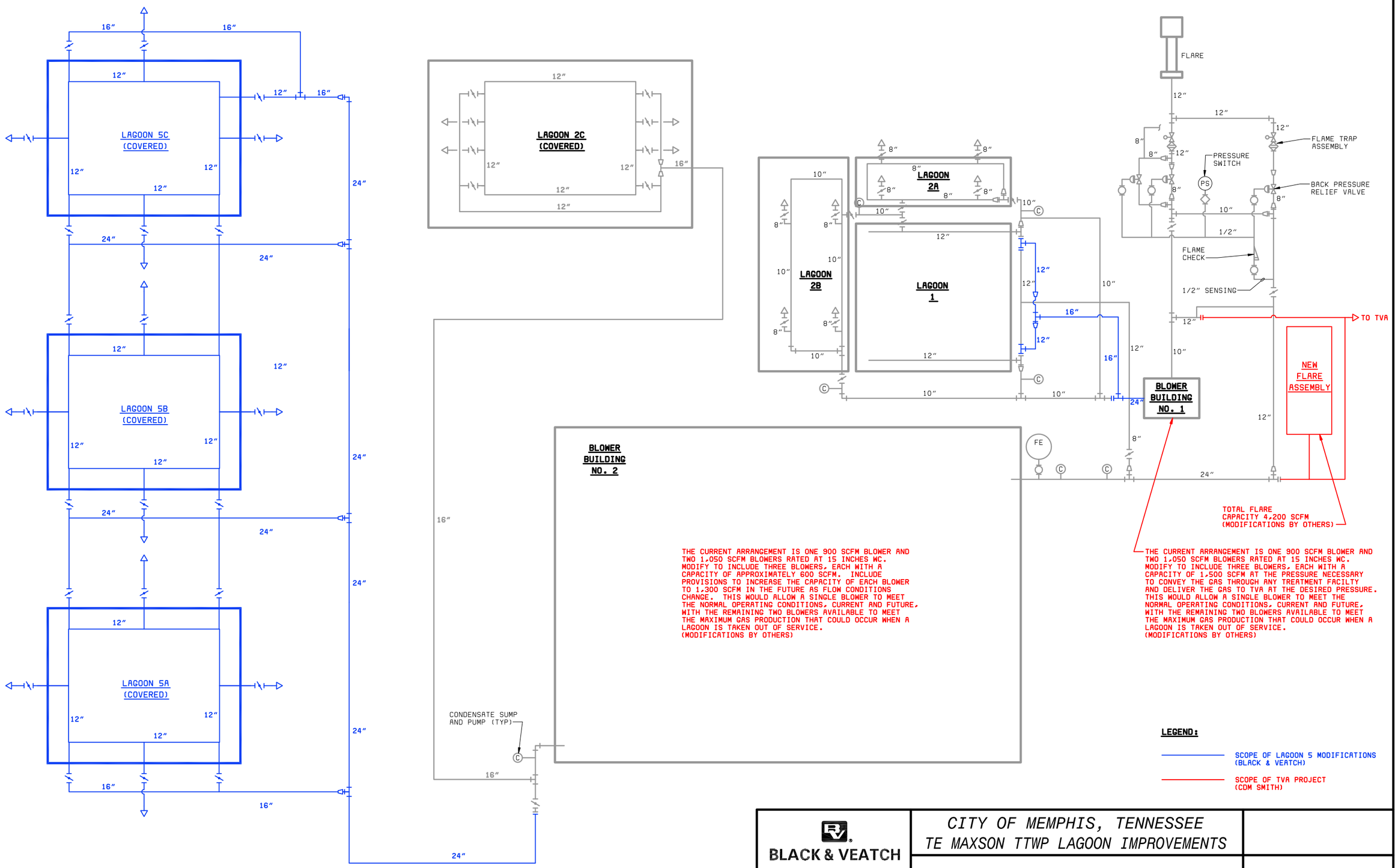
CITY OF MEMPHIS, TENNESSEE
TE MAXSON TTWP LAGOON IMPROVEMENTS

SOLIDS SCHEMATIC

FIGURE 2

B6008
FB6008



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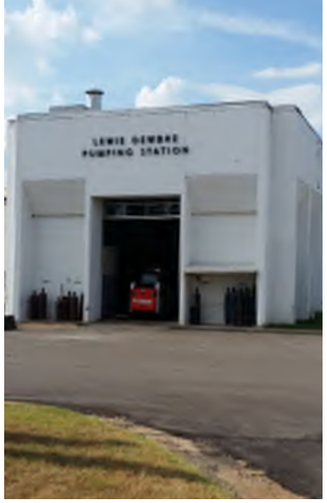
CITY OF MEMPHIS, TENNESSEE
TE MAXSON TTWP LAGOON IMPROVEMENTS

BIOGAS SCHEMATIC

FIGURE 3

B6008
FB6008



DRAFT

T.E. Maxson WWTP Process Upgrades
Conceptual Design Report

Prepared for: Memphis, Tennessee

Memphis Project Number: SW02033

JANUARY 2016

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MEMPHIS SHELBY COUNTY TENNESSEE

EPA-HQ-2019-004783 001983

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Section 1

Introduction

The T.E. Maxson Wastewater Treatment Plant (Maxson WWTP) is located in the southwestern portion of Memphis, Tennessee at 2685 Steam Plant Road. The facility, over the last five years, has treated approximately 72 million gallons per day (MGD), but is now treating an average of just under 70 MGD due to the closing of the Cargill wet corn milling facility. The Maxson WWTP has served the City of Memphis (City) since its commissioning in 1975.

Figure 1-1 shows an aerial photo of the site. Maxson WWTP discharges, either by gravity or by pumping, to a cooling channel that ultimately discharges into the Mississippi River. The site is bounded by a levee to the west and north and the 100-year flood elevation is 224.5.

With upgrades over the years, the current liquid treatment process consists of coarse bar screens, grit removal, recently installed fine bar screens, primary clarification, high-rate biotowers, activated sludge and secondary clarification. Biosolids treatment consists of anaerobic digestion and dewatering. **Figure 1-2** presents the process flow diagram of the existing facility.

1.1 2013 Process Recommendations

In 2012, the City began negotiating a new NPDES permit for the Maxson WWTP. As part of this process, the state of Tennessee required the City to implement disinfection at the Maxson WWTP. The City retained CDM Smith to evaluate available disinfection technologies for implementation at the facility. This work was on-going through 2013 including bench-testing and piloting, ultimately identifying two possible technologies for implementation at Maxson WWTP--UV and peracetic acid (PAA) disinfection.

As part of the disinfection study, it was also determined that the Maxson WWTP was over its current biological treatment capacity and that caused concerns with water quality directly impacting what disinfection technology could be implemented. This prompted the City to evaluate the existing plant to determine what would be required to meet the original design flow of 90 MGD at the current wastewater concentration.

In November 2013, a technical memorandum was provided to the City that gave recommendations regarding the expansion of the treatment process. This memorandum included conceptual 20-year lifecycle cost estimates for each alternative. Two alternatives were of similar lifecycle cost. These were:

- Alternative 1 – Conventional Aeration Expansion.
- Alternative 2 – Upgrade of Existing Biotowers and Intermediate Clarifiers.

Alternative 1 consisted of removing the existing biotowers (trickling filters) from the treatment process and increasing biological capacity through the addition of aeration basins (with associated blowers and diffusers) and secondary clarifiers (if necessary). Anaerobic selectors were proposed for uptake of readily biodegradable substrate prior to the aeration process.

Alternative 2 included upgrading the existing biotowers, adding odor control for the biotowers, reducing the biotower depth from 21 to 18 feet to accommodate room in the existing hydraulic grade line (by

raising the bottom of the biotowers) and constructing new intermediate clarifiers downstream of the biotowers, but prior to the intermediate pump station.

Discussions with the City in 2013 indicated that Alternative 1 from the 2013 report was favorable due to similar capital costs while mitigating the biotower odors.

1.2 Scope of the Conceptual Design Report

In November 2015, CDM Smith was retained by the City of Memphis to design and construct the process and disinfection improvements as outlined in the 2013 reports. During the contract negotiation, the Alternative 1 scope with UV disinfection was revisited to develop a target construction cost for the proposed improvements. A Class 4 construction cost estimate, defined by the Association for the Advancement of Cost Engineering (AACE) as an estimate at 1% to 15% of project definition, was provided for the proposed improvements at 90 MGD, 82 MGD and 74 MGD. The City reviewed the three construction cost estimates and set the target construction price based on providing 82 MGD of biological treatment capacity, with provisions for expansion to 90 MGD in the future.

During the project kickoff meeting the recommendations from the 2013 Report were revisited and the team selected to revisit Alternative 2 from the 2013 report. The project team (including CDM Smith and City of Memphis staff) felt there was potential value in continuing to use the biotowers as opposed to abandoning them in place.

During CDM Smith's evaluation, it was determined that it was not feasible to include the intermediate clarifiers in the available hydraulic capacity of the plant and thus, Alternative 2 was removed from the evaluation and is not evaluated further in this report. (See **Appendix C** and **Section 6** for further information.)

Therefore, a new alternative, Alternative 3, was selected for evaluation that included rehabilitating and reusing the existing Biotowers. Alternative 3 includes replacing and upgrading the biotower media, adding odor control to the biotowers, adding two new secondary clarifiers, and a new RAS reaeration tank upstream of the aeration basins for 90 MGD of biological treatment capacity. This configuration is referred to as Alternative 3 in this CDR.

Subsequent to the Process Recommendations, CDM Smith also updated the PAA pilot and obtained additional water quality data to support a final disinfection recommendation for use at the Maxson WWTP. This testing was conducted from June through September of 2015 evaluating both UV and PAA disinfection technologies.

1.3 Conceptual Design Report Outline

This Conceptual Design Report (CDR) is broken into sections as described below and provides recommendations regarding the final disinfection and process upgrades for implementation at the Maxson WWTP. The general outline for the CDR is:

- Executive Summary
- Section 1 - Introduction

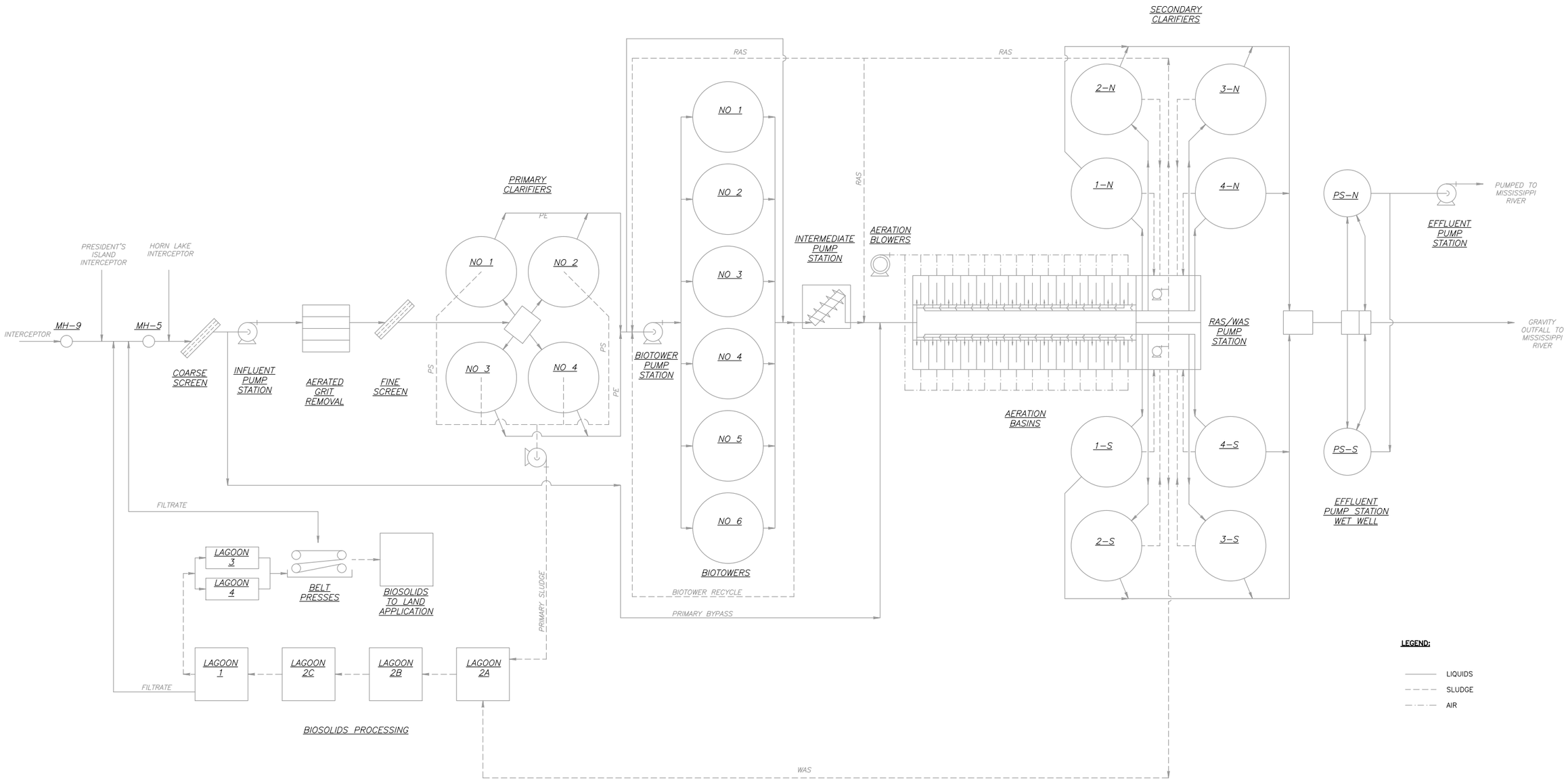
- Existing Plant Information is included in Sections:
  - Section 2 - WWTP Water Quality Data Review and Basis of Design

- Section 3 - WWTP Electrical Evaluation
- Section 4 - WWTP Existing Hydraulic Capacity Evaluation

- Process Improvements related to disinfection, process upgrades, and miscellaneous other improvements:
  - Section 5 - Disinfection Improvements and Recommendations
  - Section 6 - Secondary Process Upgrade Recommendations
  - Section 7 - Miscellaneous Plant Improvements - Effluent Pump Station (EPS) Improvements, Existing Supervisory Control and Data Acquisition (SCADA) and Instrumentation and Controls (I&C) Improvements, Coarse Screen Improvements and Headworks Odor Control Improvements
- Recommendations
  - Section 8 - Recommendations - Cost Opinion and Project Schedule

CDM Smith

Figure 1-1
MAXSON WWTP Aerial



REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

T.E. MAXSON WWTP

Figure 1-2 SHEET OF

CITY OF MEMPHIS

EXISTING PROCESS FLOW DIAGRAM

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	NOT TO SCALE
DESIGN BY	BMK	DATE	X	PROJECT	36694-111641

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

EPA-HQ-2019-004783 001998

10% SUBMITTAL - NOT FOR CONSTRUCTION

Section 2

WWTP Water Quality Data Review and Basis of Design

2.1 Introduction

The Maxson WWTP has experienced an increase in waste strength which has prompted the City to evaluate the existing plant to determine what would be required to meet the original design flow of 90 MGD. In addition, the City is currently planning an upgrade to provide disinfection as the final treatment process to meet requirements in the current draft NPDES permit.

This section of the report develops the basis of design for the raw influent and primary effluent for the secondary treatment process upgrades and the anticipated secondary effluent parameters for the disinfection upgrades being planned at the facility. This section of the report is organized in the following manner:

- Screening of existing data;
- Analysis of historical influent and primary effluent data;
- Projected design raw influent and primary effluent flows and loads for the secondary treatment process upgrades;
- Analysis of primary and waste activated sludge data;
- Analysis of the anaerobic lagoon supernatant data; and,
- Projected secondary effluent concentrations for the disinfection upgrades.

2.2 Existing Data Screening

The City provided 69 months of data from January 2009 through September 2014 for the Maxson WWTP. Sampling and monitoring data included facility flow, influent biochemical oxygen demand (BOD_5), influent total suspended solids (TSS) and volatile suspended solids (VSS), influent pH and temperature, primary effluent BOD_5, TSS and VSS values and final effluent BOD_5 and TSS. Operational data such as solids retention time (SRT), mixed liquor suspended solids (MLSS) concentration, return and waste activated sludge flows and concentrations were also provided but are not evaluated in this Section. The subsequent subsections discuss typical issues when evaluating plant data including sidestream impacts, skewing of data, and outliers and discloses modifications to the data set to account for these issues.

2.2.1 Sidestream Considerations

The main source of mass loadings in the sidestream return to the plant is the subnatant from the dewatering process at the anaerobic lagoons. The subnatant is returned upstream of the plant's influent pump station and influent flow meter. All major sidestream flows and concentrations are therefore captured in the flow measurement and sampling of the influent. Subsequent references to

"Raw Influent" for the facility include both the influent flow and the sidestream return from the anaerobic lagoons.

There are concerns that the sidestream return from the lagoons has caused in increase in measured "Raw Influent" BOD_5. From 1997 through 2004, the average "Raw Influent" BOD_5 was approximately 400,000 pounds per day. Primary sludge started to be conveyed to the lagoons for stabilization. The majority of the lagoons were also covered during this time period to capture methane. The Maxson WWTP "Raw Influent" BOD_5 increased approximately 15 to 20 percent from 2004 to 2008 from historical values, returned to pre-2004 loads from 2009-2011 (presumably due to decreased industrial loading due to economic downturn) and has since increased 10 to 12 percent per year up through 2014 which has increased the "Raw Influent" BOD_5 to over 500,000 pounds per day. Section 1.09 discusses the analysis of this data further.

2.2.2 Removal of Influent Total Suspended Solids Data from October to December 2010

A force main break under a Tennessee Valley Authority (TVA) ash pond caused a significant amount of inert material to be discharged to the plant from October through December 2010. The impacts of this force main break significantly skewed the plant influent TSS data. In as much so, the influent TSS data for these three months has been removed from the statistical analyses of the historical data. Primary effluent data over this period will continue to be analyzed as this period would suggest higher TSS loadings than typical and will help assist in correlating primary clarifier TSS removal performance in the future.

2.2.3 Removal of Primary Clarifier Data Due to Units Out of Service

Facility operating data was screened in attempts to determine when primary clarifier(s) were out of service. This was done in an attempt to evaluate primary clarifier performance when all four units were in service. In as much so, primary effluent data in September 2010, June through October 2012, and April through July 2013 were discarded because one (or all) of the primary clarifiers were out service.

2.2.4 Removal of Volatile Suspended Solids Data

Facility operating data was screened to determine days when the VSS concentrations were greater than TSS concentrations in the raw influent and primary effluent. VSS data on those days were omitted from the data set.

2.2.5 Outliers

A normal distribution of data suggests that outliers would exist outside of two standard deviations of the average of the data set. There were 2,058 data points for influent BOD_5 concentration and 2,063 data points for influent TSS concentration. The raw influent data suggests that two standard deviations for the Maxson WWTP influent BOD_5 concentrations would result in the removal of data below the 2nd and above the 98th percentile (or removal of 81 data points from the data set). Likewise, two standard deviations for influent TSS concentrations would result in removal of data below the 1st and above the 97th percentile (or removal of 68 data points from the data set).

Review of the data set indicates one data point (a TSS concentration on January 9, 2009) should be considered an outlier since it was 600 percent higher than the average mass load and 300 percent higher than the 99th percentile mass load. It is proposed that all remaining influent BOD_5 and TSS

data provided by the City (other than the TSS data from January 9, 2009 and those disclosed in subsections 2.2.2, 2.2.3 and 2.2.4) be included in the determination of the facility's historical loadings.

Influent flow data ranged from an average of 72 MGD to a 24-hour maximum day flow of 156 MGD. Review of the data suggests no reason to discard any influent flow measurements at the facility.

2.3 Service Area Characteristics

The Maxson WWTP historically had numerous industrial users that discharge into the service area that constitute approximately 60 percent of the total BOD_5 load to the facility. The two largest facilities, Solae LLC and Cargill Inc., are food facilities that process soy and corn, respectively. The Cargill facility closed in January 2015 and BOD_5 loads from Cargill have dropped 90 percent since then. The average BOD_5 and TSS mass loading from Cargill prior to January 2015 was 85,000 and 20,000 pounds per day, respectively. Direction from the City indicated that the evaluation for future loadings for the Maxson WWTP should include the loadings from Cargill to provide flexibility to add another industrial user.

Historically, these two entities have made up 29 percent and 16 percent, respectively, of the influent BOD_5 load. Both facilities discharge wastes with BOD/TSS ratios varying from 2/1 to 4/1 indicating a high soluble BOD_5 fraction in the waste stream. Estimates from data indicate that approximately 50 percent of the influent BOD_5 is soluble. **Figure 2-1** shows the influent BOD_5 mass load composition for the Maxson WWTP in 2013.

The influent TSS composition was also analyzed and confirms that the industrial contributors are discharging a highly soluble BOD_5 effluent to the Maxson WWTP. The industrial contributors are discharging roughly 31 percent of the overall TSS mass load to the Maxson WWTP. **Figure 2-2** shows the influent TSS mass load composition for the Maxson WWTP in 2013.

The variability of food processing schedules for the industrial users can cause a wide variation of mass loads which could impact day-to-day concentrations at the Maxson WWTP. The characteristics of the service area, specifically of the larger industrial dischargers, needs to be considered when evaluating the raw influent data set for outliers.

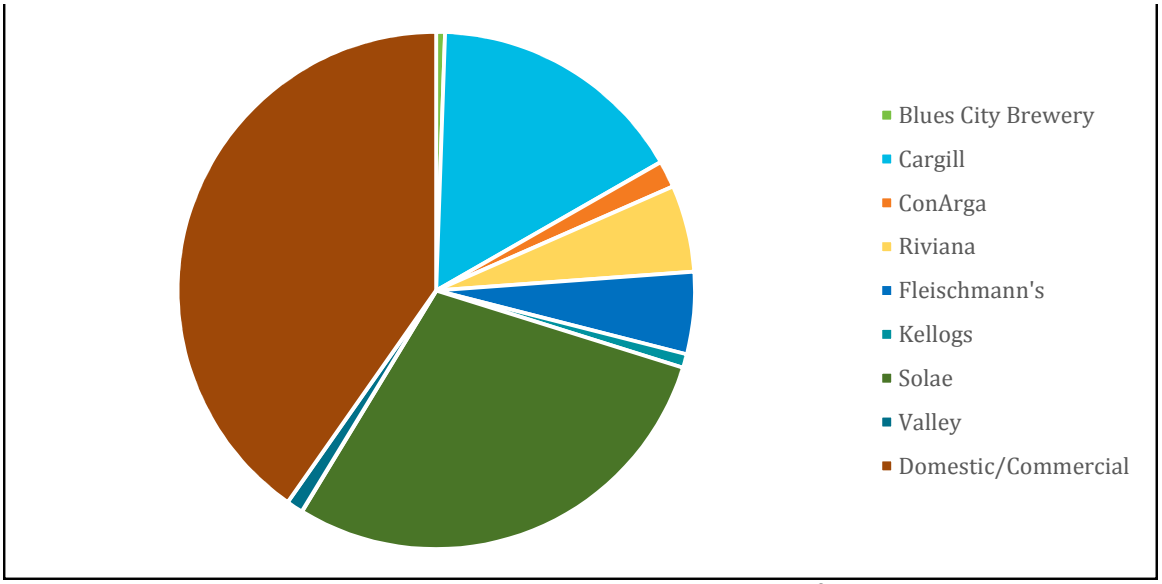


Figure 2-1 Maxson WWTP Influent BOD_5 Load Distribution

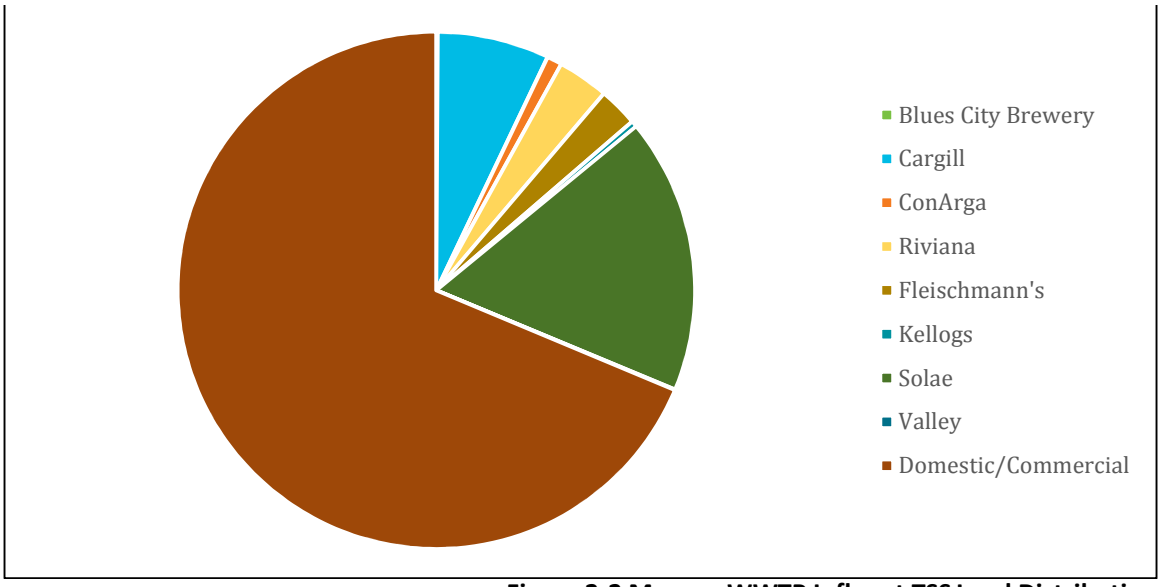


Figure 2-2 Maxson WWTP Influent TSS Load Distribution

2.4 Methodology of Analyzing Raw Influent Data

A key step in data analysis is to develop mass loadings and mass loading peaking factors to account for changes in concentration during peak flow events. The mass loading peaking factors are applied along with flow peaking factors to develop design concentrations for each constituent at each flow condition. The procedure outlined below accounts for the dilution in concentration or increase in loading of some parameters during peak flow conditions that may occur during wet weather:

- Calculate average day maximum month (ADMM), maximum day (MD) and peak hour (PH) flow peaking factors.
- ADMM flow peaking factors were taken from the maximum of the 30-day moving average of the daily flows. The MD flow peaking factor used the maximum day flow of the data set and divided by the average daily flow of the data set. PH flow peaking factors used the maximum peak hour flow of the data set and divided it by the average daily flow of the data set.
- Determine average day (AD) mass loads.

The daily mass loads for the influent parameters listed were calculated using the following equation:

where: $$T = Q \times C \times K$$

T = mass load (lb/day)

Q = Flow (MGD)

C = Concentration (mg/L)

K = Conversion constant, 8.34

- Determine 30-day moving averages for flows and mass loadings.
- The 30-day moving averages were calculated from the daily flow and mass loading of each parameter.
- Determine ADMM loading peaking factors.
- The 95th percentile of the 30-day moving average mass load was divided by the average of the daily mass load to determine the ADMM peaking factor.
- Determine MD loading peaking factors.

The 95th percentile of daily mass load was divided by the average of the daily mass load to determine the MD peaking factor.

2.5 Historical Raw Influent Characteristics

2.5.1 Raw Influent Flow

Figure 2-3 provides the daily average and 30-day moving average raw influent flows at the Maxson WWTP. The daily average influent flow from January 2009 through September 2014 was 72 MGD with a daily maximum average flow of 156 MGD on June 29, 2014 which happened to be the 7th highest daily rainfall day in the City's recorded history with almost 6-inches of rainfall that day. Other high daily flow events were influenced by significant rainfall. Most noticeable is the spike in the 30-day moving average during May 2011 which corresponded to the historical Mississippi River flooding event where the river crested almost 14 feet above flood stage.

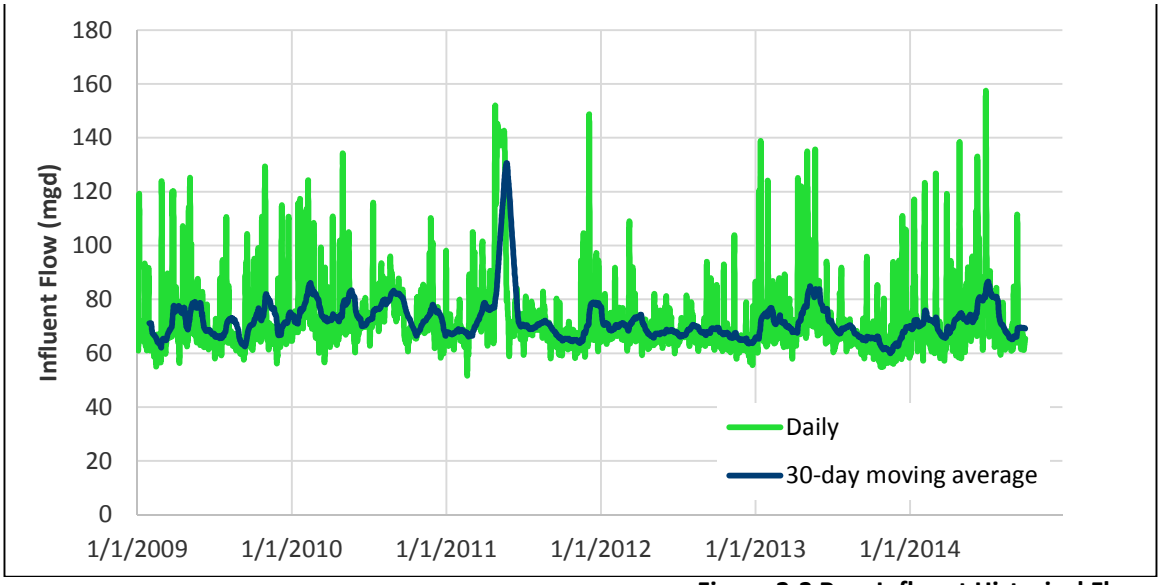


Figure 2-3 Raw Influent Historical Flows

Maximum instantaneous influent flow rates were also provided by the City. **Figure 2-4** shows the daily average flow and peak instantaneous flow for the data period. A peak instantaneous flow of 170 MGD was recorded on June 29, 2014 (which also corresponds to the maximum average daily flow). Evaluation of Figures 3 and 4 indicates that the incremental flow difference between maximum day and peak hour flows is not significant at the facility.

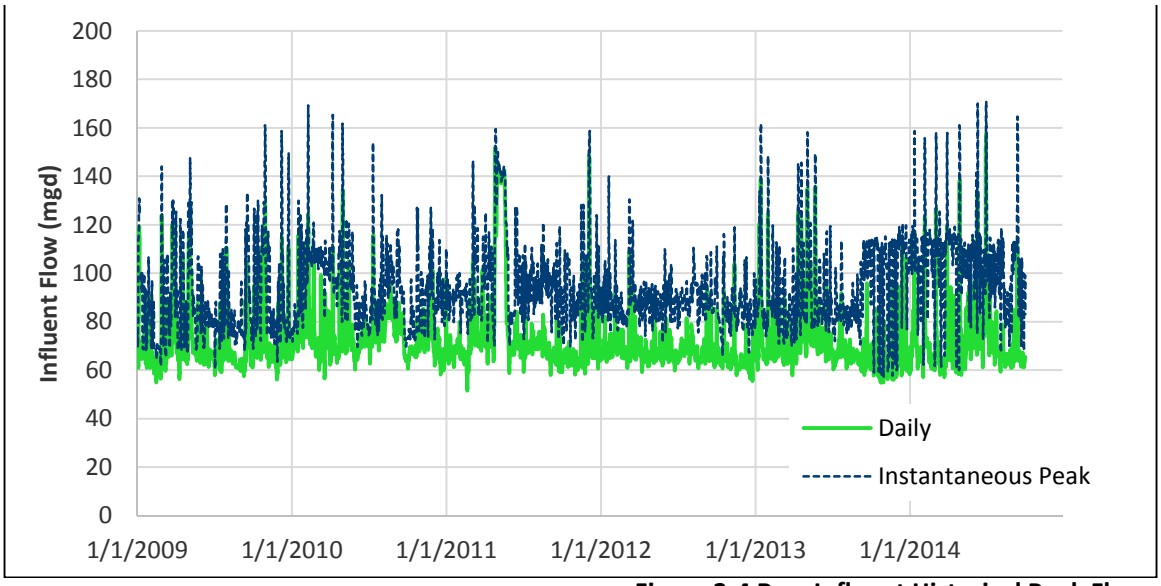


Figure 2-4 Raw Influent Historical Peak Flows

Table 2-1 summarizes historical flow data for the Maxson WWTP. **Table 2-2** provides the historical flow peaking factors based on the criteria established in Section 1-3.

Table 2-1 Historical Flow Data Summary

Parameter	Unit	Historical Flows	
		Daily	30-day moving average
Average	MGD	72.1	---
Minimum	MGD	51.7	57.7
90th percentile	MGD	85.8	80.0
92nd percentile	MGD	89.7	80.9
95th percentile	MGD	98.7	82.6
98th percentile	MGD	121.0	87.5
99th percentile	MGD	137.2	111.3
Maximum	MGD	156.3	130.6
Maximum, instantaneous	MGD	170.0	---

Table 2-2 Historical Flow Peaking Factors

Parameter	Peaking Factors			
	AD	ADMM	MD	PH
Flow	1.00	1.81	2.17	2.36

2.5.2 Raw Influent Mass Loads

2.5.2.1 Raw Influent TSS and VSS

The composition of the collection system indicates that only about one-third of the overall mass load to the Maxson WWTP is from industry. However, TSS concentrations at this facility are still significantly higher than typical domestic wastewater treatment plants. **Figures 2-5** and **2-6** show the daily raw influent TSS and VSS concentrations over the data period. The influence of the force main break in late 2010 under the TVA ash pond is evident with the higher than normal TSS values.

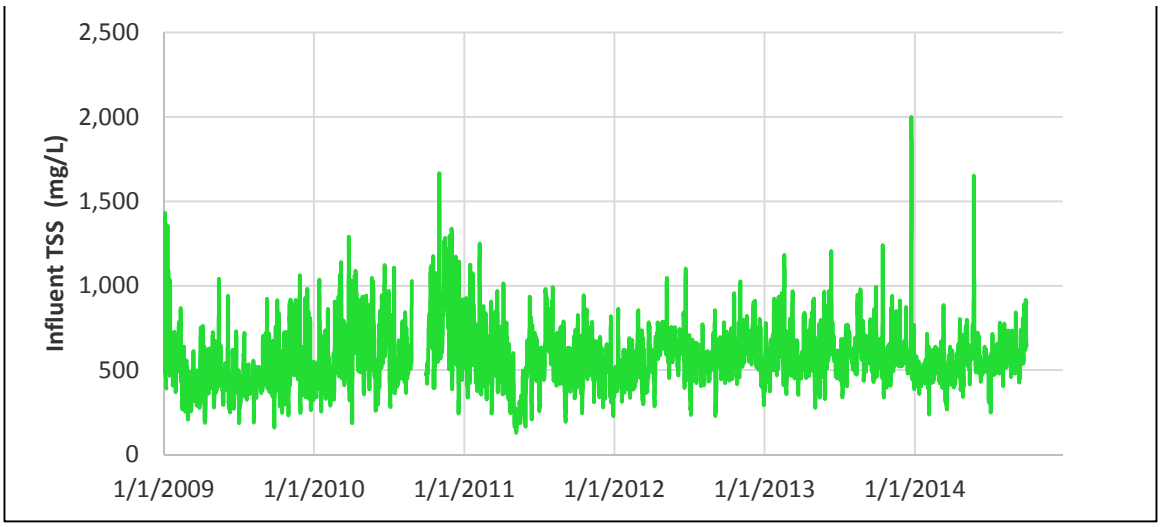


Figure 2-5 Raw Influent Historical TSS Concentrations

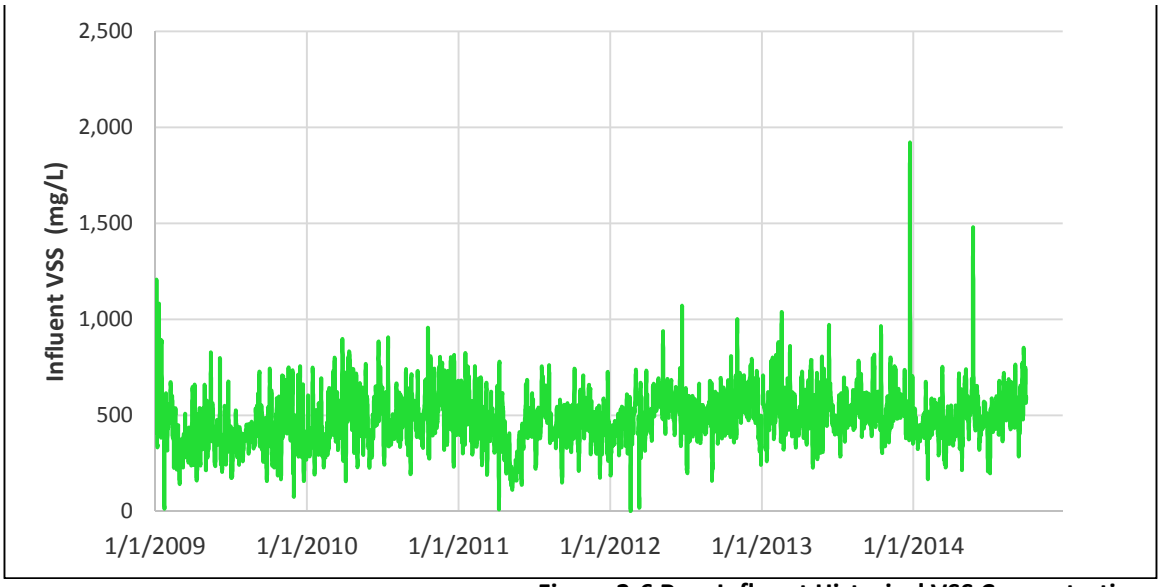


Figure 2-6 Raw Influent Historical VSS Concentrations

Figures 2-7 and **2-8** show the daily raw influent TSS and VSS mass loadings and the 30-day moving average TSS mass load for the data set. Historical mass loadings were generated using the methodology discussed in Section 1.3. Again, the influence of the force main break in late 2010 under the TVA ash pond is evident with the higher than normal TSS values and while maintaining a rather

constant VSS mass loading in the influent. Historically, the average volatile content of the influent TSS is 82% after removal of the October through December 2010 event.

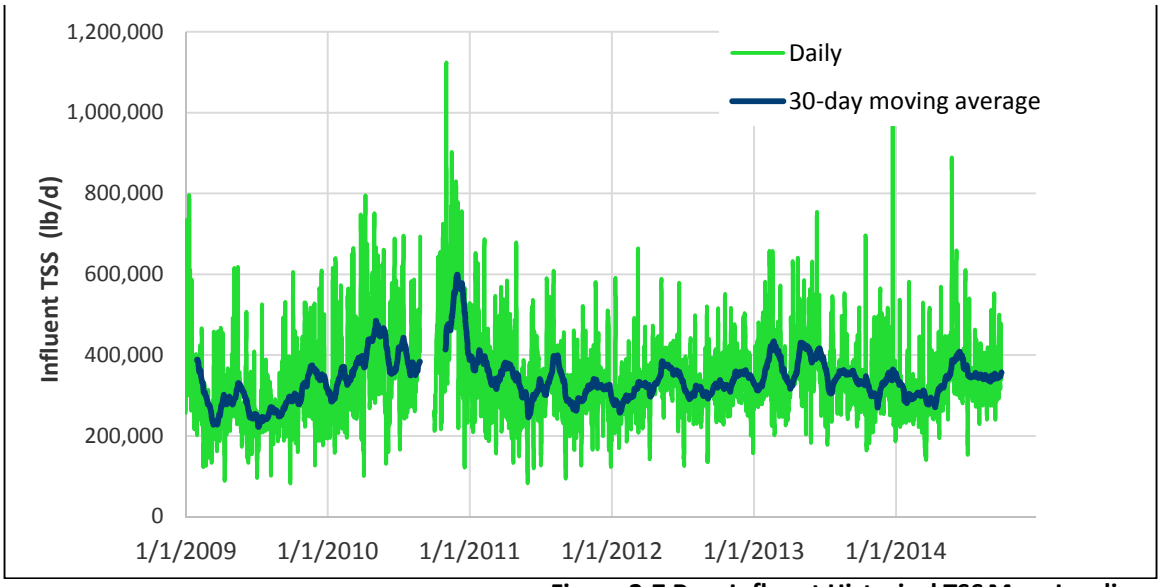


Figure 2-7 Raw Influent Historical TSS Mass Loadings

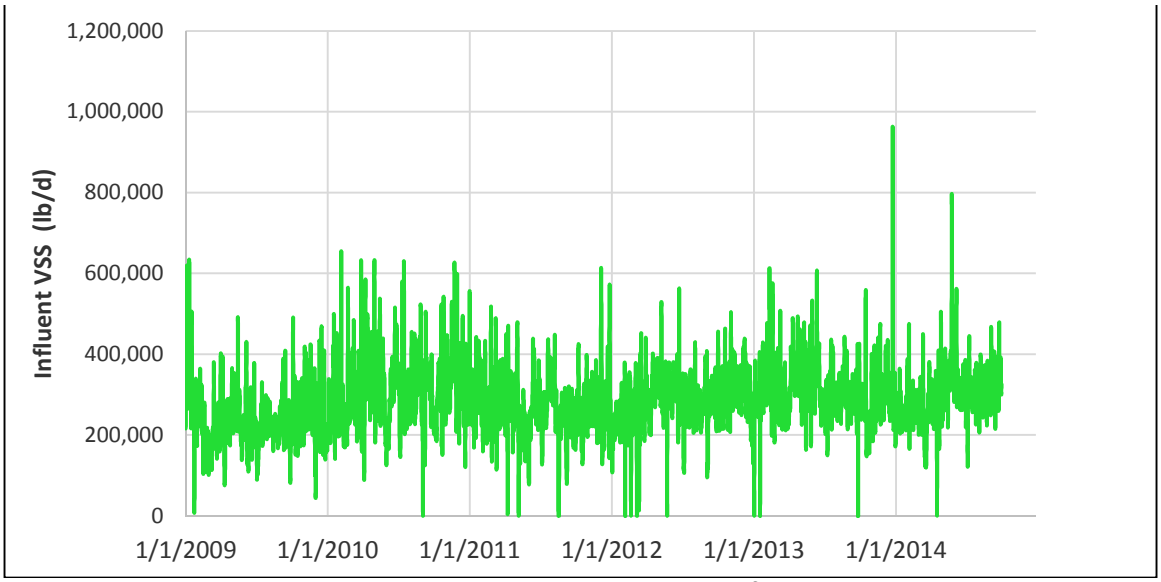


Figure 2-8 Raw Influent Historical VSS Mass Loadings

Table 2-3 summarizes historical raw influent TSS loading for the Maxson WWTP. **Table 2-4** provides the historical raw influent TSS mass loading peaking factors based on the criteria established in Section 1-3. It is important to note the TSS data for daily influent mass load and 30-day moving average mass loading from October through December 2010 was not included in the statistical analysis provided in Tables 1-3 and 1-4 due to the influent from the ash from the force main break.

Table 2-3 Historical Raw Influent TSS Mass Loading Summary

Parameter	Unit	Historical TSS Mass Loading[1]	
		Daily	30-day moving average
Average	lb/d	335,000	---
Minimum	lb/d	83,000	222,000
90th percentile	lb/d	472,000	393,000
92nd percentile	lb/d	496,000	399,000
95th percentile	lb/d	532,000	418,000
98th percentile	lb/d	609,000	438,000
99th percentile	lb/d	659,000	457,000
Maximum	lb/d	1,002,000	485,000

[1] Excludes data set from October through December, 2010 due to influence of ash in influent flow.

Table 2-4 Historical Raw Influent TSS Mass Loading Peaking Factors

Parameter	Mass Loading Peaking Factors[1]		
	AD	ADMM	MD
TSS Mass Loading	1.00	1.25	1.59

[1] Excludes data set from October through December, 2010 due to influence of ash in influent flow.

2.5.2.2 Raw Influent BOD_5

The large amount of industry in the service area contributes 60 percent of the BOD_5 load to the plant. BOD_5 concentrations at this facility are significantly higher than typical domestic wastewater treatment plants. **Figure 2-9** shows the daily raw influent BOD_5 concentrations over the data period.

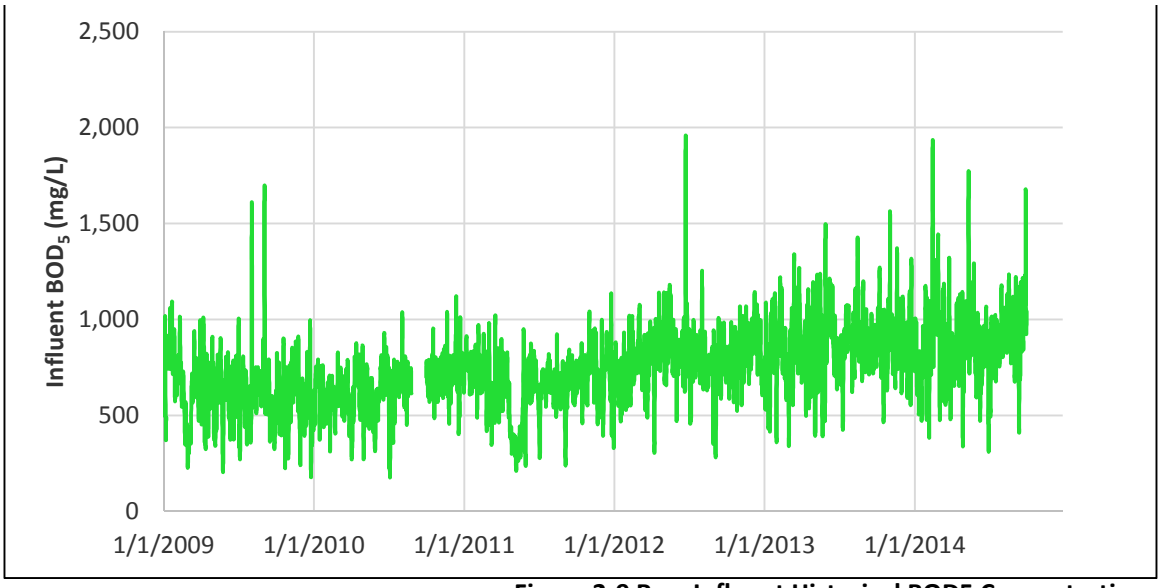


Figure 2-9 Raw Influent Historical BOD5 Concentrations

Historical BOD_5 mass loadings were generated using the methodology discussed in Section 1.3. **Figure 2-10** shows the daily raw influent BOD_5 and 30-day moving average BOD_5 mass load for the data set. **Table 2-5** summarizes historical raw influent BOD_5 loading for the Maxson WWTP. **Table 2-6** provides the historical raw influent BOD_5 mass loading peaking factors based on the criteria established in Section 1-3.

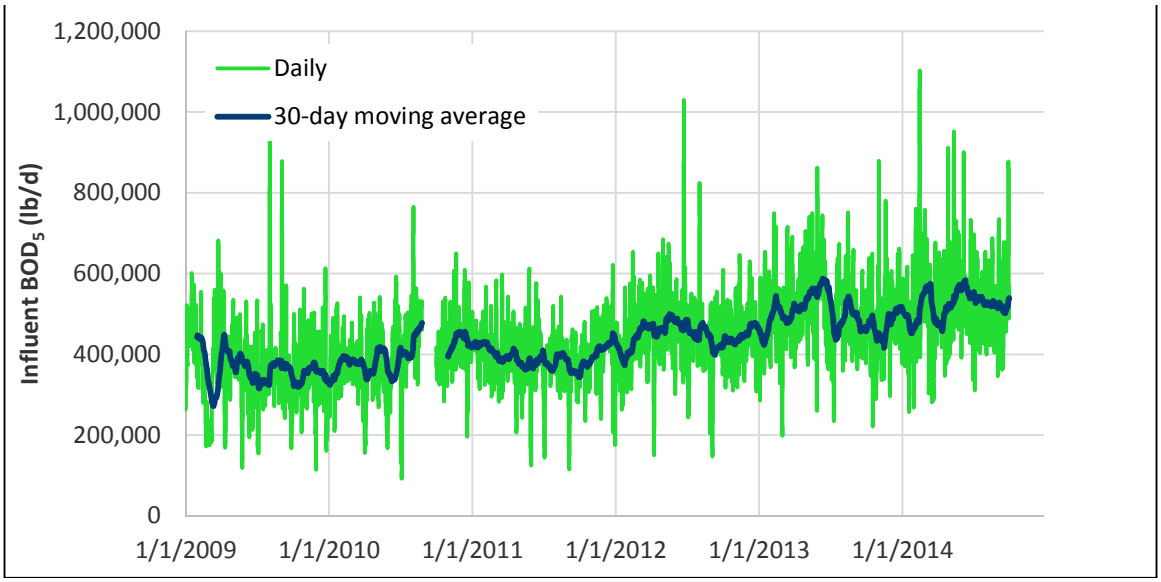


Figure 2-10 Raw Influent Historical BOD_5 Mass Loadings

Table 2-5 Historical Raw Influent BOD_5 Mass Loading Summary

Parameter	Unit	Historical BOD_5 Mass Loadings	
		Daily	30-day moving average
Average	lb/d	435,000	---
Minimum	lb/d	93,000	272,000
90th percentile	lb/d	573,000	526,000
92nd percentile	lb/d	587,000	533,000
95th percentile	lb/d	624,000	550,000
98th percentile	lb/d	681,000	567,000
99th percentile	lb/d	742,000	574,000
Maximum	lb/d	1,081,000	587,000

Table 2-6 Historical Raw Influent BOD_5 Mass Loading Peaking Factors

Parameter	Mass Loading Peaking Factors		
	AD	ADMM	MD
BOD_5 Mass Loading	1.00	1.26	1.43

2.5.3 Raw Influent Temperature

Figure 2-11 provides the daily average and 30-day moving average raw influent temperatures at the Maxson WWTP. Temperature is not as critical in the biological treatment process since nitrification is not required and heterotrophic bacteria grow quickly even during colder months. That being said, soluble BOD_5 removal is impacted by temperature and, given the short SRT of the facility, minimum one to two day temperature will be important as a design parameter. **Table 2-7** summarizes the historical temperature data.

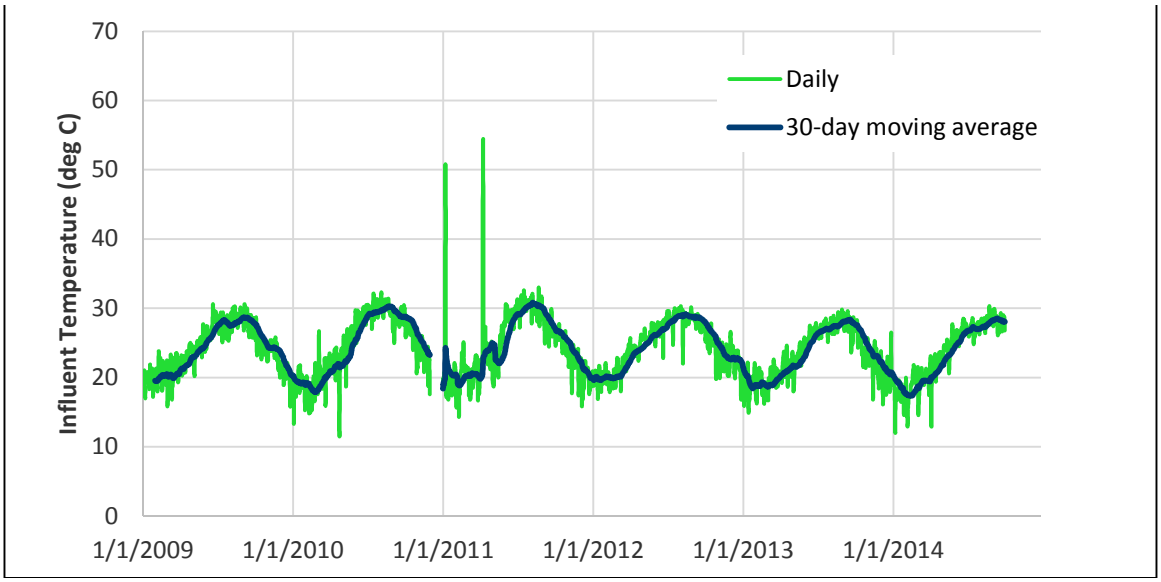


Figure 2-11 Raw Influent Historical Temperature

Table 2-7 Historical Temperature Data Summary

Parameter	Unit	Historical Temperature			
		Daily	2-day moving average	7-day moving average	30-day moving average
Average	deg C	24.1	---	---	---
Minimum	deg C	11.5	14.1	15.6	17.4
Maximum	deg C	54.4	54.2	33.2	30.8

2.5.4 Raw Influent pH

Figure 2-12 provides the daily raw influent pH at the Maxson WWTP. Just like temperature, pH is not as critical in the biological treatment process at this facility since nitrification is not required and heterotrophic bacteria are not as sensitive to pH values between 6 and 6.5 as the autotrophic bacteria. The low (less than 4.5) pH values through 2011 were a result of dumping of ferrous chloride upstream of the influent sampling point. This has since ceased as shown by the data in 2012 and beyond. **Table 2-8** summarizes the historical pH data.

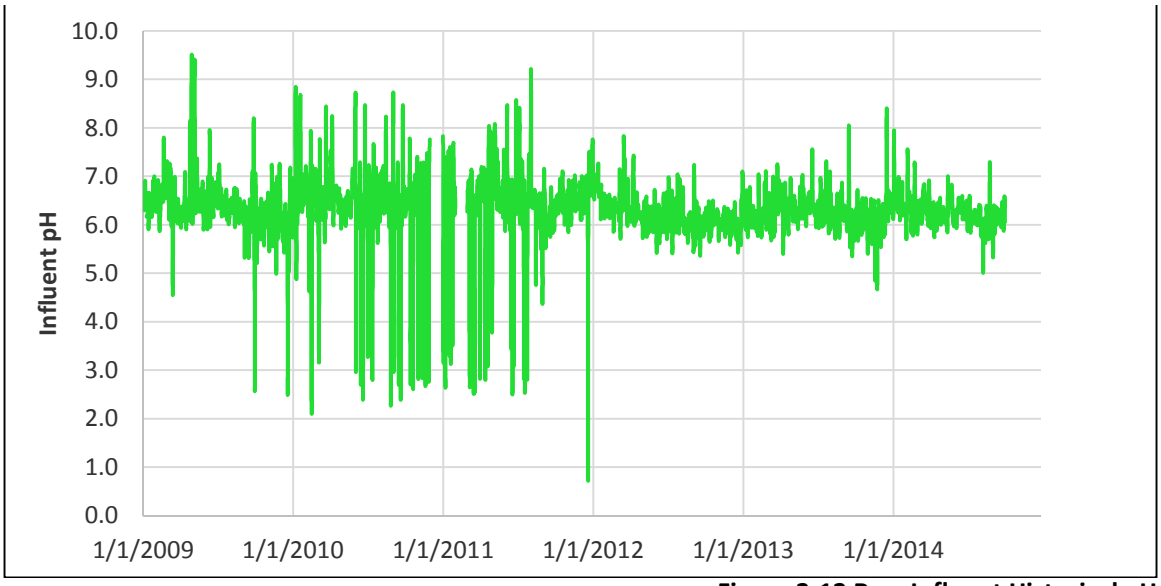


Figure 2-12 Raw Influent Historical pH

Table 2-8 Historical pH Data Summary

Parameter	Unit	Historical pH	
		Daily	30-day moving average
Average	---	6.3	---
Minimum	---	0.7	5.0
Maximum	---	9.5	7.8

2.5.5 Summary of Raw Influent Data

Table 2-9 provides a summary of the evaluation of the raw influent data.

Table 2-9 Historical Raw Influent Peaking Factors, Flows, and Mass Loads

Parameter		Peaking Factors		
		AD	ADMM	MD
Flow		1.00	1.81	2.17
BOD_5 mass load		1.00	1.26	1.43
TSS mass load		1.00	1.25	1.59
Parameter	**Unit**	**Historical Influent Flows and Mass Loads**		
		AD	ADMM	MD
Flow	MGD	72.1	130.6	156.3
BOD_5	mg/L	724	505	478
	lb/day	435,000	550,000	624,000
TSS	mg/L	557	384	408
	lb/day	335,000	418,000	532,000

2.6 Historical Primary Effluent Characteristics

The Maxson WWTP utilizes four 180-foot diameter primary clarifiers for particulate BOD_5 and TSS removal. Historical primary effluent (PE) data was evaluated to determine historical performance of the primary clarifiers and identify possible trends in TSS and BOD_5 removal and correlation of primary effluent VSS/TSS ratio.

2.6.1 Primary Effluent TSS and VSS

2.6.1.1 Historical Performance

Figure 2-13 and **Figure 2-14** show the historical primary effluent concentrations for TSS and VSS in the primary effluent, respectively. **Figure 2-15** and **Figure 2-16** show the historical mass loads for TSS and VSS, respectively. The gaps in the data set are from omission of primary effluent data from the evaluated data set that were taken during days when one or multiple units were out of service so that an evaluation could be made with all operating units in service. Primary effluent data from October through December 2010 was utilized and included in the evaluation in an attempt to correlate clarifier performance at higher TSS loadings.

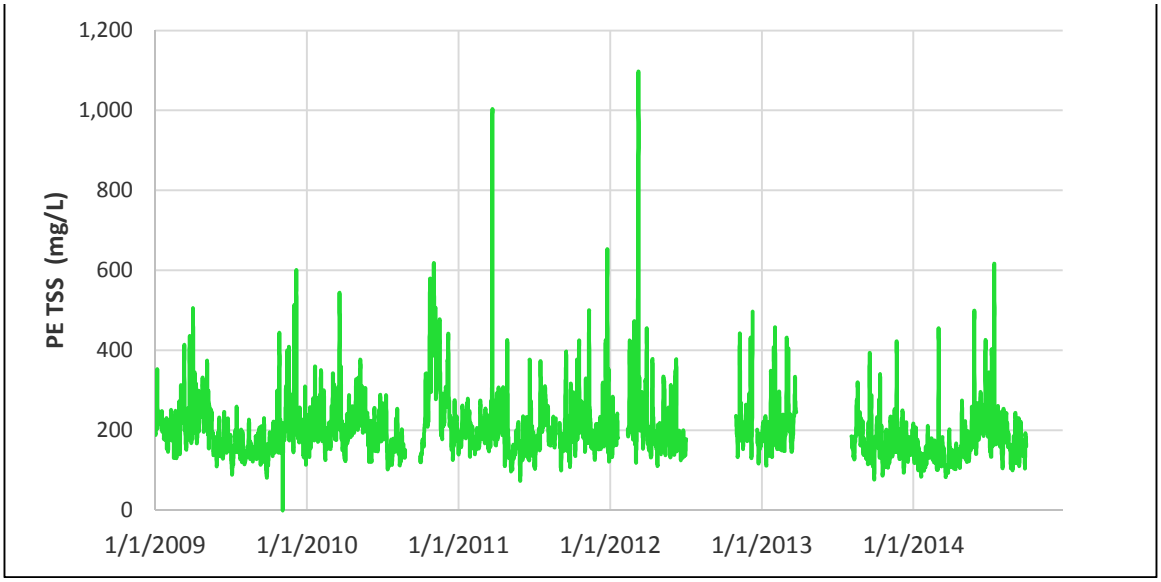


Figure 2-13 Maxson WWTP PE Historical TSS Concentrations

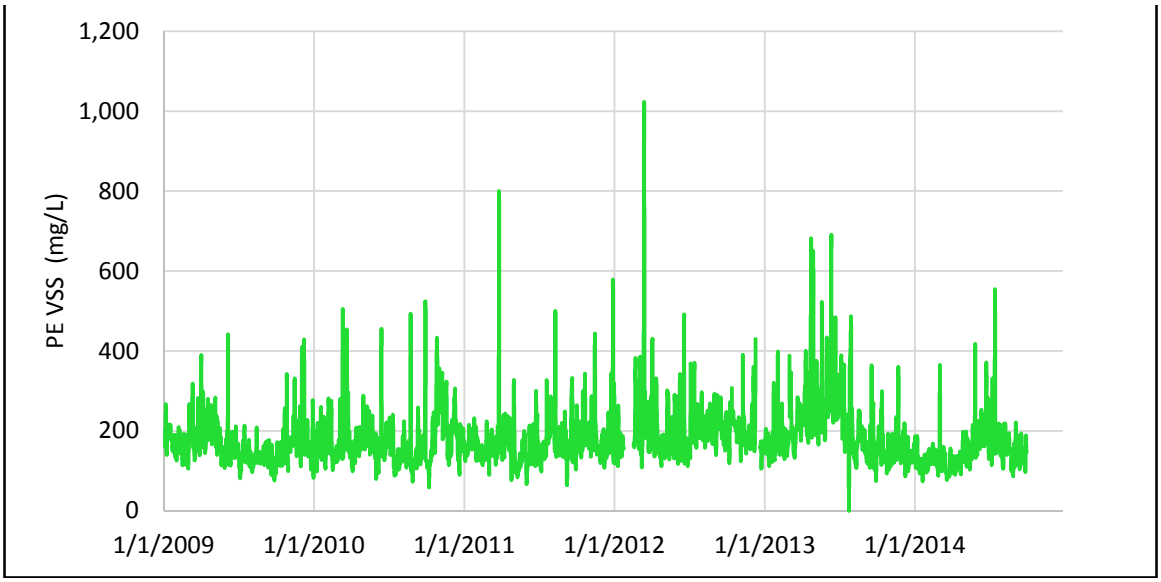


Figure 2-14 Maxson WWTP PE Historical VSS Concentrations

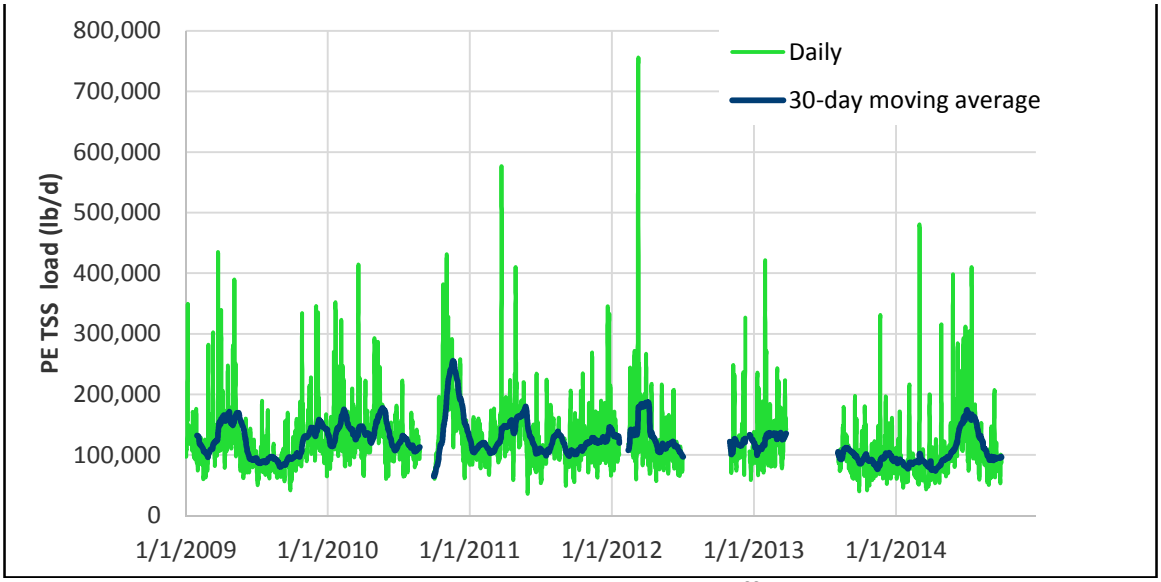


Figure 2-15 Primary Effluent Historical TSS Mass Loadings

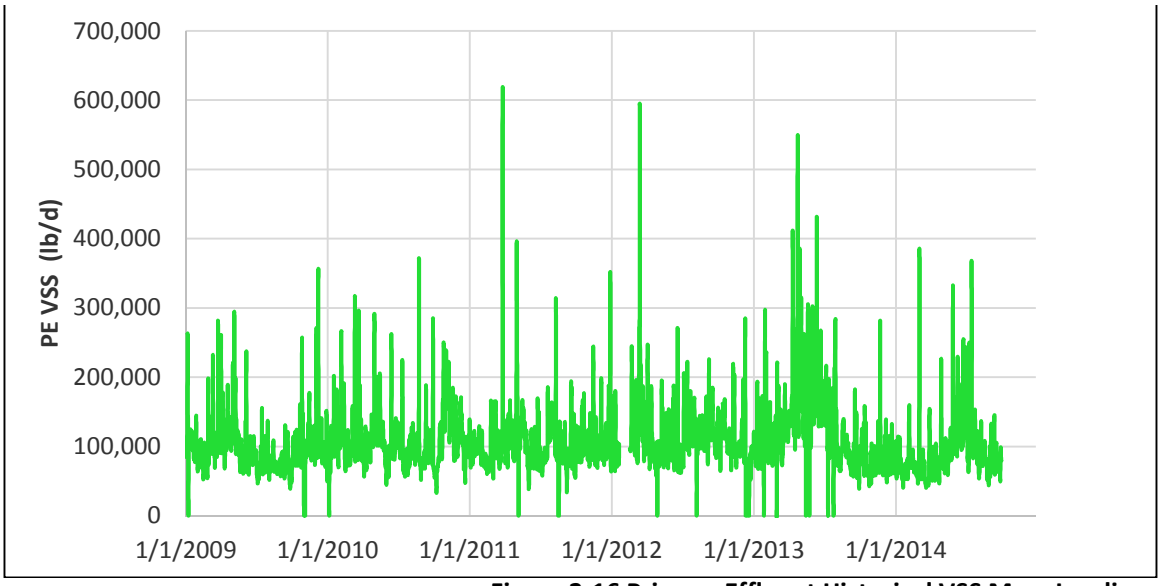


Figure 2-16 Primary Effluent Historical VSS Mass Loadings

Figure 2-17 shows the removal efficiencies of the primary clarifiers. Evaluation of the primary effluent data indicates, on average, that the units remove, between 60 to 65 percent of the raw influent TSS mass load. This value is typical for well performing primary clarifiers operating at a typical hydraulic overflow rate. The primary clarifiers at the Maxson WWTP averaged a hydraulic overflow rate of approximately 700 gallons per day per square foot for the data period.

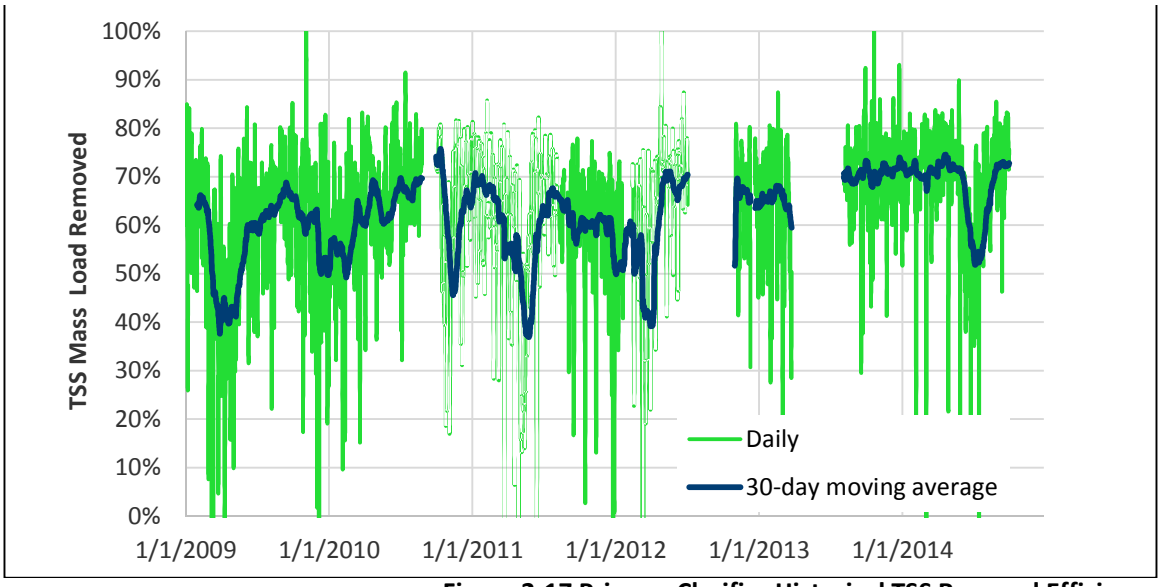


Figure 2-17 Primary Clarifier Historical TSS Removal Efficiency

There are 30-day periods where the clarifiers performed at removal efficiencies of approximately 40 percent. These occurred in April/May 2009, May 2011, and April 2012. The April/May 2009 event occurred when 30-day moving average TSS mass loads in the influent were under the 5th percentile and can be attributed to decreased performance at lower loadings. This is discussed more in detail in the next section. The May 2011 data is skewed due to the rain events during the historical Mississippi

River flooding event that month. Decreased performance in April 2012 cannot be explained from evaluating the data.

Volatile suspended solids content in the primary effluent was statistically analyzed to determine the variability in volatile content. This parameter is important in process design as it will directly impact sludge production at the facility. **Figure 2-18** shows the rank and percentile analysis. The analysis indicates that approximately half of the data falls between a VSS/TSS ratio of 80 to 90 percent. The average and median of the data set is 83 and 86 percent, respectively. It is proposed to utilize an average VSS content of 83 percent of the primary effluent TSS as part of the process design.

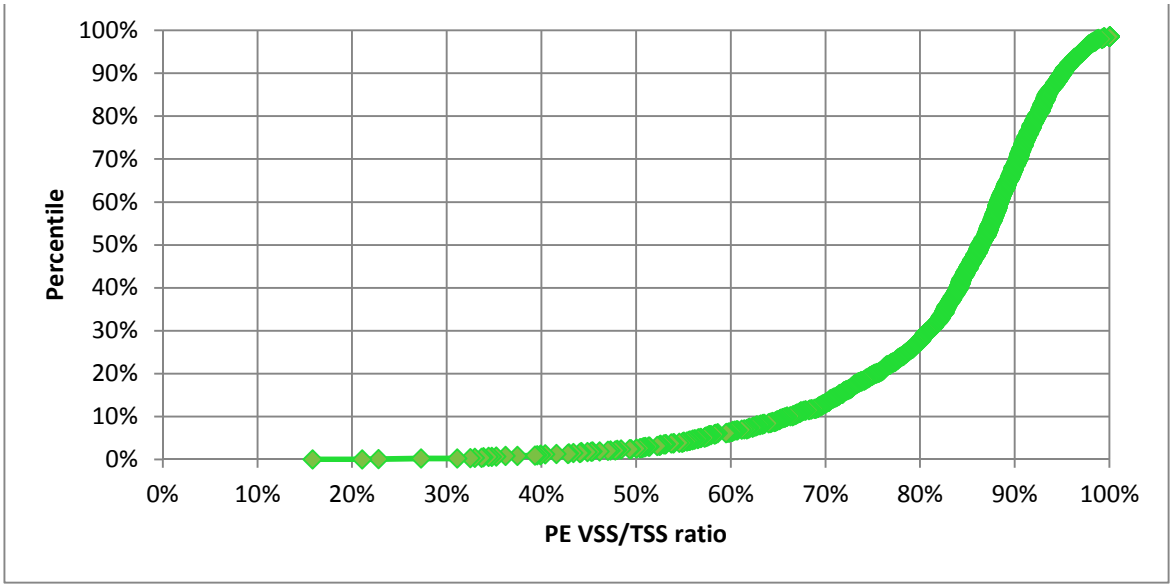


Figure 2-18 Primary Effluent VSS/TSS Ratio Percentile Analysis

Historical primary effluent TSS mass loadings were generated using the methodology discussed in Section 1.3. **Table 2-10** summarizes historical primary effluent TSS loading for the Maxson WWTP. **Table 2-11** provides the historical primary effluent TSS mass loading peaking factors based on the criteria established in Section 1-3.

Table 2-10 Historical Primary Effluent TSS Loading Summary

Parameter	Unit	Historical TSS Mass Loadings[1]	
		Daily	30-day moving average
Average	lb/d	123,000	---
Minimum	lb/d	36,000	65,000
90th percentile	lb/d	180,000	163,000
92nd percentile	lb/d	194,000	165,000
95th percentile	lb/d	225,000	174,000
98th percentile	lb/d	291,000	193,000
99th percentile	lb/d	345,000	231,000
Maximum	lb/d	736,000	255,000

[1] Includes data set from October through December, 2010 that has ash in influent flow.

Table 2-11 Historical Primary Effluent TSS Mass Loading Peaking Factors

Parameter	Mass Loading Peaking Factors[1]		
	AD	ADMM	MD
TSS Mass Loading	1.00	1.41	1.83

[1] Includes data set from October through December, 2010 that has ash in influent flow.

2.6.1.2 Performance Evaluation

The primary effluent data was evaluated further in an attempt to correlate TSS removal to various parameters. As Figure 2-17 indicated, there were periods where TSS removal was well below the average. These trends are important as they will help understand variability in performance and will be used to predict future performance at increased flow and mass loads. The variables evaluated included:

- Influent flow rate
- Raw influent TSS mass loading

2.6.1.2.1 Influent Flow Rate

TSS removal efficiency for all flows in the data set and for all flows greater than 90 MGD were generated. Flows at 90 MGD and greater were evaluated to determine if correlations exist at flows at and beyond the plant's current rated design capacity. Best-fit regression trendlines have been superimposed on the data set to assist in the correlation of the data. **Figure 2-19** and **Figure 2-20** show the results. Both plots show significant scatter and variation of removal efficiency at varying flow conditions. It is not recommended that either of these correlations be used to predict primary clarifier TSS removal performance.

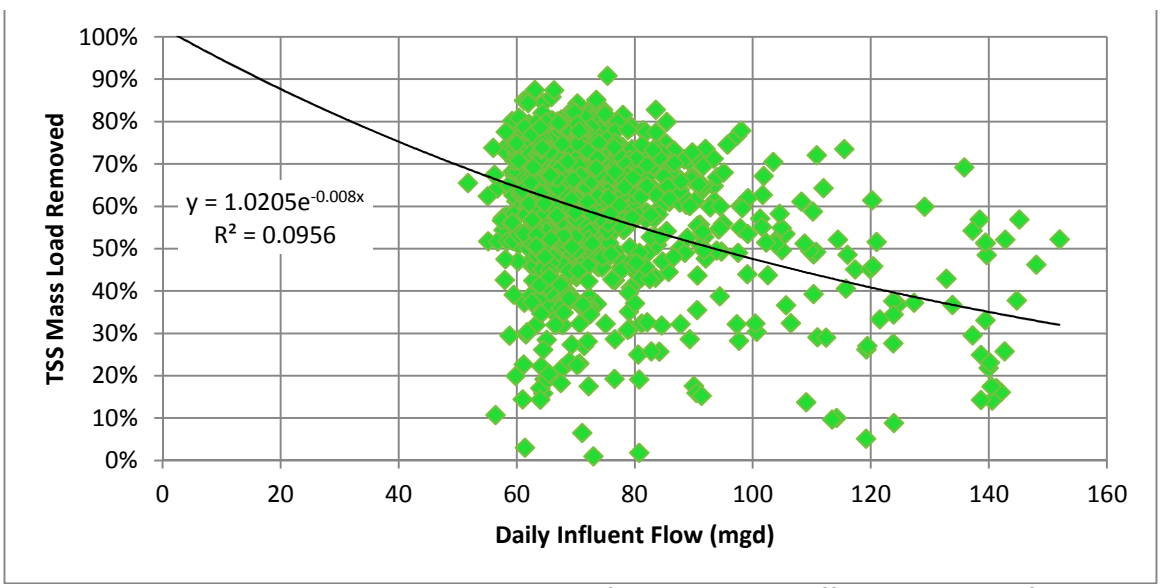


Figure 2-19 Primary Clarifier TSS Removal Efficiency versus Influent Flow

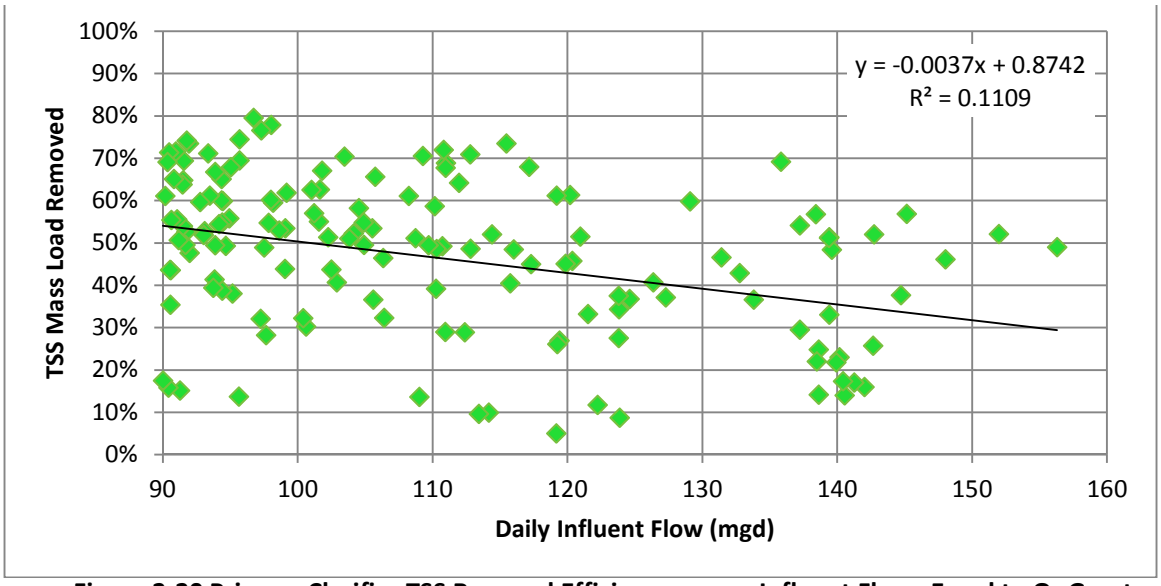


Figure 2-20 Primary Clarifier TSS Removal Efficiency versus Influent Flows Equal to Or Greater Than 90 MGD

2.6.1.2.2 Raw Influent TSS Mass Loading

Raw influent TSS mass loading was evaluated in an attempt to correlate primary clarifier removal efficiency or predicted primary effluent TSS mass load to this parameter. Use of raw influent TSS data from October through December 2010 was included in this evaluation to provide correlations at higher loading events. Best-fit regression trendlines have been superimposed on the data set to assist in the correlation of the data. **Figures 2-21** through **2-24** show the results.

Figure 2-21 shows a trend of increased TSS removal efficiency at higher influent TSS loadings for the entire data set. While there may be a trend, it would not be prudent to project future influent TSS mass loadings (which will be higher than the historical data) to predict a higher removal efficiency. Therefore, the correlation in Figure 2-21 is not recommended to be used to project primary clarifier TSS removal performance.

Conversely, Figure 2-22 shows a trend of decreased TSS removal when the data set is only evaluated at flows 90 MGD or greater. The correlation of the data in Figure 2-22 is promising, however, the majority of the TSS mass loads in this plot are below the average raw influent TSS mass load from the historical data set (341,000 pounds per day). Figure 2-22 appears to be showing decreased TSS removal efficiencies during wet weather events from the historical data. Utilizing the trend of this data would suggest that the primary clarifier TSS removal efficiency at the average raw influent TSS value of 341,000 pounds per day would result in a removal efficiency of less than 30 percent. Historical data indicates that the removal efficiency is roughly double this. In as much so, it is not recommended to utilize this correlation to project primary clarifier TSS removal performance.

Figures 2-23 and 2-24 plot the historical primary effluent mass loading as a function of the raw influent mass loading for all data and only for conditions where the average daily flow was 90 MGD or greater, respectively. Both figures indicate that increased raw influent TSS mass load will yield increased primary effluent TSS mass load which, most likely, is an accurate representation of what will occur during operation. The trend in Figure 2-24 will predict a higher primary effluent TSS mass load than that predicted in Figure 2-23. Furthermore, Figure 2-24 utilizes influent flow data at or above the present permitted design capacity of the facility. It is recommended to use the trend in Figure 2-24 to predict future primary clarifier performance.

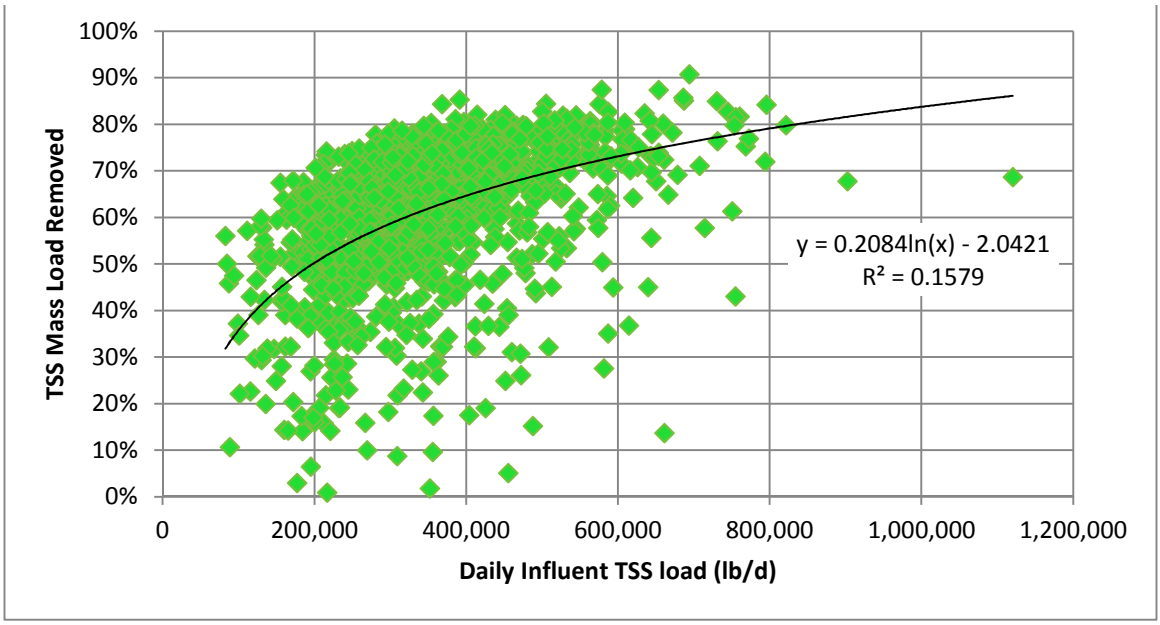


Figure 2-21 Primary Clarifier TSS Removal Efficiency versus Raw Influent TSS Mass Load

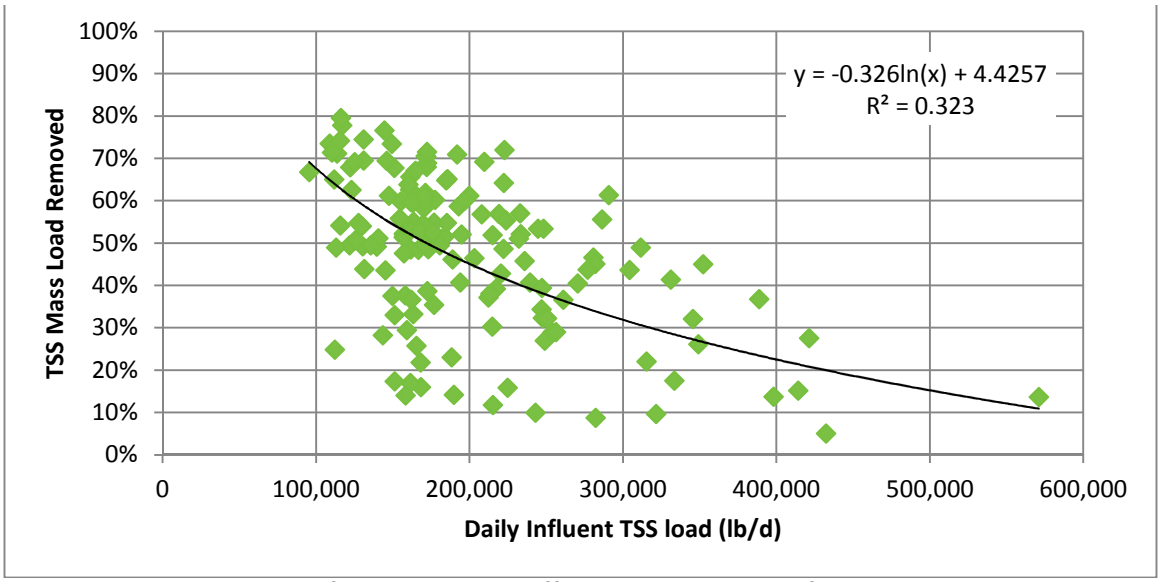


Figure 2-22 Primary Clarifier TSS Removal Efficiency versus Raw Influent TSS Mass Load At Flows Equal To Or Greater Than 90 MGD

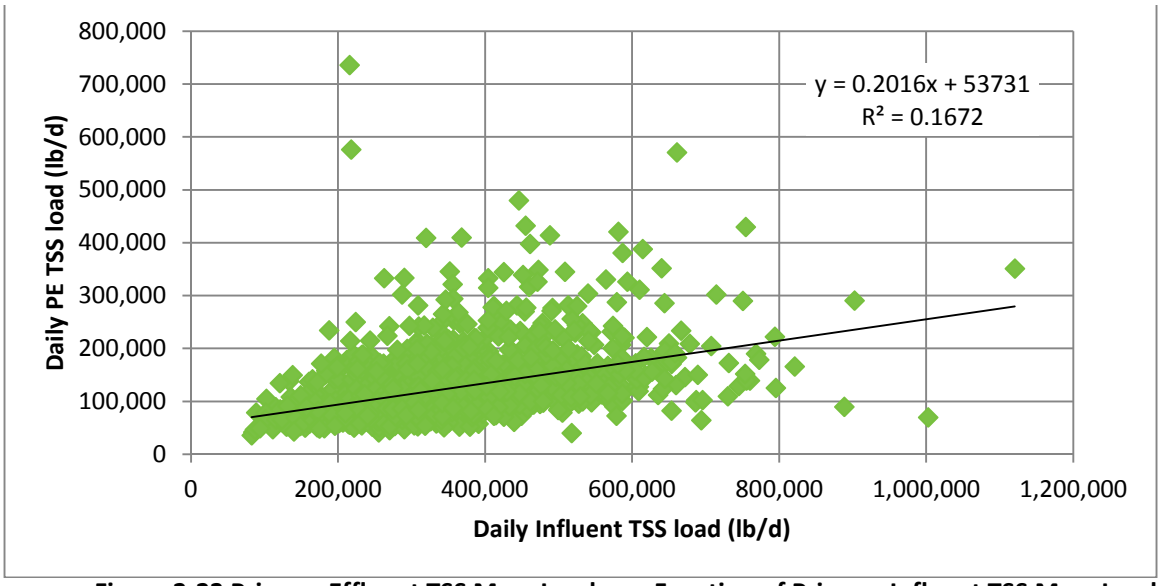


Figure 2-23 Primary Effluent TSS Mass Load as a Function of Primary Influent TSS Mass Load

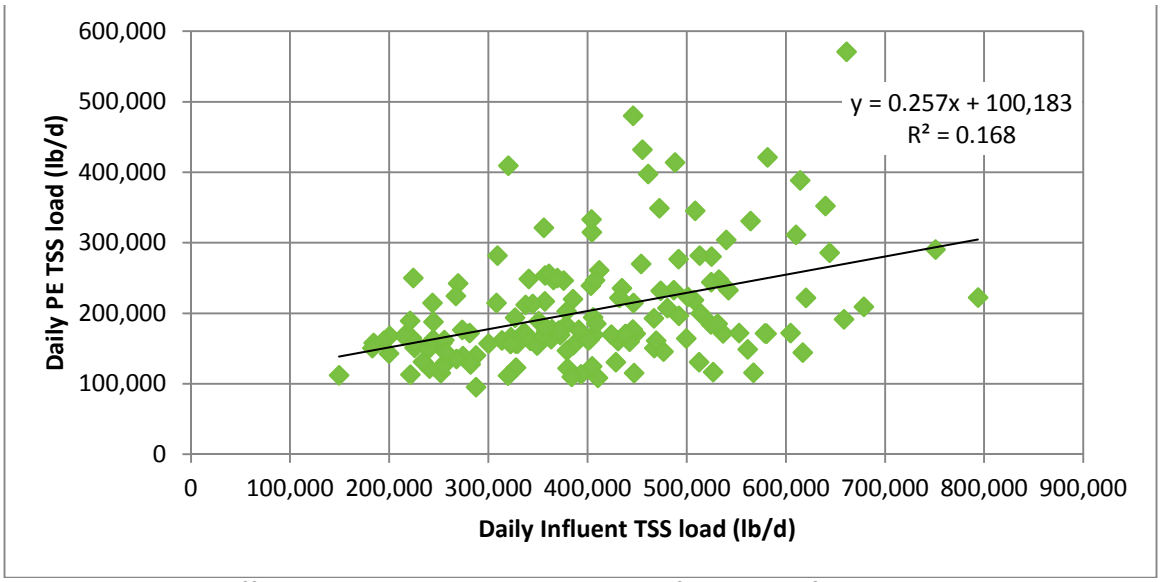


Figure 2-24 Primary Effluent TSS Mass Load as a Function of Primary Influent TSS Mass Load at Flows Equal to or Greater than 90 MGD

2.6.2 Primary Effluent BOD_5

2.6.2.1 Historical Performance

Figure 2-25 and **Figure 2-26** show the historical primary effluent concentrations and mass loads for the evaluated time period. The gaps in the data set are from omission of primary effluent data from the evaluated data set that were taken during days when one or multiple units were out of service so that an evaluation could be made with all operating units in service.

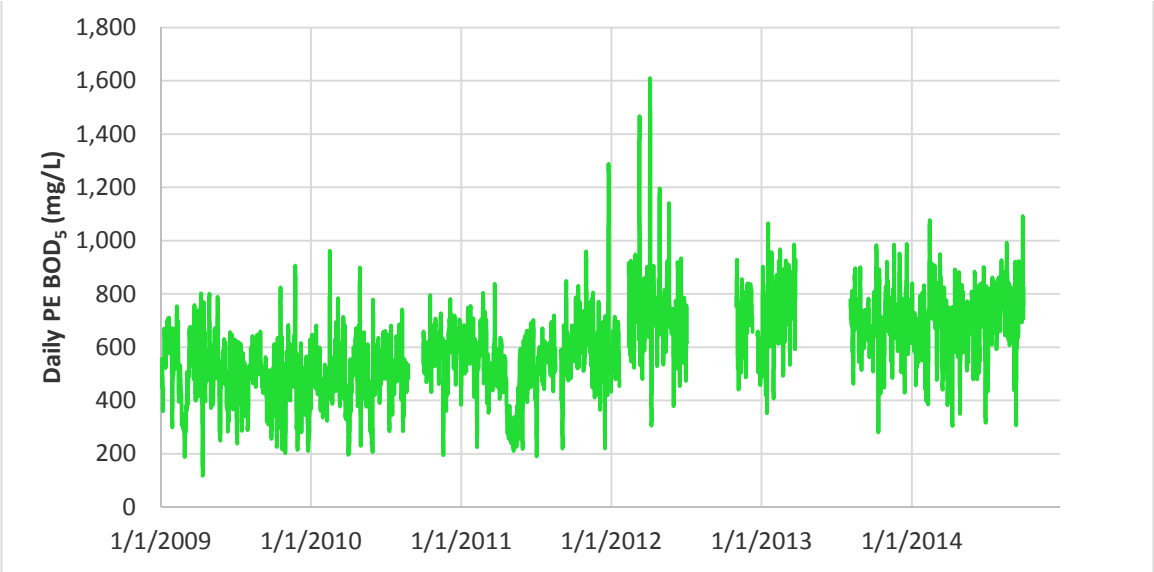


Figure 2-25 Primary Effluent Historical BOD_5 Concentrations

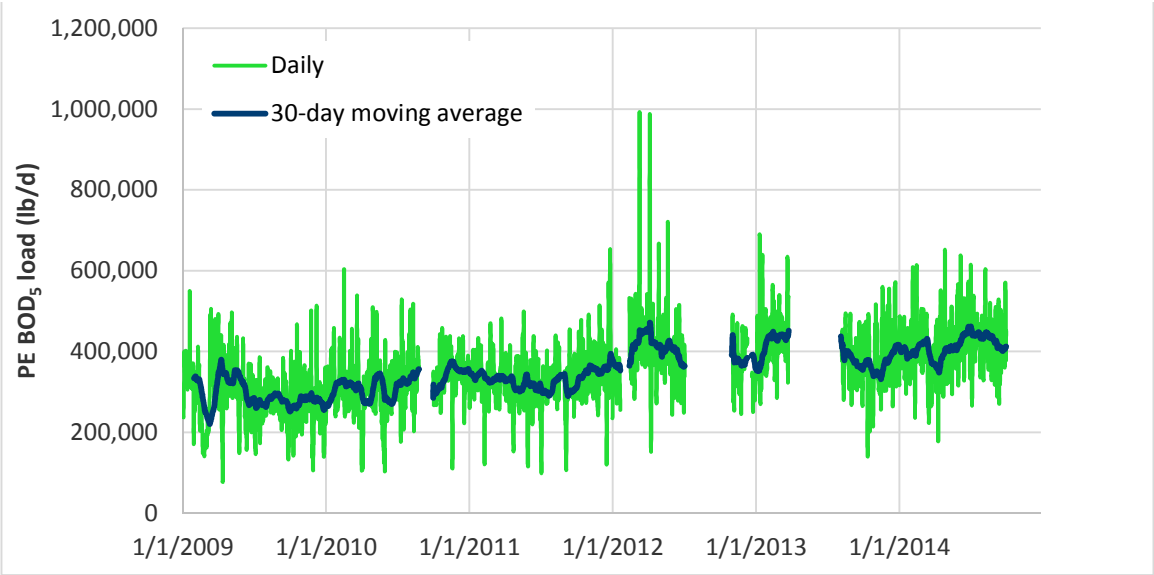


Figure 2-26 Primary Effluent Historical BOD_5 Mass Loadings

Figure 2-27 shows the removal efficiencies of the primary clarifiers. Evaluation of the primary effluent data indicates that the units remove, on average roughly 20 percent of the raw influent BOD_5 depending on the loading condition at the Maxson WWTP. This value is typically low for primary clarifiers that averaged an overflow rate of approximately 700 gallons per day per square foot for the data period and suggests that the soluble BOD_5 component of the raw influent is significant.

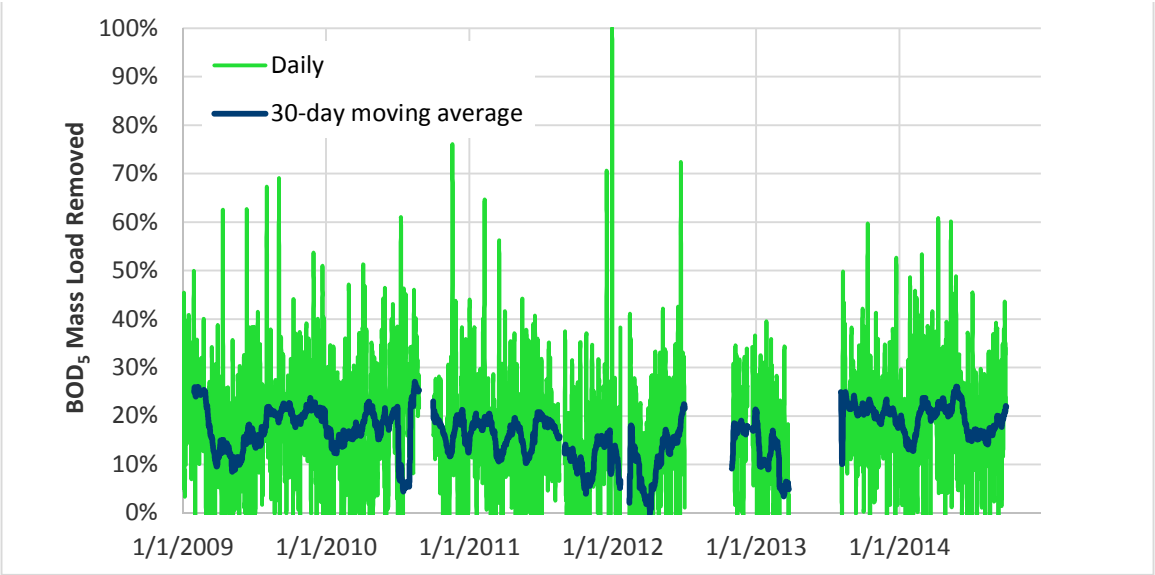


Figure 2-27 Primary Clarifier Historical BOD_5 Removal Efficiency

It should be noted that Figure 2-27 is not showing data where the BOD_5 increased after the primary clarifiers (i.e. indicating a negative BOD_5 removal on the y-axis of Figure 2-27). There were numerous occurrences of this. Spot checks of the primary clarifier sludge blanket measurements on the dates where the BOD_5 increased after the primary clarifiers showed blankets typically less than 1 foot which would indicate rapid removal of primary sludge and mitigation of fermentation in the blanket. The blanket measurements are just a "snapshot" at that instantaneous moment in time. There could be the possibility that the sludge blankets are typically higher than what the operating data suggests which could yield these higher BOD_5 values.

The primary effluent data showing "negative removal" of BOD_5 are inclusive in the data set evaluated. In as much so, if fermentation is occurring in the blanket and can be mitigated by operational measures, the historical performance of BOD_5 removal in the primary clarifiers can be deemed conservative since it accounts for days of sludge fermentation and increase of BOD_5 in the primary clarifiers.

Historical primary effluent BOD_5 mass loadings were generated using the methodology discussed in Section 1.3. **Table 2-12** summarizes historical primary effluent BOD_5 loading for the Maxson WWTP. **Table 2-13** provides the historical primary effluent BOD_5 mass loading peaking factors based on the criteria established in Section 1-3.

Table 2-12 Historical Primary Effluent BOD_5 Mass Loading Summary

Parameter	Unit	Historical BOD_5 Mass Loadings	
		Daily	30-day moving average
Average	lb/d	351,000	---
Minimum	lb/d	80,000	220,000
90th percentile	lb/d	458,000	427,000
92nd percentile	lb/d	570,000	434,000
95th percentile	lb/d	493,000	441,000
98th percentile	lb/d	539,000	448,000
99th percentile	lb/d	571,000	452,000
Maximum	lb/d	991,000	471,000

Table 2-13 Historical Primary Effluent BOD_5 Mass Loading Peaking Factors

Parameter	Mass Loading Peaking Factors		
	AD	ADMM	MD
BOD_5 Mass Loading	1.00	1.26	1.40

2.6.2.2 Performance Evaluation

The primary effluent data was evaluated further in attempt to correlate BOD_5 removal to various parameters. These included:

- Influent flow rate
- Raw influent BOD_5 mass loading

2.6.2.2.1 Influent Flow Rate

BOD_5 removal efficiency for all flows in the data set and for all flows greater than 90 MGD was generated. Flows at 90 MGD and greater were evaluated to determine if correlations exist at flows at and beyond the plant's current rated design capacity. Best-fit regression trendlines have been superimposed on the data set to assist in the correlation of the data. **Figure 2-28** and **Figure 2-29** show the results. Both plots show significant scatter and variation of removal efficiency at varying flow conditions. It is not recommended that either of these correlations be used to predict primary clarifier BOD_5 removal performance.

2.6.2.2.2 Raw Influent BOD_5 Mass Loading

Raw influent BOD_5 mass loading was evaluated in an attempt to correlate primary clarifier removal efficiency or predicted primary effluent BOD_5 mass load. Best-fit regression trendlines have been superimposed on the data set to assist in the correlation of the data. **Figure 2-30, Figure 2-31, Figure 2-32, and Figure 2-33** show the results of the daily data. **Figure 2-34** shows monthly averages of the BOD_5 data set.

Figure 2-30 shows a similar trend of increased removal of BOD_5 at higher loadings (similar to Figure 2-21 for TSS). It also shows a baseline amount of BOD_5 that will not be removed in the primary clarifiers due to the soluble component ranging from 200,000 to 400,000 pounds per day. Figure 2-31 also shows an increasing trend in BOD_5 removal at higher loadings specifically at those occurring at flows of 90 MGD or greater.

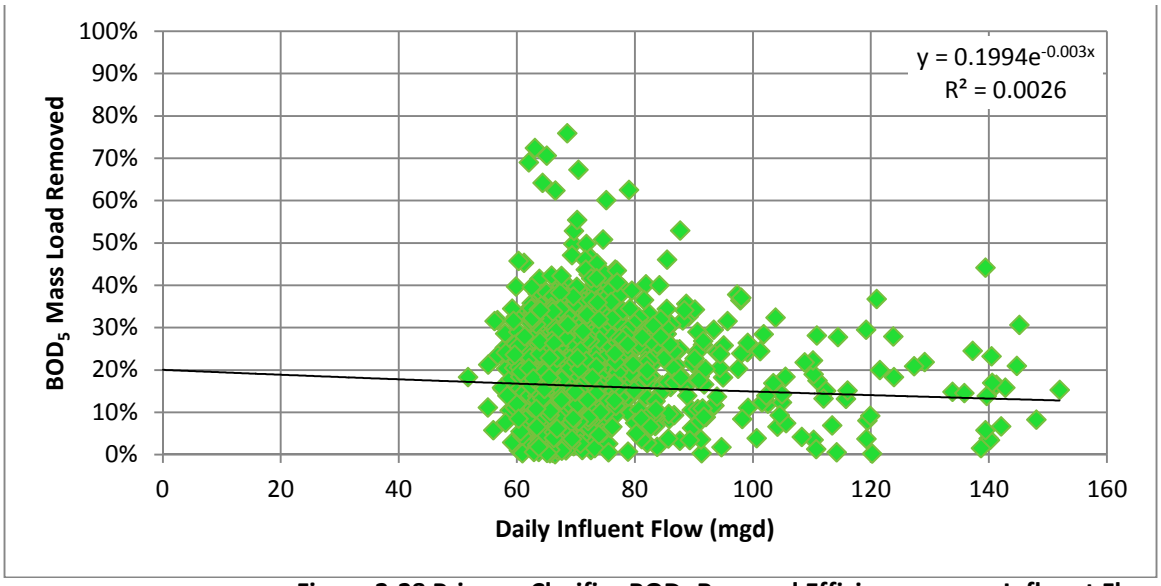


Figure 2-28 Primary Clarifier BOD_5 Removal Efficiency versus Influent Flow

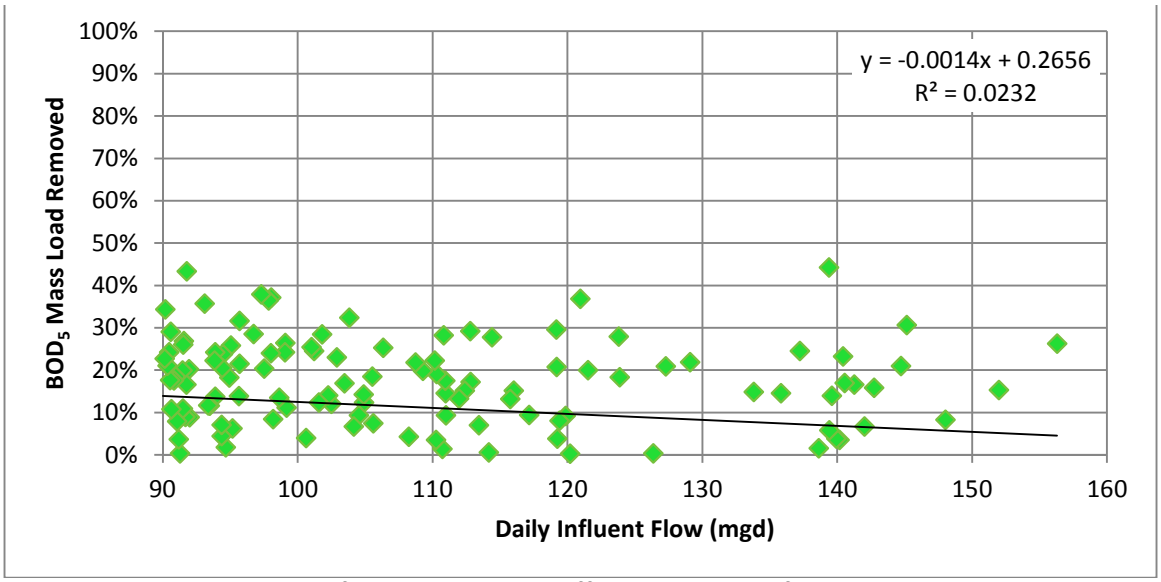


Figure 2-29 Primary Clarifier BOD_5 Removal Efficiency versus Influent Flows Equal to Or Greater Than 90 MGD

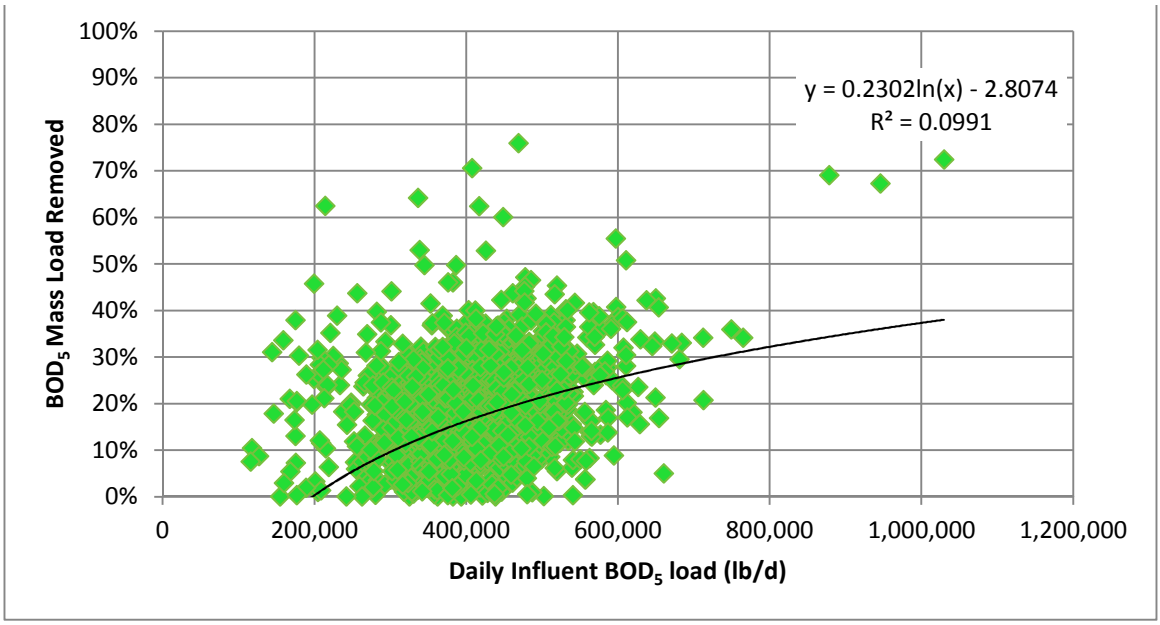


Figure 2-30 Primary Clarifier TSS Removal Efficiency versus Raw Influent BOD_5 Mass Load

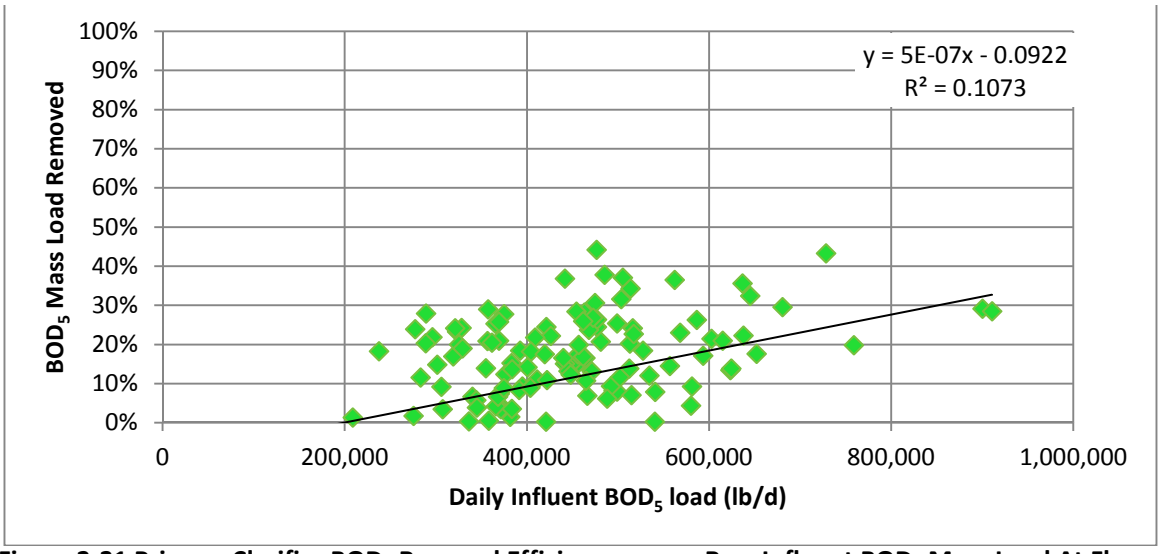


Figure 2-31 Primary Clarifier BOD_5 Removal Efficiency versus Raw Influent BOD_5 Mass Load At Flows Equal To Or Greater Than 90 MGD

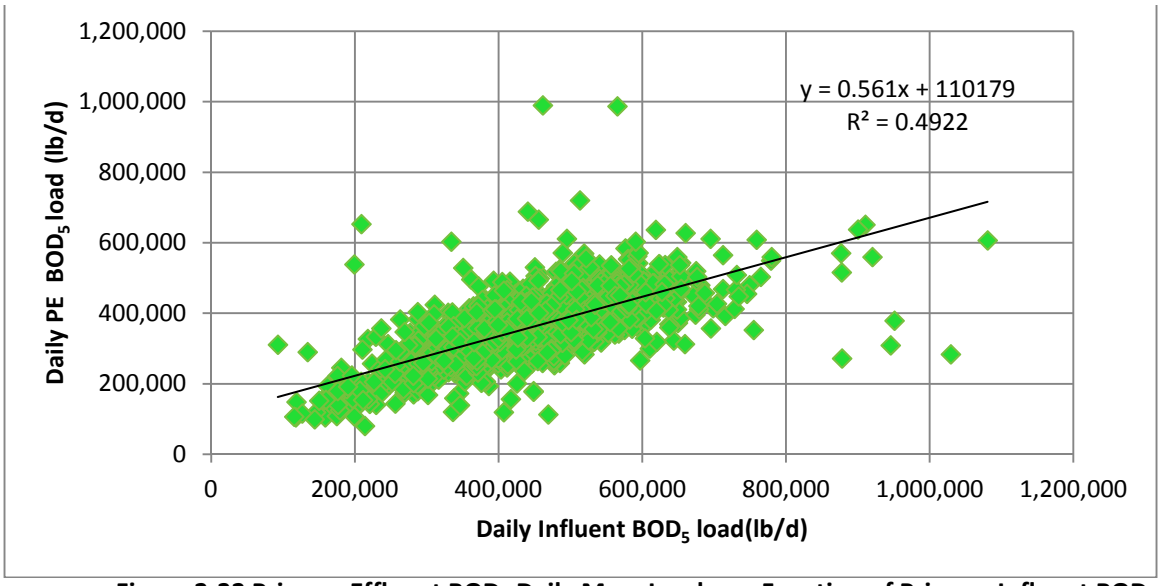


Figure 2-32 Primary Effluent BOD_5 Daily Mass Load as a Function of Primary Influent BOD_5 Daily Mass Load

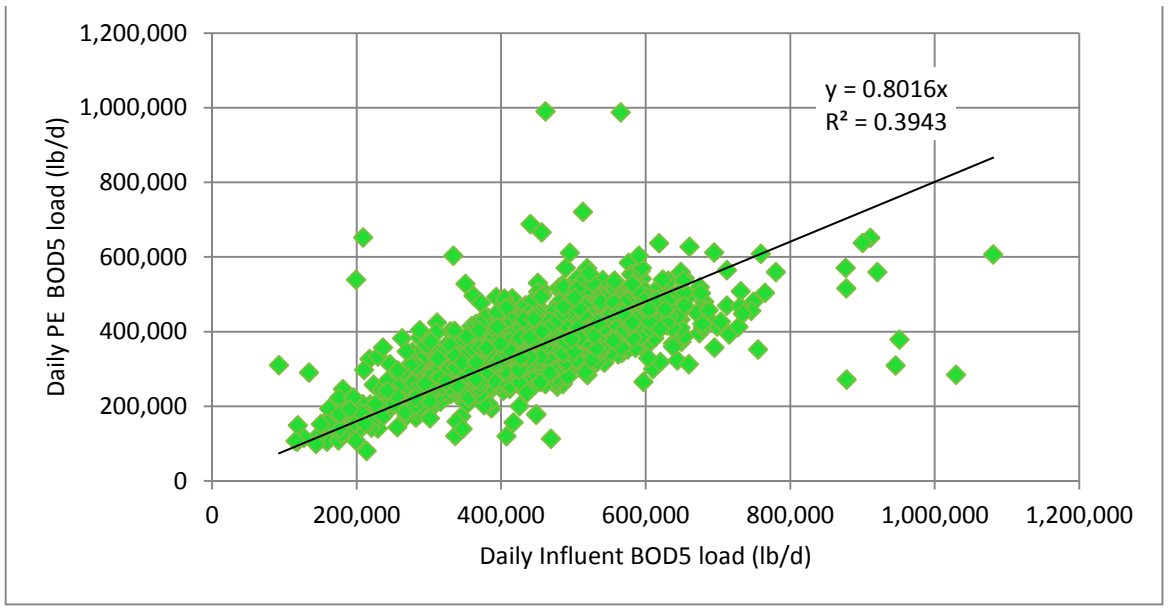


Figure 2-33 Primary Effluent BOD_5 Daily Mass Load as a Function of Raw Influent BOD_5 Daily Mass Load With Y-Intercept at Zero

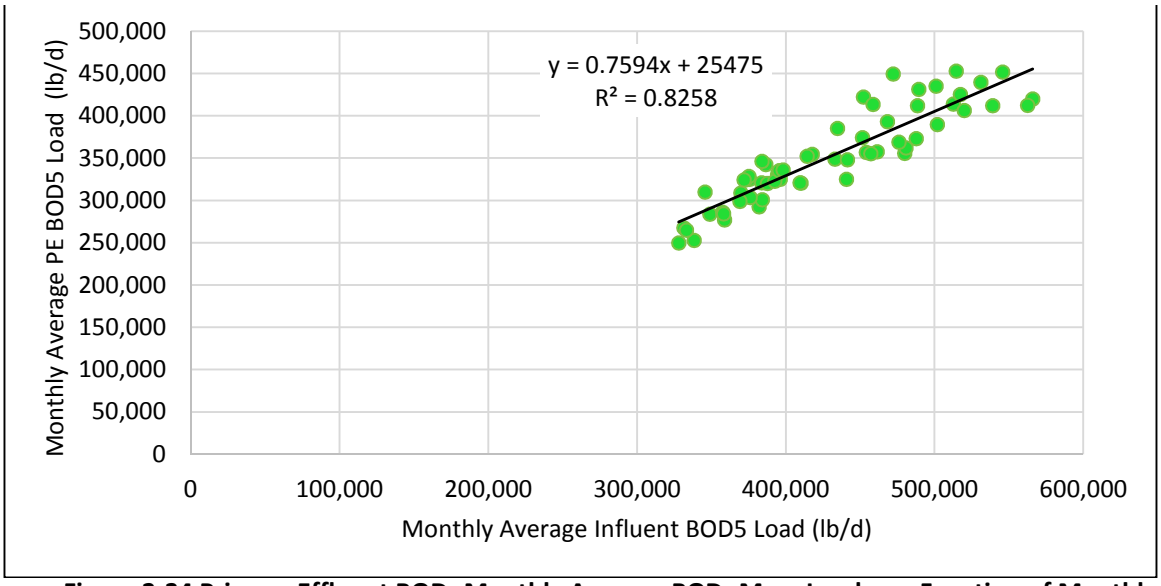


Figure 2-34 Primary Effluent BOD_5 Monthly Average BOD_5 Mass Load as a Function of Monthly Average Raw Influent BOD_5 Mass Load

Figure 2-32 shows a strong correlation between influent BOD_5 load and primary effluent BOD_5 load and also indicates that primary clarifier performance deteriorates at lower influent BOD_5 mass loads. The regression, at face value, would predict that primary effluent BOD_5 load would be higher than the influent BOD_5 loads when influent loadings are less than 250,000 pounds per day. This, of course, is impossible unless fermentation is occurring in the sludge blanket.

Figure 2-33 can be manipulated by forcing the y-intercept to zero to provide another trendline to assess the data. Figure 2-33 shows the results with only forcing the trendline to intercept the y-axis at zero.

Figures 30 through 34 all indicate increased BOD_5 removal in the primary clarifiers at increased influent BOD_5 loadings. The data shown in Figures 32 through 34 can be used to predict the projected primary effluent BOD_5 mass load as a function of influent BOD_5 mass load and should be used to predict primary clarifier performance for future conditions.

2.6.3 Primary Effluent Summary

Table 2-14 provides a summary of the evaluation of the historical primary effluent mass loads.

Table 2-14 Historical Primary Effluent Mass Loading Peaking Factor and Mass Loading

Parameter		Peaking Factors		
		AD	ADMM	MD
BOD_5 mass load		1.00	1.26	1.40
TSS mass load		1.00	1.41	1.83
BOD_5	lb/day	351,000	441,000	493,000
TSS	lb/day	123,000	174,000	225,000

2.7 Projected Raw Influent Characteristics

2.7.1 Raw Influent Flow

The Maxson WWTP is presently permitted for 90 MGD of flow capacity. Growth in the service area is unknown and it is unclear as to when the facility will reach 90 MGD of daily flow capacity. Design loading conditions will be developed for an interim biological treatment capacity of 82 MGD of daily flow capacity and for the ultimate biological treatment capacity at 90 MGD of daily flow capacity.

Analysis of the historical data indicates that the facility has experienced daily flows above 90 MGD roughly 8 percent of the time. These times have corresponded primarily with storm events with the maximum month, maximum day and instantaneous peak historical flows occurring during significant rain and flooding events. Application of the historical peaking factors for these conditions may not be applicable due to the fact that the service area is built out and the majority of the increase in flow was due to infiltration and inflow. Therefore, it is proposed to use the historical maximum month, maximum day, and peak hour flows as the projected values at both the 82 MGD and 90 MGD daily flow conditions as well since these are more a function of infiltration and inflow in the service area than increased flows from new customers. **Table 2-15** summarizes the proposed raw influent flows for design.

Table 2-15 Proposed Raw Influent Flow and Flow Peaking Factors

Parameter	Unit	Proposed Design Flows			
		AD	ADMM	MD	PH
Flow – interim capacity	MGD	82.0	130.6	156.3	170.0
Flow – ultimate capacity	MGD	90.0	130.6	156.3	170.0
Parameter		**Derived Peaking Factors**			
		AD	ADMM	MD	PH
Flow – interim capacity		1.00	1.59	1.91	2.07
Flow – ultimate capacity		1.00	1.45	1.74	1.89

2.7.2 Raw Influent Mass Loads

Direction from the City indicated that the design parameters for the Maxson WWTP include the loadings from Cargill even though the facility shut down in January 2015. This was done to allocate future biological capacity for another significant industrial user in the future. The existing service area is built-out and significant changes to the characteristics of the service area are not anticipated. Given these assumptions, it is reasonable to assume that the waste strength should remain fairly constant. The raw influent BOD_5 and TSS concentrations and VSS/TSS ratio are assumed to be similar to those historically. Mass load peaking factors developed from the historical data are applied to the interim an ultimate average day flows of 82 and 90 MGD, respectively, to develop the projected raw influent mass loads for the facility. **Tables 2-16** and **2-17** summarizes the projected influent mass loads.

Table 2-16 Summary of Raw Influent Flows and Mass Loading at 82 MGD

Parameter		Peaking Factors		
		AD	ADMM	MD
Flow		1.00	1.59	1.91
BOD_5 mass load		1.00	1.26	1.43
TSS and VSS mass load		1.00	1.25	1.59
Parameter	**Unit**	**Proposed Raw Influent Flows and Mass Loading**		
		AD	ADMM	MD
Flow	MGD	82.0	130.6	156.3
BOD_5	mg/L	724	575	543
	lb/day	495,000	626,000	707,000
TSS	mg/L	557	436	464
	lb/day	381,000	475,000	605,000
VSS	mg/L	455	356	379
	lb/day	311,000	388,000	494,000

Table 2-17 Summary of Raw Influent Flows and Mass Loading at 90 MGD

Parameter		Peaking Factors		
		AD	ADMM	MD
Flow		1.00	1.45	1.74
BOD_5 mass load		1.00	1.26	1.43
TSS and VSS mass load		1.00	1.25	1.59
Parameter	**Unit**	**Proposed Raw Influent Flows and Mass Loading**		
		AD	ADMM	MD
Flow	MGD	90.0	130.6	156.3
BOD_5	mg/L	724	630	596
	lb/day	543,000	686,000	776,000
TSS	mg/L	557	479	510
	lb/day	418,000	522,000	664,000
VSS	mg/L	455	391	416
	lb/day	341,000	426,000	542,000

2.7.3 Raw Influent Temperature

Historical water temperatures for the Maxson WWTP are shown in Table 2-7. There is not a valid reason to deviate from the values from the historical data. The minimum water temperature that should be utilized for process design should be 14 degrees Celsius.

2.7.4 Raw Influent pH

Historical pH values for the Maxson WWTP are shown in Table 2-8. pH values have consistently been between 5 and 8 in the influent, with an average between 6.3 and 6.5, and can be used for the process

design. pH fluctuations could occur again, with pH values less than 6.0, if ferrous chloride is added again to the lagoons or lagoon overflow.

2.8 Projected Primary Effluent Characteristics

2.8.1 Primary Effluent TSS and VSS

Section 1.5.1.2.1 analyzed trends in the historical data set in an attempt to correlate data so it could be used to predict primary clarifier performance at increased flow and mass loads. The correlations found in Figures 2-23 and 2-24 were the most promising. The correlation in Figure 2-24 predicts a higher primary effluent TSS mass load than that in Figure 2-23 and, thus, will be used for projecting primary effluent mass loads. **Tables 2-18** and **2-19** summarize the predicted primary effluent characterization at 82 and 90 MGD, respectively, using the correlation in Figure 2-24.

Table 2-18 Projected Primary Effluent TSS Mass Loading at 82 MGD

Parameter	Unit	TSS Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	381,000	475,000	605,000
Primary Effluent	lb/day	198,000	222,000	256,000
Removal Efficiency	%	48	53	58

Table 2-19 Projected Primary Effluent TSS Mass Loading at 90 MGD

Parameter	Unit	TSS Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	418,000	522,000	664,000
Primary Effluent	lb/day	208,000	234,000	271,000
Removal Efficiency	%	50	55	59

The projected primary clarifier removal efficiency in Tables 2-18 and 2-19 predicts removals of 48 to 60 percent which is lower than the historical data which indicated 60 to 65 percent removal. This makes logical sense since flows and mass loads to the primary clarifiers will increase. The removal efficiencies are also in-line (if not conservative) with removal efficiencies for units that are loaded within conventional design parameters. The VSS content of the primary effluent is presumed to be similar to the historical data and a value of 83 percent is proposed.

2.8.2 Primary Effluent BOD_5

Section 2.5.1.2.2 analyzed trends in the historical data set in an attempt to correlate data so it could be used to predict primary clarifier performance at increased flow and mass loads. The correlations found in **Figures 2-32 through 2-34** were the most promising. **Tables 2-20** and **2-21** summarize the predicted primary effluent BOD_5 loads at the various design conditions using the correlations found in **Figures 2-27 through 2-29**.

Table 2-20 Comparison of Projected Primary Effluent BOD_5 Mass Loading From Analysis in Figures 2-32 through 2-34 at 82 MGD

Parameter	Figure Correlation	Unit	BOD_5 Mass Loading at Design Capacity		
			AD	ADMM	MD
Raw Influent	N/A	lb/day	495,000	626,000	707,000
Primary Effluent	32	lb/day	378,000	461,000	507,000
Primary Effluent	33	lb/day	397,000	502,000	567,000
Primary Effluent	34	lb/day	419,000	523,000	588,000
Average	N/A	lb/day	401,000	495,000	554,000

Table 2-21 Comparison of Projected Primary Effluent BOD_5 Mass Loading From Analysis in Figures 2-32 through 2-34 at 90 MGD

Parameter	Figure Correlation	Unit	BOD_5 Mass Loading at Design Capacity		
			AD	ADMM	MD
Raw Influent	N/A	lb/day	543,000	686,000	776,000
Primary Effluent	32	lb/day	415,000	495,000	545,000
Primary Effluent	33	lb/day	435,000	550,000	622,000
Primary Effluent	34	lb/day	457,000	571,000	643,000
Average	N/A	lb/day	436,000	539,000	603,000

The variation in the data predicted by the three correlations from **Figures 2-32, 2-33, and 2-34** is approximately 10 to 12 percent, depending on the loading condition. An average of the three predicted correlations is proposed to be utilized for the projected primary effluent mass loading. Furthermore, the use of the average of the three regression correlations would result in BOD_5 removal efficiencies of 20 to 22 percent which are in line with historical data and consider some increase in removal efficiency at higher influent BOD_5 loading events. **Tables 2-22** and **2-23** summarize the predicted primary effluent characterization at 82 and 90 MGD, respectively.

Table 2-22 Projected Primary Effluent BOD_5 Mass Loading at 82 MGD

Parameter	Unit	BOD_5 Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	495,000	626,000	707,000
Primary Effluent	lb/day	401,000	495,000	554,000
Removal Efficiency	%	19	21	22

Table 2-23 Projected Primary Effluent BOD_5 Mass Loading at 90 MGD

Parameter	Unit	BOD_5 Mass Loading at Design Capacity		
		AD	ADMM	MD
Raw Influent	lb/day	543,000	686,000	776,000
Primary Effluent	lb/day	436,000	539,000	603,000
Removal Efficiency	%	20	21	22

2.8.3 Primary Effluent Summary

Tables 2-24 and **2-25** provide a summary of the evaluation of the historical primary effluent loads and will be used as the basis of design for the secondary treatment process depending on the decision of utilizing the interim capacity of 82 MGD of average day flow or the ultimate capacity of 90 MGD of average day flow.

Table 2-24 Summary of Proposed Primary Effluent Flows and Mass Loads at 82 MGD

Parameter		Peaking Factors		
		AD	ADMM	MD
Flow		1.00	1.59	1.91
BOD_5 mass load		1.00	1.26	1.43
TSS and VSS mass load		1.00	1.28	1.62
Parameter	**Unit**	**Proposed Primary Effluent Flows and Mass Loadings**		
		AD	ADMM	MD
Flow	MGD	82.0	130.6	156.3
BOD_5	mg/L	587	455	425
	lb/day	401,000	495,000	554,000
TSS	mg/L	290	204	196
	lb/day	198,000	222,000	256,000
VSS	mg/L	239	169	162
	lb/day	164,000	184,000	211,000

Table 2-25 Summary of Proposed Primary Effluent Flows and Mass Loads at 90 MGD

Parameter		Peaking Factors		
		AD	ADMM	MD
Flow		1.00	1.45	1.74
BOD_5 mass load		1.00	1.26	1.43
TSS and VSS mass load		1.00	1.28	1.62
Parameter	**Unit**	**Proposed Primary Effluent Flows and Mass Loadings**		
		AD	ADMM	MD
Flow	MGD	90.0	130.6	156.3
BOD_5	mg/L	581	494	463
	lb/day	436,000	539,000	603,000
TSS	mg/L	277	215	208
	lb/day	208,000	234,000	271,000
VSS	mg/L	229	178	172
	lb/day	172,000	194,000	224,000

2.9 Sludge Production Analysis

2.9.1 Primary Sludge

Historical primary sludge quantity from the 2009-2014 data set can be estimated by subtracting the raw influent TSS from the primary effluent TSS. **Figure 2-35** shows the plot of the historical monthly average primary sludge production over time from 2009-2014 including the influence the two highest TSS loading events that occurred in April 2010 (cause unknown) and in the fourth quarter of 2010 due to the impacts of the ash. The data indicates that the primary sludge quantity has been trending upwards approximately four percent per year from 2009.

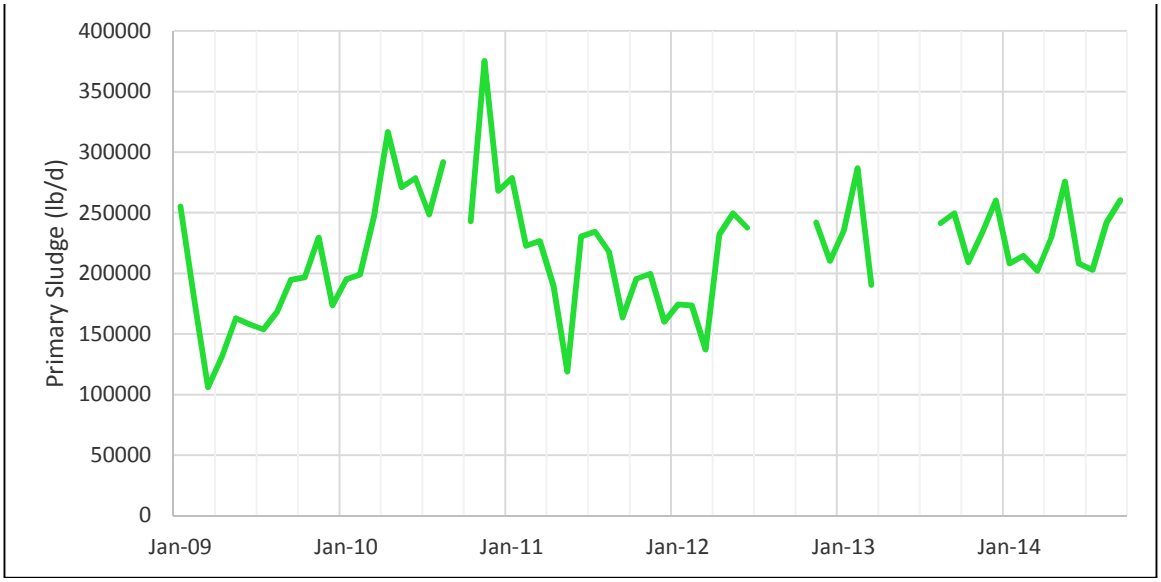


Figure 2-35 Historical Primary Sludge Quantity

A mass balance of the inert suspended solids (ISS), which are the difference between the total and volatile suspended solids, was performed on the data set from 2009 through 2014 to evaluate the accuracy of the reported total suspended solids data at the primary clarifiers. The ISS cannot be degraded biologically and, theoretically, the pounds of ISS entering the primary clarifiers should equal the amount of ISS in the primary effluent and the primary sludge. **Figure 2-36** shows the results.

Figure 2-36 shows that the actual amount of ISS recorded is higher in the solids leaving the primary clarifiers than what is entering the primary clarifiers. This may be due to several issues including accuracy of flow meters and skewing of data due to use of grab samples (presumed for the primary sludge) versus composite samples (for the raw influent and primary effluent) to close the mass balance.

Figure 2-36 Cumulative ISS Balance Around Primary Clarifiers From 2009-2014

2.9.2 Waste Activated Sludge

Historical waste activated sludge data was compiled for each month from the 2009-2014 data and averaged. **Figure 2-37** shows the plot of the monthly average waste activated sludge data over time. **Figure 2-38** shows the plot of the monthly average waste activated sludge and primary effluent total suspended solids over time.

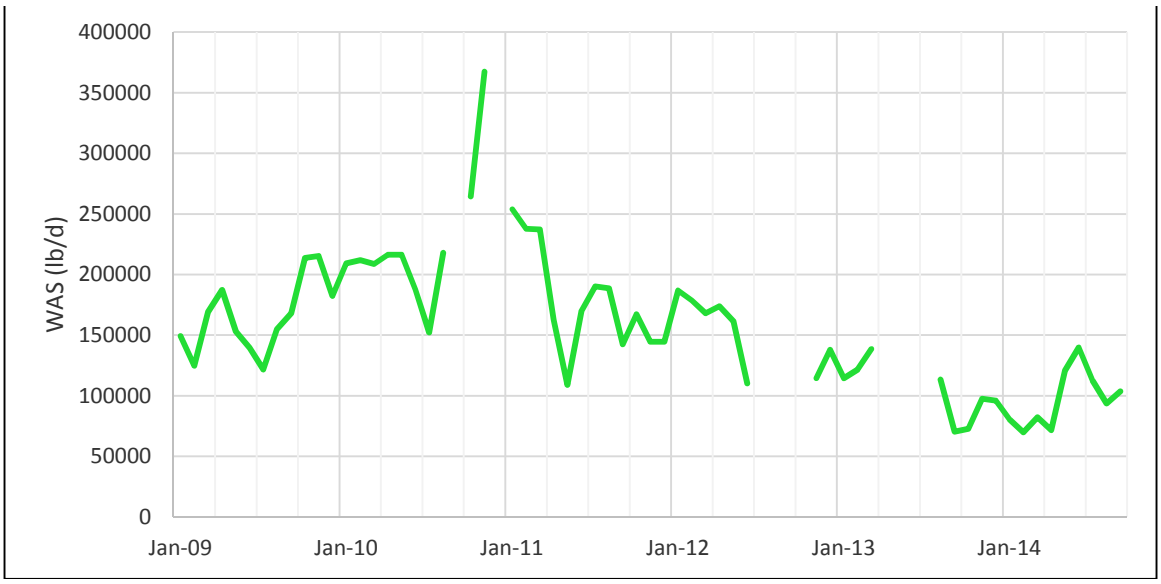


Figure 2-37 Historical Waste Activated Sludge Quantity

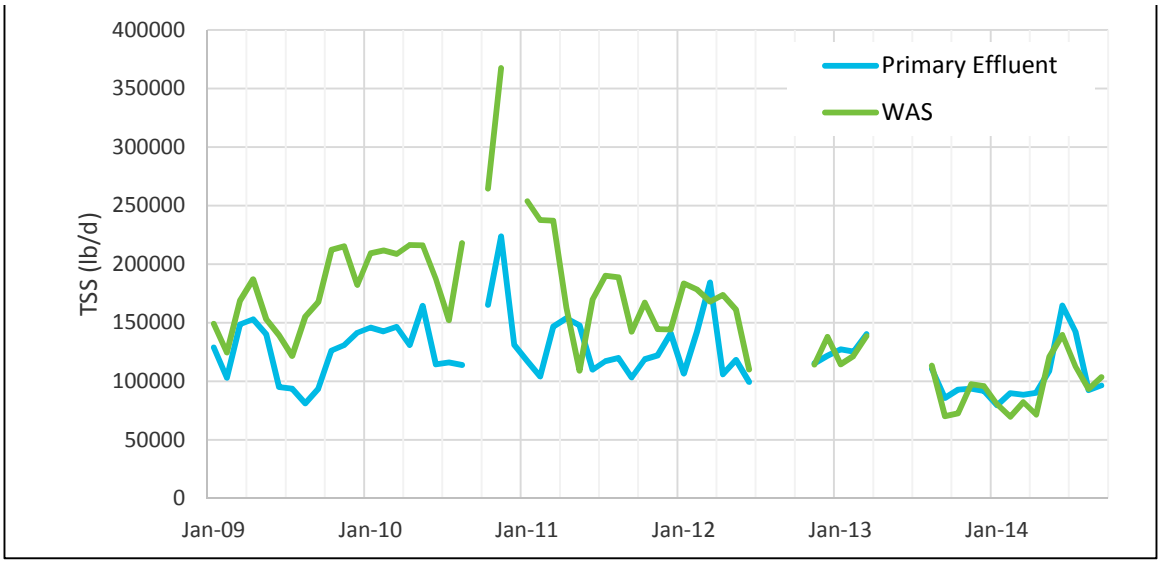


Figure 2-38 Comparison of Historical Primary Effluent TSS and WAS Production

The data indicates an increase in waste activated sludge production (WAS) in 2009 through 2010 but then a decrease in WAS by almost half from 2011 through 2014. Data for primary effluent TSS, shown in Figure 2-38 shows a similar trend, with a decreasing trend from 2011 through 2014. The decreasing primary effluent TSS trend is probably the primary reason for the decreasing WAS. However, a contributing reason may be changes in the operating solids retention time of the facility. **Figure 2-39** shows the historical solids leaving the secondary treatment process (waste activated sludge and effluent suspended solids) and SRT from 2009 to 2014.

The data set from 2009 through 2014 indicates that the average biomass inventory in the aeration basins has increased from 241,000 pounds to 298,000 pounds from 2009 to 2014. This, compounded with the decreased waste sludge production, has caused the solids retention times to double from 2009 to 2014.

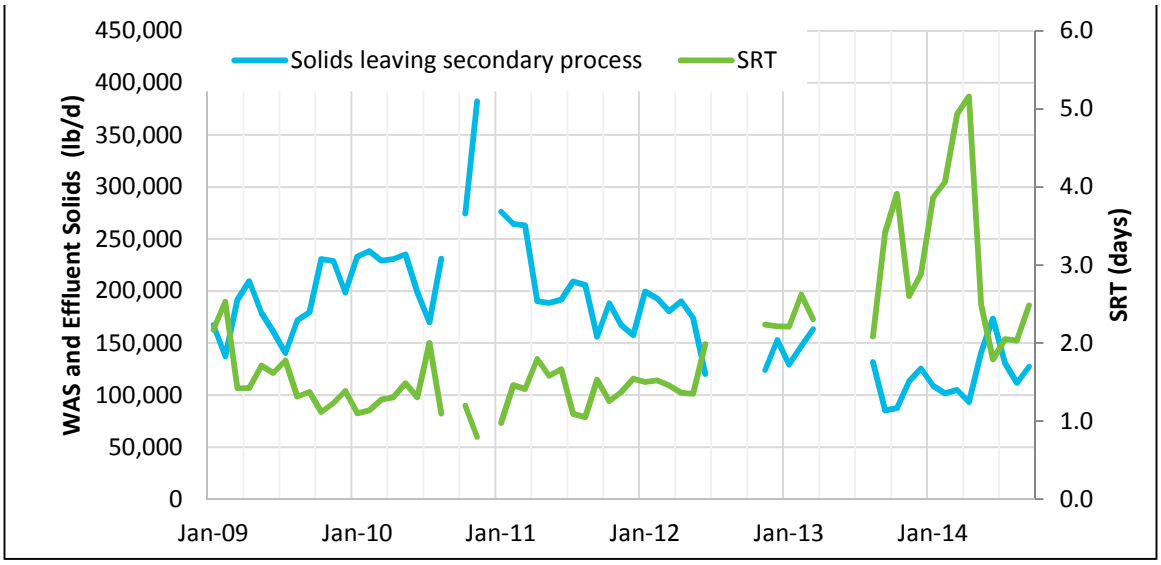


Figure 2-39 Historical Solids Leaving Secondary Treatment and SRT

A mass balance of the inert suspended solids (ISS), which are the difference between the total and volatile suspended solids, was performed on the secondary treatment process (primary effluent, WAS, and final effluent) from January 2009 through August 2010 to evaluate the accuracy of the reported total suspended solids data in the waste activated sludge. The August 2010 date was chosen because the primary clarifiers went offline during this month. Theoretically, the pounds of ISS in the primary effluent should equal the amount of ISS in the WAS plus the ISS in the secondary effluent. **Figure 2-40** shows the results.

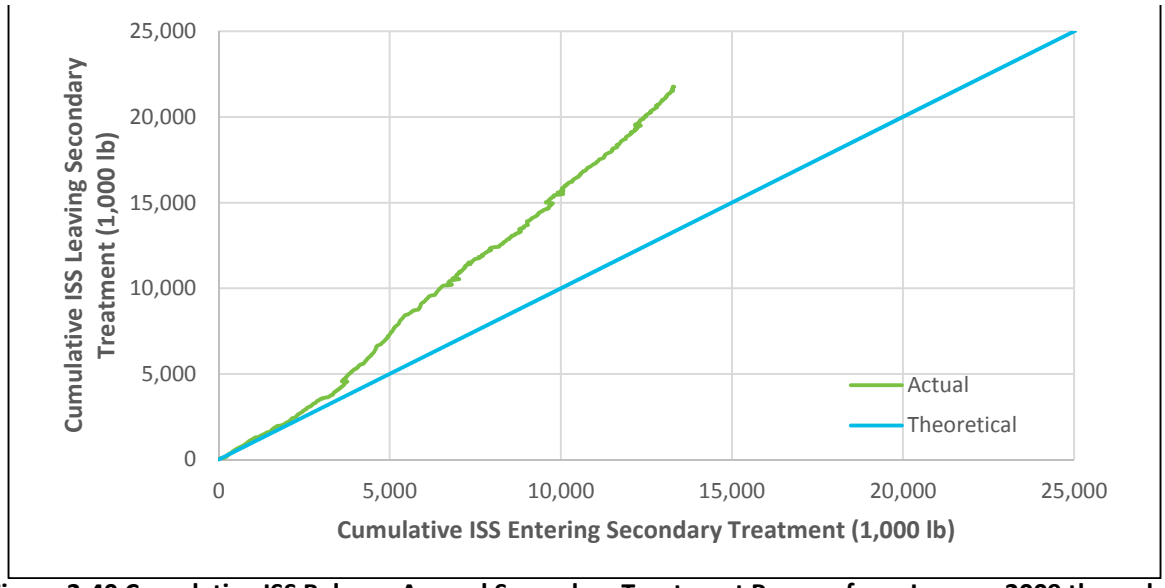


Figure 2-40 Cumulative ISS Balance Around Secondary Treatment Process from January 2009 through August 2010

Figure 2-40 shows that the actual amount of ISS recorded is higher in the solids leaving the secondary process than what is entering in the primary effluent. It is anticipated that the composite samples taken for the primary effluent and secondary effluent are more reliable than the sampling done on the waste activated sludge. Therefore, it is anticipated that the volatile content of the waste activated sludge is higher on a daily basis than the data that is measured presently or the WAS flow meters and totalizers may be recording incorrectly. From the data, it is interesting that, initially, ISS leaving the secondary process matched fairly closely the primary effluent ISS. Then there was a fairly constant discrepancy (suggested by the straight line). It is possible that an adjustment was made to the flowmeters, sampling, or laboratory procedures at the time that the deviation appears to start.

2.10 Anaerobic Lagoon Sidestream Analysis

2.10.1 Historical Data Analysis

Historical data from 2009 through 2014 along with supplemental sampling performed in October and November 2015 was used to assess the impact of sidestream BOD_5 and TSS loadings to the overall mass loading to the Maxson WWTP. As stated previously, BOD_5 loadings have increased in the raw influent since 2004 which also corresponds when the lagoons were covered and primary sludge was conveyed to the lagoons.

Lagoon return flow is estimated by assuming steady-state conditions (i.e. no storage of liquid) exist. Flow can be estimated by adding the waste activated sludge flow and primary sludge flows together

and again presumes that flow into the lagoons has to equal the flow out of the lagoons. Waste activated sludge flow is currently measured. Primary sludge flow was estimated by determining the amount of primary sludge and using primary sludge concentrations to determine primary sludge flow. The recycled flow averages around 3.5 MGD over the last five years. **Figure 2-41** shows the estimation of flow from the anaerobic lagoons back to the plant.

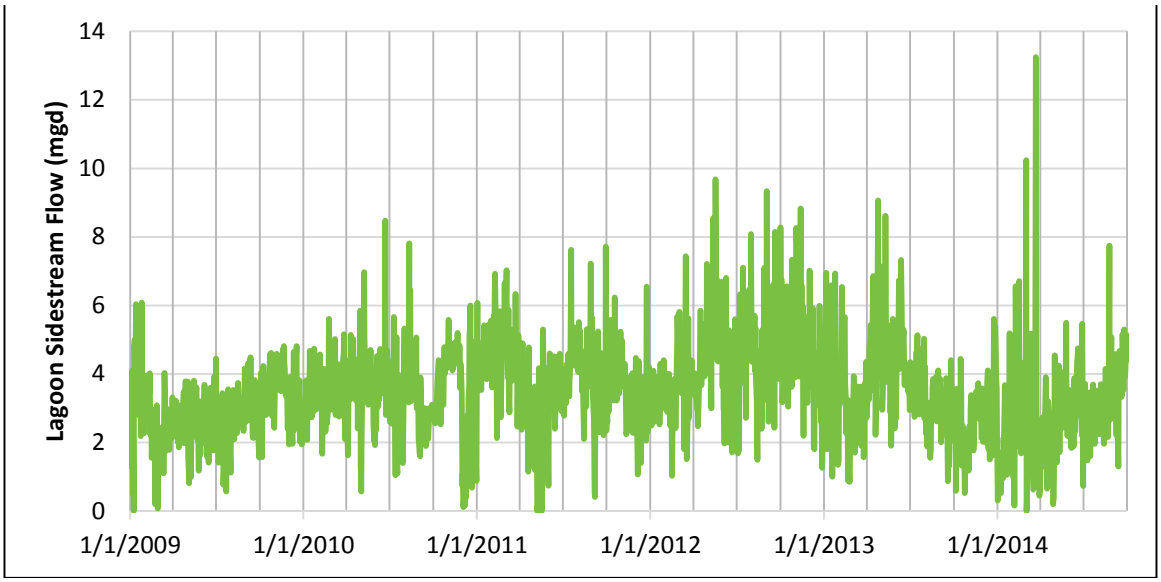


Figure 2-41 Lagoon Sidestream Flow Estimation

Lagoon return total suspended solids is typically measured daily with a grab sample. Lagoon return BOD_5 data is more limited and, on average, has been sampled for one to two times per week since 2012. **Figure 2-42** shows the lagoon return BOD_5 and TSS mass loads since 2012. The sidestream average BOD_5 and TSS loadings are 17,000 and 71,000 pounds per day, respectively. This would be expected as the BOD_5 in the return stream should be between 20 and 40 percent of the TSS in the return stream due to the decreased volatile solids in the sidestream.

The BOD_5/TSS ratio in the sidestream can provide insight as to whether the BOD_5 was particulate or soluble in nature. **Figure 2-43** shows the BOD_5/TSS ratio in the sidestream since 2012. It appears that the lagoons go through a cycle during the late winter to early spring where the BOD_5/TSS ratio increases to 1 or higher indicating soluble BOD_5 release. The lagoons are not mixed and stratification is most likely occurring due to temperature and density differentials. As ambient temperatures increase, the ponds are most likely turning over causing a release of soluble BOD_5 during these conditions. It is inferred from the graph that there is some soluble BOD_5 for one to two months per year.

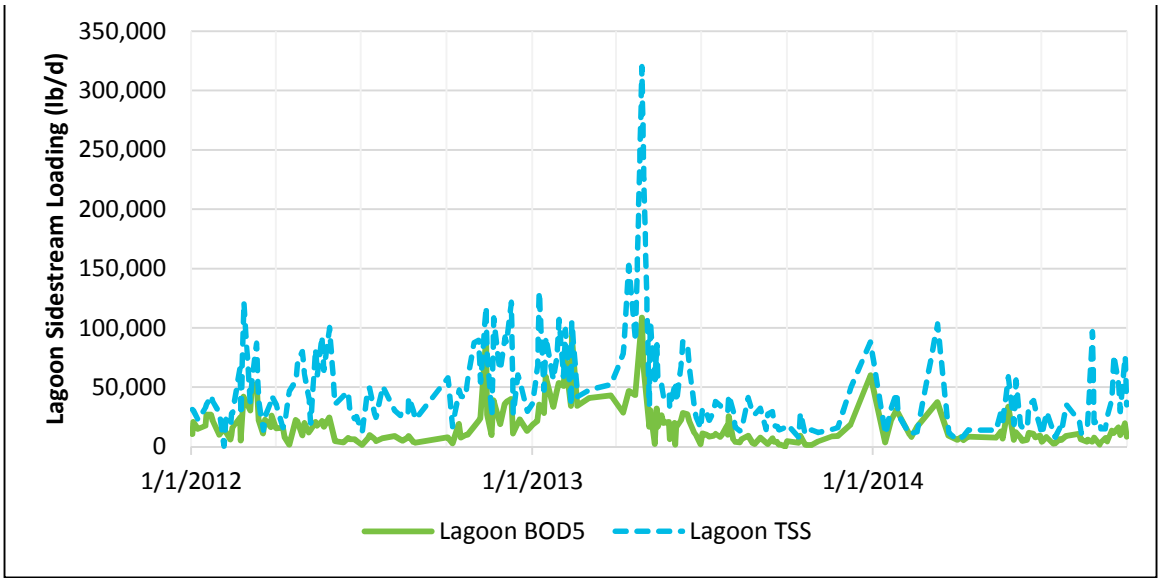


Figure 2-42 Lagoon Sidestream Load Estimation

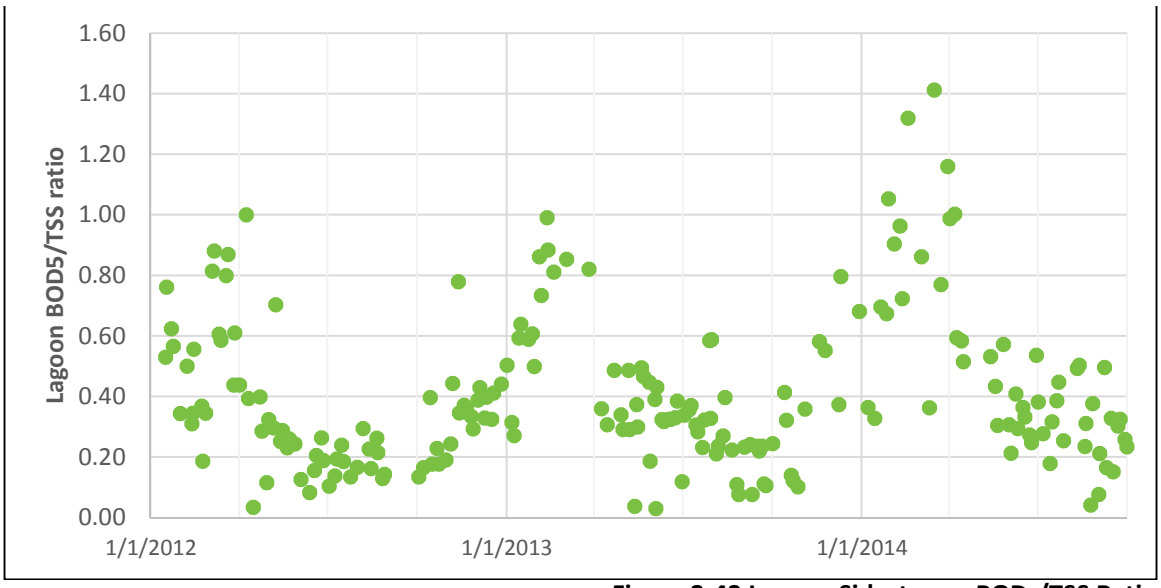


Figure 2-43 Lagoon Sidestream BOD_5/TSS Ratio

The average lagoon sidestream return BOD_5 for the period 2012 through 2014 was approximately 17,000 pounds per day. The average primary effluent BOD5 load over the same period was approximately 400,000 pounds per day. It is evident that the lagoon sidestream returns, although significant, represent a relatively small fraction, less than 5%, of the overall BOD_5 load to secondary treatment.

2.10.2 Special Sampling Regiment

Additional sampling was performed by the City of Memphis in October and November 2015. At the time of this memo, approximately two weeks of sampling data had been analyzed at two locations along the Nonconnah Interceptor and in the lagoon sidestream. The purpose of the sampling was

to determine the impacts of the lagoon sidestream flow, specifically BOD_5 and soluble BOD_5, to the concentrations in the Nonconnah Interceptor. The sample locations are as denoted below:

- Manhole #9: Located upstream of the lagoon sidestream return on the Nonconnah Interceptor. This interceptor carries 80 to 90 percent of the flow to the Maxson WWTP.
- Lagoon manhole: Located just north of the lagoon system. Captures flow back from the lagoons prior to combining into the Nonconnah Interceptor.
- Manhole #5: Located downstream of the lagoon sidestream return on the Nonconnah Interceptor.

BOD_5, soluble BOD_5 ($sBOD_5$), COD, TSS, and VSS measurements were taken at each location during this sampling event. **Table 2-26** summarizes the data for Manhole #9. **Table 2-27** summarizes the data for the lagoon manhole. **Table 2-28** summarizes the data for Manhole #5.

Table 2-26 Summary of Sampling at Nonconnah Interceptor Manhole #9

Date	Parameter				
	BOD_5	$sBOD_5$	COD	TSS	VSS
October 18, 2015	590	392	1110	422	ND[1]
October 19, 2015	987	572	1620	457	437
October 20, 2015	1030	727	1940	466	402
October 21, 2015	1110	570	1820	552	516
October 22, 2015	745	560	1540	596	ND[1]
October 25, 2015	825	Outlier	1470	512	452
October 26, 2015	963	466	1300	396	342
October 27, 2015	644	377	1160	360	314
October 28, 2015	730	507	1250	346	307
October 29, 2015	682	459	1280	346	324
Average	**831**	**514**	**1449**	**445**	**387**

[1] ND = No data

Table 2-27 Summary of Sampling at Lagoon Manhole

Date	Parameter				
	BOD_5	$sBOD_5$	COD	TSS	VSS
October 18, 2015	1127	330	7520	5700	ND[1]
October 19, 2015	1750	229	8440	6150	4775
October 20, 2015	1159	10	8990	6875	4900
October 21, 2015	2830	240	7600	6525	4825
October 22, 2015	1370	204	8280	5725	ND[1]
October 25, 2015	1034	<100	6320	6225	3675
October 26, 2015	1450	49	5030	6050	3100
October 27, 2015	1672	<100	7000	4875	4350
October 28, 2015	1220	<40	4450	4025	ND[1]
October 29, 2015	809	<40	4530	5925	ND[1]
Average	**1,442**	**134**	**6,816**	**5,808**	**4,270**

[1] ND = No data

Table 2-28 Summary of Sampling at Nonconnah Interceptor Manhole #5

Date	Parameter				
	BOD_5	$sBOD_5$	COD	TSS	VSS
October 18, 2015	742	408	ND[1]	890	ND[1]
October 19, 2015	874	464	ND[1]	1055	820
October 20, 2015	1010	544	ND[1]	1110	830
October 21, 2015	1220	539	ND[1]	1380	1100
October 22, 2015	880	590	ND[1]	1257	ND[1]
October 25, 2015	923	Outlier	ND[1]	1170	955
October 26, 2015	1080	460	ND[1]	1050	800
October 27, 2015	696	359	ND[1]	815	660
October 28, 2015	902	591	ND[1]	454	384
October 29, 2015	877	492	ND[1]	817	670
Average	**920**	**494**	ND[1]	**1,000**	**777**

[1] ND = No data

The following observations/conclusions can be made upon review of the sampling data:

- The BOD_5 concentration in Manhole #9 averaged 830 mg/L. This flow stream is not impacted by the lagoon discharge back to the Maxson WWTP.
- On average, the sBOD/BOD ratio in Manhole #9 averaged 0.43. This suggests that the influent wastewater to the Maxson WWTP, despite being of high strength, does not have highly unusual characteristics.
- On average, the COD/BOD ratio in Manhole #9 averaged 1.74. This ratio is not highly unusual for influent wastewater, although one might expect the ratio to be somewhat higher. Therefore, for the reported BOD values, the corresponding COD is slightly on the low side of that expected.
- The average change in BOD_5 due to the lagoon sidestream (neglects impact from President's Island Interceptor) is 89 mg/L or approximately a 10% increase.
- Several very low soluble BOD_5 values were measured on October 25th in Manhole #9 (94 mg/L and Manhole #5 (76 mg/L). These are significantly lower than normal and were discounted as outliers and not used in the soluble BOD_5 averages calculated.
- The soluble BOD_5 content in the lagoon sidestream averaged less than 10 percent of the overall BOD_5 returned in the sidestream. The BOD_5 being returned during the sample period is due to solids carryover during the decant process. This result is as expected for a digested sludge supernatant.
- The BOD_5/TSS ratios in the sidestream are between 0.14 and 0.43 which matches the data presented in Figure 2-43 during the time period where it is believe the lagoons are not turning over.

- The VSS/TSS ratio in the sidestream averaged 0.77 which is not indicative of a system that is stabilizing sludge efficiently.

2.10.3 Conclusions and Recommendations

The results of the historical data analysis along with the additional sampling performed indicate that the BOD_5 in the lagoon sidestream is particulate in nature for a large majority of the year. It appears that soluble BOD_5 is returned in late winter and early spring presumably due to lagoon turnover due to temperature differentials in the lagoon. Furthermore, it appears that the wastewater strength in the Nonconnah Interceptor prior to the lagoon is higher than what has been anticipated.

Sidestream treatment for soluble BOD_5 would only appear to be a seasonal solution at best. The historical data suggests that soluble BOD_5 is only prevalent during the first quarter of each year. A biological treatment system for sidestream treatment would have to be started up and operated seasonally and, most likely, is not worth the capital and operational expenditure to do so.

Solids carryover in the decanting process does provide a significant source of BOD_5 that is returned to the Maxson WWTP. The average BOD_5 from the lagoons from 2012 through 2014 was 17,000 pounds per day and most of it is particulate in manner. Sidestream treatment for particulate BOD_5 would be in the form of TSS reduction in the decant flow stream. The primary clarifiers are efficient in capturing the TSS (historically capturing 60 to 65 percent) in the flow stream and can continue to be used in this manner to remove TSS/particulate BOD_5.

Sidestream treatment could be expected to remove 5,000 to 6,000 pounds per day of BOD_5 (or roughly 1.25 percent of the primary effluent load) that would not be removed in the primary clarifiers. This is based on 17,000 pounds per day of BOD_5 and assuming 90 percent of it is particulate and 65% removal of TSS in the primary clarifiers. It would appear unlikely that this would be worth the capital and operational expenditure to do this.

2.11 Projected Secondary Effluent Characteristics

The Maxson WWTP presently operates under NPDES Permit TN0020729. **Table 2-29** highlights components of the NPDES permit that are directly affected by the proposed secondary treatment process upgrades.

Table 2-29 Current NPDES Permit Requirements Affected by Secondary Treatment

Parameter	Effluent Limitations				
	Monthly		Weekly	Daily	
	Avg (mg/L)	% Removal	Avg (mg/L)	Max (mg/L)	% Removal
BOD_5	42	85	63	84	40
TSS	48	85	72	96	40
Ammonia-Nitrogen	Report	Report	---	Report	---
Total Nitrogen	Report	Report	---	Report	---
Total Phosphorus	Report	Report	---	Report	---

The secondary treatment process will be designed achieve 30 mg/L of BOD_5 and 30 mg/L of TSS on a maximum monthly basis. The capacity of the secondary clarifier system will be the critical unit

process for maintaining permit compliance on a weekly average and daily maximum basis as they are most sensitive to plant flows.

Instances of sludge volume indices higher than 130 mL/g, coupled with sustained 24-hour daily flows of over 156 MGD (maximum day historical flow with four new clarifiers in service), 140 MGD (99th percentile historical flow with three new clarifiers in service) or peak flows of 170 MGD occurring over several hours could result in rising sludge blankets in the secondary clarifiers. This could lead to an erosion in TSS removal performance and, subsequently, BOD_5 removal performance that could cause permit violations during a weekly or daily maximum event.

Section 3

WWTP Electrical Evaluation

3.1 Introduction

This section of the CDR summarizes the evaluation CDM Smith performed of the existing electrical system and equipment at the Maxson WWTP.

3.1.1 Background

The plant's electrical distribution system was originally built in 1970s and underwent reliability and protection modifications in 1980 and 1991 respectively. A number of other improvements were also made over the years, but they generally focused on specific treatment processes or systems, and appear to have been implemented with little consideration to the overall electrical power system. Discussion with the plant maintenance staff indicated that there has not been a plant-wide electrical system study to assess the condition of existing electrical equipment, and analyze facility loading, reliability and future plant expansion. As part of the disinfection upgrade conceptual design effort, a plant-wide electrical system evaluation has been authorized.

3.1.2 Objectives

The scope of the evaluation is to assess the condition of the electrical power distribution equipment and available on-site power, make recommendations of replacement schedule, if necessary, and identify major improvements needed to incorporate future processes, particularly those associated with disinfection.

The assessment of the existing plant's electrical system and the presentation of recommendations are based on the following key objectives:

- Operational Flexibility – The electrical distribution system should provide maximum flexibility to operate under a range of conditions. The system should be designed to facilitate installation of future loads without replacement of the switchgear or other major electrical components.
- Ease of Operation and Maintenance – The electrical distribution system should be designed to provide ease of operation and reduce maintenance requirements.
- Increased Reliability – The electrical distribution system should be designed to minimize impacts from failures, avoid common mode failures, and utilize a split bus design, where applicable.
- Expandability – Review of any foreseeable upcoming plant improvements to determine future plant capacities and the necessary modifications.

3.1.3 Methodology

The investigation of the electrical distribution system included collection, organization and review of record drawings from the WWTP. Although it is not uncommon that a plant built in multiple phases over a few decades does not have a consolidated electrical one-line diagram, it is a priority to derive

one from all available record drawings along with field verification. Therefore, an updated one-line diagram was generated, as it is fundamental to the understanding of the electrical system architecture.

The objectives of the evaluation required field inspection of the major equipment. Although intrusive methods such as infrared survey and functional testing may provide more detail and definitive information on the equipment condition, they are costly, time-consuming and interrupt plant operation. Therefore, physical inspection performed by experienced professional engineers is typically adequate to assess the condition of the equipment and identify evidence of problematic conditions, such as condensation of water leak, rust spots, corrosion, deformation, cracks, chips, breaks, discoloration or oxidation due to overheating, etc. Inspection of the major current carrying components such as the busses, circuit breakers, etc. while energized was not performed.

On-site meetings with the plant maintenance staff were conducted to document performance deficiencies of the power distribution system and discuss possible system improvements. The WWTP's recent monthly electric utility bills were requested and provided by the City, as they allow for better understanding of the nature of the WWTP's overall electrical load.

3.2 Electrical System Review

The City provided CDM Smith with record drawings for the existing WWTP electrical system. The record drawings are particularly important to understand the electrical system; therefore, have been reviewed during the evaluation. A list of record drawings is provided in **Appendix A**.

The plant's electrical distribution system was designed to be a two-source primary selective, secondary selective system with one normal and one emergency circuits, and can be divided into four subsystems based on the voltage level: 23kV subsystem, 4.16kV subsystem, 480V subsystem and 208V subsystem. The 23kV subsystem is used for plant-wide power distribution purpose. The 4.16kV subsystem is used primarily for large process equipment loads rated from 200HP to 1500HP. The 480V subsystem is used for smaller process equipment and building mechanical equipment loads. The 208V subsystem is used primarily for lighting, controls, and miscellaneous loads that require lower voltage. The electrical system evaluation was broken down into these 4 categories. A one-line diagram for the medium-voltage distribution system is presented in **Figure 3-1**.

The three criteria utilized for evaluating the electrical equipment are:

- Age of the equipment
- Availability of replacement parts
- Physical condition of the equipment

In general, most major electrical equipment has a service life of 20-25 years. Older equipment is usually more maintenance intensive and often harder to keep operational due to the lack of available spare parts. In this Section an assessment of "good" is defined as being in good condition and capable of serving its intended use for over ten years with proper maintenance. "Fair" indicates the equipment is in a condition that requires attention to maintain reliable operation, and it should be scheduled for replacement within 5 years. "Poor" is defined as being in a condition that needs to be replaced. Equipment defined as "Poor" is at the highest risk for failure and should be replaced within 2-3 years.

Much of the existing distribution equipment is well past its design life and should be scheduled for replacement. The reliability of this equipment is questionable and higher maintenance costs are expected.

The age of equipment contributes to the difficulty in obtaining repair parts, and when these parts can be found, they typically come at a premium cost. The cost of maintenance will typically increase as equipment ages due to normal mean-time failures, but these costs can increase dramatically due to a major component, insulation, or equipment failure. These types of catastrophic failures result in operations downtime and higher repair costs. As more components fail, the need for replacement parts will continue to rise and the parts themselves will be difficult to find. In addition, long delivery times for critical components are common and, depending on critical nature of the equipment, jeopardize its usability for plant operations.

3.2.1 Equipment Evaluation – 23kV Distribution Subsystem

The 23kV subsystem is designed as a primary selective configuration with two circuits, one normal and one emergency, from the overhead utility riser poles to a main-tie-main Substation "S". The 23kV feeders for both circuits run to pad-mounted transformers, a.k.a., power centers (PC) throughout the plant for various process and buildings. The field observation, condition assessment, and representative photograph of each equipment are presented below. The headline shows the equipment name, rating, age and condition in the following format for quick reference: *Equipment (Rating) (Age) (Condition).*

3.2.1.1 North and South Riser Poles (23kV, Fused at 400A, 3PH, 3W) (36) (Fair)

Located by Riverport Road to the east of the plant, the North and South wooden riser poles support two 23kV feeders (Circuit #82301 and Circuit #82315) for the entire plant from the MLG&W service poles across the road. Fused switches were installed on top of the poles. The pole and the switch assemblies are over 35 years old and show signs of material deterioration. According to the owner, they have also been difficult to operate and maintain. It is preferable to move the risers to the MLG&W poles, and install the primary switchgears on the ground.

3.2.1.2 Substation "S" (23kV, 1200A, 3PH, 3W) (36yrs) (Fair)

Located in the air-conditioned Main Substation Building, Substation "S" consists of eleven cubicles with a primary selective main-tie-main configuration (**Figure 3-2**). Built in 1982 by Siemens-Allis, cubicles 1 to 9 host the two main breakers, the tie breaker and the N (Normal) Bus. Cubicles 10 and 11 host the two fused load breakers on the E (Emergency) Bus and was built in 1992 by Westinghouse.

Figure 3-2 Substation "S"

Maintenance staff stated that they do not like the two fused load breakers on the Emergency Bus because they cause operational and maintenance difficulties. They prefer the power breakers as on the Normal Bus.

3.2.1.3 PS1, PS2, PS3, PS4, PS5, PS6, PS7, PS8, PS9, PS10 (23kV, 600A, 3PH, 3W) (2yrs) (Good)

Pad-mounted switch stations PS1 through PS10 were originally installed in 1991 and replaced with S&C VISTA underground distribution switchgears in 2014 (**Figure 3-3**). Medium voltage cables were replaced in some sections. These ten switch stations are designed and installed in pairs, one for the normal circuit and the other for the emergency circuit, to enable downstream secondary selectivity.

Figure 3-3 Switch Stations PS1 through PS10

3.2.1.4 PS11 (23kV, 600A, 3PH, 3W) (16yrs) (Good)

Pad-mounted switch station PS11 was installed in 2000 for the odor filter facility (**Figure 3-4**). Unlike other pad-mounted switch stations, PS11 was not replaced in 2014. It is fed from PS8 on the normal circuit and does not have a redundant one from the emergency circuit.

3.2.2 Equipment Evaluation – 4.16kV Subsystem

The 4.16kV subsystem is primarily used to supply power to large motor loads, including six 1500HP blowers, four raw water pumps of 700HP or 1200HP, ten 350HP biofilter pumps and four 300HP effluent pumps.

3.2.2.1 PC-EAST and PC-WEST (23kV–4.16kV, 5MVA, 3PH) (2yrs) (Good)

Pad-mounted transformers PC-EAST and PC-WEST are located outside the Main Substation Building and fed from Substation "S" (**Figure 3-5**). They supply power to the blowers and raw water pumps via MCC1 also located in the Main Substation Building. They were originally installed in 1970 and replaced with two Cooper transformers in August 2014. They were sized for only half of the loads on the split bus on MCC1; therefore, do not provide 100% redundancy. Their size would need to be doubled to achieve the desired redundancy level.

Figure 3-4 Switch Station PS11

Figure 3-5 Transformers PC-EAST and PC-WEST

3.2.2.2 MCC1 (4.16kV, 1200A, 3PH, 3W) (24yrs) (Fair)

MCC1 is located in the Main Substation Building with a main-tie-main configuration (**Figure 3-6**). It feeds six 1500HP blowers, one 1200HP influent pump, and three 700HP influent pumps that are scheduled to be replaced with 1200HP ones. MCC1 does not have 100% redundancy. When one power source is lost, the other one cannot assume all loads needed for full flow capacity on the buses. Along with the upstream transformers PC-EAST and PC-WEST, MCC1 would need to be upgraded to achieve the desired redundancy level.

3.2.2.3 MCC4 (4.16kV, 1000A, 3PH, 3W) (36yrs) (Poor)

MCC4 is located in the Electrical Building, which is not climate controlled (**Figure 3-7**). It has a main-tie-main configuration with a normal bus and emergency bus feeding three 200HP screw pumps on each side. It also feeds MCC5 in the biofilter pump station. MCC4 was installed in 1980 and expanded in 1992 to add the main-tie-main breakers as well as breakers for feeders to MCC5. It is in poor condition due to the age and the harsh environment.

3.2.2.4 MCC5 (4.16kV, 400A, 3PH, 3W) (36yrs) (Poor)

MCC5 is located in the Biofilter Building, which is not climate controlled (**Figure 3-8**). It has a main-tie-main configuration with a normal bus and emergency bus feeding five 350HP biofilter pumps on each side. It is in poor condition due to the age and the harsh environment.

3.2.2.5 PC-8 and PC-9 (23kV–4.16kV, 5MVA, 3PH) (35yrs) (Poor)

Pad-mounted transformers PC-8 and PC-9 are located outside the Electrical Building and fed from Substation "S" (**Figure 3-9**). They supply power to the screw pumps and biofilter pumps via MCC4 and MCC5. They were originally installed in 1981 and are in poor condition due to the age and the harsh environment. There are evidence of rust and oil leakage. The plant maintenance staff are concerned about their condition.

3.2.2.6 PC-11 (23kV–4.16kV, 1MVA, 3PH) (33yrs) (Poor)

Pad-mounted transformer PC-11 is located outside the Effluent Pump Station, is not climate controlled, and is fed from Substation "S" (**Figure 3-10**). It supplies power to four 300HP effluent pumps. The transformer was installed in 1983 and is in poor condition due to the age and the harsh environment. Rust spots are visible in multiple locations on the enclosure. It is also undersized, as it is unable to carry all the effluent pump station loads. There is no alternative power source for the effluent pump station. The plant maintenance staff has expressed concerns over its condition and performance.

3.2.2.7 MCC6 (4.16kV, 1200A, 3PH, 3W) (33yrs) (Poor)

MCC6 is located in the Effluent Pump Station Building, which is not climate controlled (**Figure 3-11**). It does not have a main-tie-main configuration. The 1200A bus feeds four 300HP effluent pumps. There is no redundancy within MCC6, making it a single point of failure for the Effluent Pump Station. The maintenance staff also stated that MCC6 does not appear to have enough capacity for all the connected loads. It is in poor condition due to the age and the harsh environment.

Figure 3-6 MCC1

Figure 3-7 MCC4

Figure 3-8 MCC5

Figure 3-9 Transformers PC-8 and PC-9

Figure 3-10 Transformer PC-11

Figure 3-11 MCC6

3.2.3 Equipment Evaluation – 480V Subsystem

The 480v subsystem consists of an MCC in the primary sludge pump station, distribution panels for loads in various buildings, along with various transfer switches and pad-mounted transformers located throughout the WWTP.

3.2.3.1 PC-1A and PC-1B (23kV–480V, 1MVA, 3PH) (36yrs) (POOR)

PC-1A and PC-1B are part of the double-ended unit substation outside the return sludge pump building (**Figure 3-12**). They supply power to return sludge pumps, clarifier motors, and other mechanical loads via MCC2. The substation was installed in 1980 and is in poor condition due to the age and the harsh environment. Rust spots are visible in multiple locations on the enclosure. PC-1A is currently out of service as the result of a lightning strike last year and is scheduled to be replaced.

Figure 3-12 Transformers PC-1A and PC-1B

3.2.3.2 PC-2 and PC-3 (23kV–480V, 150KVA, 3PH) (36yrs) (FAIR)

PC-2 and PC-3 are located outside the blower building (**Figure 3-13**). They supply power to all the loads in the blower buildings except the blowers. They were installed in 1980 and are in fair to poor condition due to the age and the harsh environment.

Figure 3-13 Transformers PC-2 and PC-3

3.2.3.3 PC-4 and PC-5 (23kV–480V, 500KVA, 3PH) (36yrs) (FAIR)

PC-4 and PC-5 are located outside the influent pump station building (**Figure 3-14**). They supply power to all the loads in the influent pump station except the influent pumps. They were installed in 1980 and are in fair to poor condition due to the age and the harsh environment.

Figure 3-14 Transformers PC-4 and PC-5

3.2.3.4 PC-6 and PC-7 (23kV–480V, 500KVA, 3PH) (35yrs) (POOR)

PC-6 and PC-7 are located outside the electrical building (**Figure 3-15**). They supply power to Switchboards DP-1 and DP-2. They were installed in 1981 and are in poor condition due to the age and the harsh environment.

Figure 3-15 Transformers PC-6 and PC-7

3.2.3.5 PC-10 and PC-12 (23kV–480V, 500KVA, 3PH) (25, 36yrs) (FAIR, POOR)

PC-10 and PC-12 are located outside the administration building (**Figure 3-16**). They supply power to both the maintenance and administration buildings. PC-12 was installed in 1981 and is in poor condition due to the age and the harsh environment. Rust spots are visible in multiple locations on the enclosure. PC-10 was installed in 1991 for redundancy purpose and is in fair condition due to the age and the harsh environment.

Figure 3-16 Transformers PC-10 and PC-12

3.2.3.6 PC-14 (23kV–480V, 500KVA, 3PH) (16yrs) (FAIR)

PC-14 is located at the odor control system facility and supplies power to the odor control system equipment (**Figure 3-17**). It was installed in 2000 and is in fair condition.

3.2.3.7 MCC3 (480V, 600A, 3PH, 3W) (36yrs) (POOR)

MCC3 is located in the Primary Sludge Pump Station Building, which is not climate controlled (**Figure 3-18**). It has a main-tie-main configuration. The main breakers and the tie are not kirk keyed. It is in poor condition due to the age and the harsh environment. In fact, the plant intended to issue an RFP to replace this MCC and provide climate controlled environment in 2013 but had to stop the project due to lack of funding. It is still a priority of the plant to replace it due to concerns of its age and condition.

Figure 3-17 Transformers PC-14

Figure 3-18 MCC3

3.2.3.8 MSB-1 (480V, 600A, 3PH, 3W) (46yrs) (POOR) and MTS-MSB-1 (480V, 600A, 3PH, 3W) (36yrs) (POOR)

MSB-1 is located in the Influent Pump Station Building that was built in 1970 and is not climate controlled. It has one feeder that is connected to a manual transfer switch (MTS-MSB-1) that was installed in 1980 (**Figure 3-19**). Both the MSB-1 and the manual transfer switch are in poor condition due to the age and the harsh environment.

Figure 3-19 MSB-1 and MTS-MSB-1

3.2.3.9 MSB-2 / MCC2 (480V, 1600A, 3PH, 3W) (5yrs) (GOOD)

MSB-2 was originally built in 1971 in the Return Sludge Pump Building (**Figure 3-20**). In 2011 it underwent a rehabilitation project and was replaced with a new motor control center (MCC2) located in a new climate controlled room in the pipe gallery. MCC2 is fed from the double-ended unit substation PC1 and serves return sludge pumps, clarifier motors, and various process and building mechanical loads.

Figure 3-20 MCC2

3.2.3.10 MCC7 (480V, 600A, 3PH, 3W) (34yrs) (POOR)

MCC7 was originally built in 1982 and located in the Sludge Dewatering Control Room in the pipe gallery (**Figure 3-21**). Two additional sections were added in 1996 during an improvement project. It was intended to serve the sludge dewatering equipment. According to the maintenance staff, most of the equipment is no longer in service due to the change of the process. The Sludge Dewatering Control Room is no longer air conditioned and the condition of MCC7 is poor, which could cause safety concerns. The bus is still energized for a few miscellaneous small loads. It is recommended to feed the miscellaneous from another source so that MCC7 can be decommissioned.

Figure 3-21 MCC7

3.2.3.11 DP1, DP2 (480V, 600A, 3PH, 4W) (20yrs) (FAIR)

Located in the Electrical Building, panelboards DP1 and DP2 were originally built in 1992 and replaced in 1996 (**Figure 3-22**). They provide normal and emergency power to MCC3, DP3, and DP4. Despite of the non-air conditioned environment and their age, they appear to be in fair condition.

3.2.3.12 DP3 (480V, 70A, 3PH, 4W) (25yrs) (FAIR) / ATS-DP3 (480V, 100A, 3PH, 4W) (25yrs) (FAIR)

Located in the Electrical Building, panelboard DP3 and ATS-DP3 were originally built in 1992 (**Figure 3-23**). ATS-DP3 receives normal and emergency power from panelboards DP1 and DP2 and feeds panelboard DP3, which feeds seven grease pumps, electrical building exhaust fan, unit heater and the lighting panel. Despite of the non-air conditioned environment and their age, they appear to be in fair condition.

Figure 3-22 Panelboards DP1 and DP2

Figure 3-23 Panelboards DP3 and ATS-DP3

3.2.3.13 DP4 (480V, 225A, 3PH, 4W) (25yrs) (FAIR) / ATS-DP4 (480V, 150A, 3PH, 4W) (25yrs) (FAIR)

Located in the Main Substation Building, panelboard DP4 and ATS-DP4 were originally built in 1992. ATS-DP4 receives normal and emergency power from panelboards DP1 and DP2 and feeds panelboard DP4, which feeds the air conditioning equipment for the Main Substation Building. They are in fair condition.

3.2.3.14 DP5 (480V, 200A, 3PH, 4W) (3yrs) (GOOD) / ATS-DP5 (480V, 200A, 3PH, 4W) (3yrs) (GOOD)

Located in the Electrical Building, panelboard DP5 and ATS-DP5 were built in 2013 for the bar screen motors, gates, and lights (**Figure 3-24**).

3.2.3.15 ATS-P5 (480V, 100A, 3PH, 3W) (25yrs) (FAIR)

Located in the Biofilter Pump Station Building (**Figure 3-25**), ATS-P5 was built in 1991 for the building's 480V unit heater and 208V lighting loads on panel P5.

Figure 3-24 Panelboards DP5 and ATS-DP5

Figure 3-25 ATS-P5

3.2.3.16 DPB (480V, 600A, 3PH, 4W) (45yrs) (POOR) / ATS-DPB (480V, 600A, 3PH, 4W) (36yrs) (POOR)

Located in the Blower Building, panelboard DPB, field labeled as panelboard A was originally built in 1971 and ATS-DPB was built in 1980 to receive normal and emergency power from pad-mounted transformers PC2 and PC3 (**Figure 3-26**). Panelboard DPB provides power to three 208V panelboards via dry-type transformers for various loads in the blower building. All electrical distribution system equipment that is 480V and lower is in poor condition due to the age and harsh environment of the non-air conditioned blower building.

Figure 3-26 Panelboards DPB and ATS-DPB

3.2.3.17 DP-ADMIN (480V, 400A, 3PH, 4W) (20yrs) (FAIR) / ATS-ADMIN (480V, 600A, 3PH, 4W) (25yrs) (FAIR)

Located in the Administration Building, panelboard DP-ADMIN has two 400A sections fed directed from the 600A ATS-ADMIN (**Figure 3-27**). Panelboards in the Administration Building was first built in 1970 and has undergone several modifications. The current two panelboards were installed in 1996 and appear to be in fair to good condition since they are in the air conditioned electrical room. The ATS-ADMIN was installed in 1991 to take feeders from pad-mounted transformers PC10 and PC12. It is in fair condition.

Figure 3-27 Panelboards DP-ADMIN and ATS-ADMIN

3.2.4 Equipment Evaluation – 208V Subsystem

Throughout the plant site there are numerous aged 480-120/208V transformers and associated panelboards that serve lighting, control and instrumentation equipment, general purpose outlets, etc. Many of these transformers and panelboards are over 30 years old and in fair condition at best. These transformers and panelboards should be slated for replacement.

3.3 Recommendations

Throughout this Section numerous issues were presented regarding the existing electrical infrastructure at the Maxson WWTP. These items are summarized below with recommendations for improvements. These recommendations are not presented in order of priority.

3.3.1 Aging Electrical Equipment

Much of the existing electrical equipment at this site has exceeded its design life and should be replaced. The equipment denoted as 'poor' should be the first in line for replacement. It is noted that the overall equipment will continue to age and equipment now considered as 'fair' may fall into the 'poor' category depending upon when it is slated for replacement.

It is recommended that all equipment indicated as poor be replaced. To minimize capital costs, where possible, existing MCC's should be removed and replaced with smaller and centrally located panelboards.

3.3.2 Aging Electrical Cabling

Much of the existing low voltage distribution cable at this site has exceeded its design life and should be replaced.

3.3.3 Improve Reliability

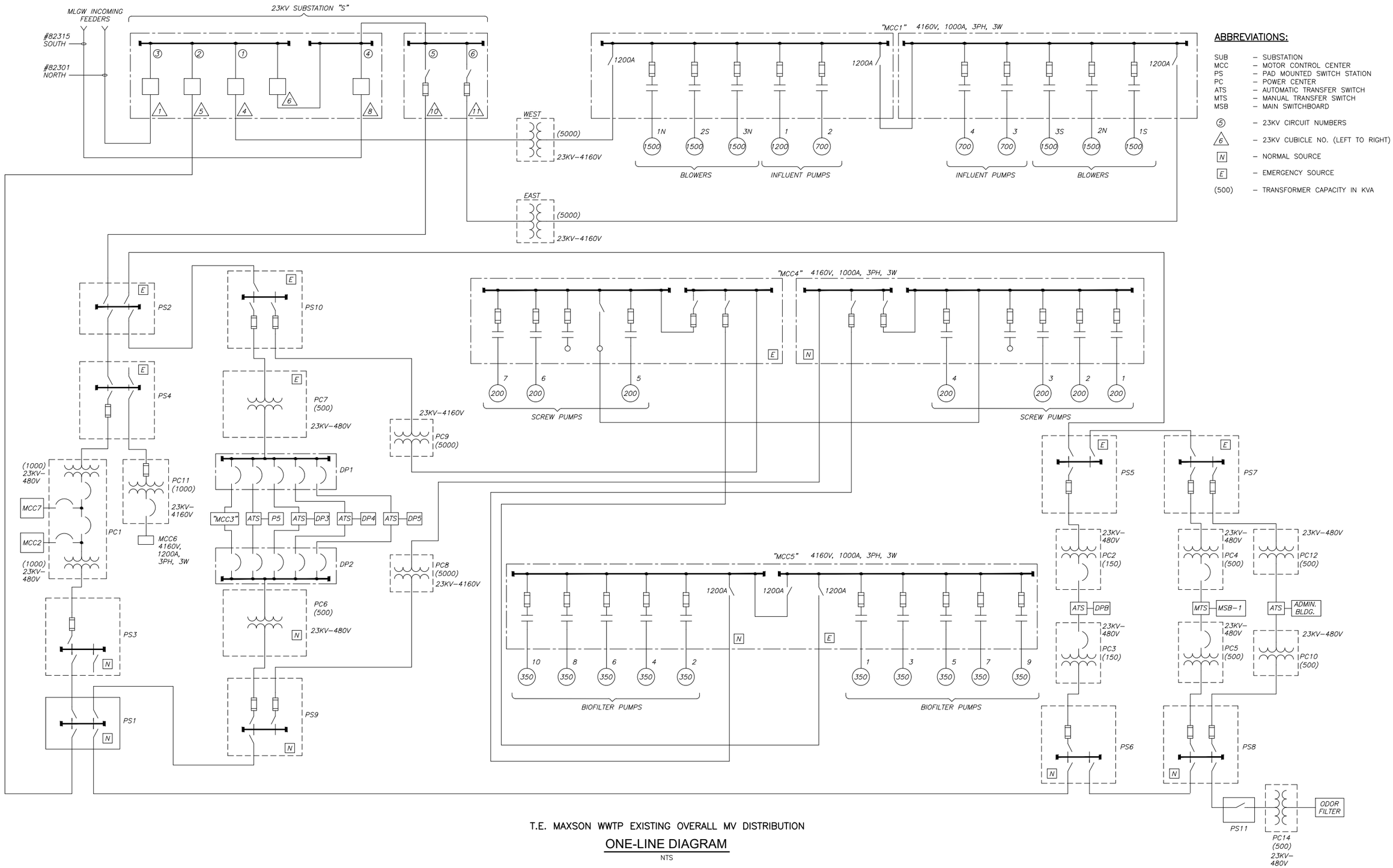
In areas where single panels or MCC's feed critical processes, secondary selective system designs should be employed to increase overall plant reliability and operational flexibility.

3.3.4 Climate Controlled (A/C) Electrical Rooms

The general recommendation for any new electrical room is to provide climate control. The climate controlled rooms will increase the equipment longevity. At a minimum, any rooms with variable frequency drives or PLC control systems must be climate controlled to increase equipment life cycles.

3.3.5 Lighting Transformers/Panelboards

Replacement of all old (i.e. 30 plus year) transformers and associated panelboards is recommended. Any future work for the WWTP improvements project should limit any use of these older panels and it is recommended that new transformers/panels be provided in lieu of utilizing existing equipment where possible.



T.E. MAXSON WWTP EXISTING OVERALL MV DISTRIBUTION

ONE-LINE DIAGRAM

NTS

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CDM Smith

Figure 3-1
T.E. MAXSON WWTP MV DISTRIBUTION SYSTEM
AUG 2015

Section 4

WWTP Existing Hydraulic Capacity Evaluation

4.1 Introduction

This section of the report documents the development of the hydraulic model for the T.E. Maxson Wastewater Treatment Plant and how it was used to determine the hydraulic capacity at the plant for the 25-year flood stage level. The Maxson WWTP discharges into a cooling channel, which drains to the Mississippi River. For the purposes of this analysis, the 25-yr flood elevation (4-percent annual chance of occurrence) at the cooling channel's confluence with the Mississippi was used as the starting downstream water surface elevation (WSE) in the model. When the river is above the 25-year flood stage level gravity flow from the plant starts to be impeded and the use of the effluent pump station is needed. The purpose of the hydraulic model is to predict the plant performance with a free gravity discharge to the outfall.

The original facility was commissioned in 1975, and has undergone several upgrades in past decades. For the hydraulic modelling effort, the plant's various process units and interconnecting piping and structures were analyzed, including grit removal, fine bar screens, primary clarifiers, aeration tanks, and final clarification. Though the plant's original design flow was 90 MGD, the plant now treats an average of just under 70 MGD. Results from this analysis can be used to determine the reliable and emergency hydraulic capacities of the plant's various treatment units currently in use. **Figure 4-1** is the Existing Hydraulic Profile for the plant.

4.2 Capacity Analysis Approach

4.2.1 Hydraulic Modeling

The Maxson WWTP hydraulic capacity analysis was conducted for combinations of flows through closed conduits, open channel flows, and hydraulic control points through the entire treatment plant. For this analysis, commercially available programs were used to evaluate the specific hydraulic elements of the WWTP. To analyze plant hydraulics between process units, Visual Hydraulics (version 4.2) software by Innovative Hydraulics was used.

The hydraulic model was developed for two distinct profiles in the Maxson WWTP, separated by the hydraulic break at the intermediate pump station, downstream of the primary clarifiers. Downstream hydraulic control points were determined for each profile, all hydraulic losses were added one-by-one back to the upstream side of the profile, while incorporating intermediate hydraulic controls and devices. Intermediate hydraulic boundaries included weirs and a Parshall flume. Friction losses in piping and conduits were obtained using the Hazen Williams equation and in open channels were obtained using Manning's equation. Minor head losses at all fittings, transitions, openings, gates, valves and open channel bends were computed by multiplying the appropriate coefficient by the velocity head. Head loss through the fine screens were calculated using installed bar dimensions and appropriate screen blinding rates.

The following assumptions were made for this analysis:

- The influent flow meter on the discharge side of the influent pumps was representative of the flow through the WWTP.
- Steady state flow conditions throughout the plant.
- Dimensions and flow paths in units were constructed as per the contract drawings (1970 through 2011) and input from plant staff. Any modifications or variations from the contract drawings were not incorporated when developing this model unless specifically stated in the text that follows.
- Elevations adjusted per survey data.

The model was calibrated using surface water elevations measured at dry weather flow conditions during the field hydraulic testing. By taking specific tanks and process units off-line, this data reflects a simulated high flow condition of the Maxson WWTP to accurately estimate roughness and minor loss coefficients for the calibration.

4.2.2 System Description

The hydraulic model (Model 1) for the profile upstream of the intermediate pump station consisted of all units and piping between the comminutor influent channel and the pump station influent structure, including the following:

- Comminutor Chambers
- Grit Chambers
- Fine Screens
- Primary Clarifier Splitter Box
- Primary Clarifiers

The comminutor basin/grit chamber structure receives pumped influent via a 72-inch pipe from the influent pump station at the front of the WWTP. It is worth noting that the plant flow meter is located on the discharge side of the influent pump station. Flow travels through three comminutor chambers (the comminutors are no longer in service) before flowing to four grit chambers. Flow exits each grit chamber over an 18-ft weir and discharges into the grit chamber effluent channel. From the effluent channel wastewater is conveyed through a 90-inch gravity pipe to the fine screens structure, where it is split between three 6-ft wide screening channels. Screened wastewater then flows through a 90-inch gravity pipe to the primary clarifier splitter box that divides flow over four separate 10-ft long adjustable weir gates to each primary clarifier. Primary clarifier effluent combine back together into a common 90-inch pipe that discharges to the intermediate pump station. For the purposes of this evaluation, hydraulics associated with the high-rate biotowers downstream of the primary clarifiers were not included in the analysis.

The hydraulic model (Model 2) for the profile downstream of the intermediate pump station consisted of all units piping between the pump station effluent structure and the WWTP's outfall to the cooling channel, including the following:

- Flow Control Structure
- Aeration Tanks
- Secondary Clarifiers
- Parshall Flume Structure
- Chlorine Contact Distribution Box
- Bypass Junction Box
- Levee Gate Structure
- Discharge Structure to Cooling Channel

After the primary clarifier effluent is lifted by the intermediate pump station, the flow is sent through a 102-inch gravity pipe to a flow control structure that splits the incoming flow into the two streams. Return activated sludge (RAS) flow is added to the 102-inch main by tees that intersect the line, approximately half-way between the intermediate pump station and the flow control structure. In the flow control structure, the combined primary clarifier effluent and RAS flow are split by two 5-ft x 5-ft slide gates. One flow stream goes to the north activated sludge treatment train, and the other goes to the south activated sludge treatment train. Each activated sludge treatment train consists of 14 interconnected aeration tanks (total of 28 ATs) and 4 secondary clarifiers (total of 8 SCs). Flow is conveyed from the flow control structure to the aeration tanks and secondary clarifiers through a network of pressurized conduits and piping that have been modified over the years to meet operational needs. The conduit network in the vicinity of the aeration tanks is particularly complex due to changes made to the flow path since it was originally constructed. CDM Smith derived flow paths through this section of the plant based on revised record drawings, a site visit, and discussions with, and information provided by, the plant staff. See **Figure 4-2** for a schematic interpretation of pipe gallery flow paths in the vicinity of the aeration tanks.

Mixed liquor on the north and south side of the plant remain separated downstream of the aeration tanks, and are directed to their dedicated battery of secondary clarifiers. The two secondary clarifier effluent streams combine in the Parshall flume influent chamber. Dimensions of the 10-ft Parshall flume are known to be different from what was intended in the original design, and therefore, flow measurement from the Parshall flume is widely understood to be inaccurate. For the hydraulic modeling effort, a unique Parshall flume coefficient was developed to more accurately reflect observed conditions during the field testing.

The combined plant effluent flow from the Parshall flume structure is then directed through an 8-ft x 6-ft rectangular culvert to the chlorine contact distribution box. In past plant operations, flow was split in this structure and sent to two additional secondary clarifiers that once served as chlorine contact basins, and more recently as wet wells for the effluent pump station. These basins and the effluent pump station are rarely utilized. Currently, the plant effluent is sent directly to a 8-ft x 6-ft effluent culvert that bypasses the effluent pump station. Plant effluent is conveyed through a bypass junction box and levee gate structure, each connected by a 78-in circular pipe, before discharging through the plant's outfall structure, which drains to the cooling channel and on to the Mississippi River.

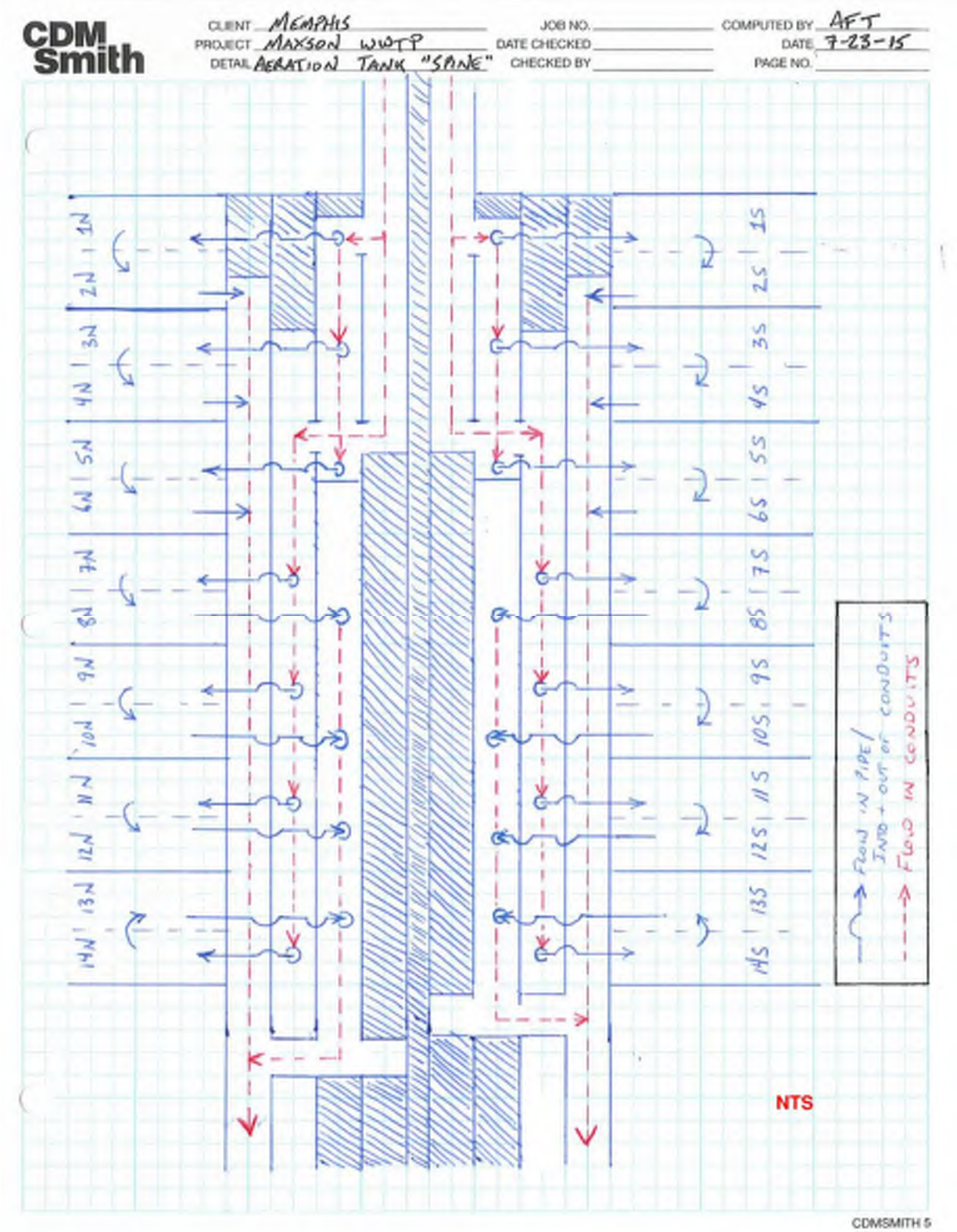


Figure 4-2 Pipe Gallery Schematic

4.2.3 Mississippi River 25-Year Flood Elevation

In order to begin the hydraulic modelling effort for process units in Model 2, the most downstream control point at the plant's outfall was determined by studying where the cooling channel drains to the Mississippi River, near Lake McKellar. For the purposes of this analysis, the 25-yr flood elevation (4-percent annual chance of occurrence) at the cooling channel's confluence with the Mississippi was used as the starting downstream water surface elevation (WSE) in the model. From there, all hydraulic losses were added one-by-one back to the discharge side of the intermediate pump station.

The FEMA Flood Insurance Study (FIS) for Shelby County (#47157CV002B) includes a detailed hydraulic profile of the Mississippi River from the Tennessee state line with Mississippi to north side of Memphis. The FEMA profile includes the 10-, 50-, and 100-year recurrent flood events. The peak discharge frequency relationships for floods at the selected recurrence intervals were developed from previous studies of the Mississippi River by the U.S. Army Corps of Engineers, Memphis District. The 500-year recurrent flood event was not determined due to the difficulty in analyzing flood frequency in such a large drainage basin.

The hydraulic profile for each peak discharge in the effective FIS (2013) was calculated using a detailed hydraulic model of the Mississippi River developed in HEC-RAS. **Figure 4-3** shows the Mississippi River at its confluence with the cooling channel near the WWTP. The FEMA base flood elevation cross sections were used to locate the confluence on the FIS flood profiles. **Figure 4-4** shows the detailed effective profile of the Mississippi in the vicinity of the facility and the cooling channel. **Table 4-1** shows the river stations and peak flood WSEs for the FIS cross sections.

Table 4-1 Mississippi River FEMA Flood Insurance Study Flood Elevations

FEMA XS	River Station (mi)[1]	Flood Elevation[2]		
		10% Annual Chance	2% Annual Chance	1% Annual Chance
XS @ County Boundary	715.2	El. 212.0 ft.	El. 218.1 ft.	El. 220.6 ft.
XS @ Cooling Channel	724.5	El. 216.0 ft.	El. 222.0 ft.	El. 224.5 ft.
XS @ McKellar Lake Entrance	725.6	El. 216.5 ft.	El. 222.8 ft.	El. 225.0 ft.
XS @ Water Gage near Hubert, AK	727.6	El. 217.8 ft.	El. 224.0 ft.	El. 226.5 ft.

Notes: 1. River station is distance above Head of Passes in miles
2. All elevations refer to NAVD88 datum
3. Peak WSEs taken by graphical interpolation from the effective FEMA profile (Panel 75 P in FIS #47157CV002B)

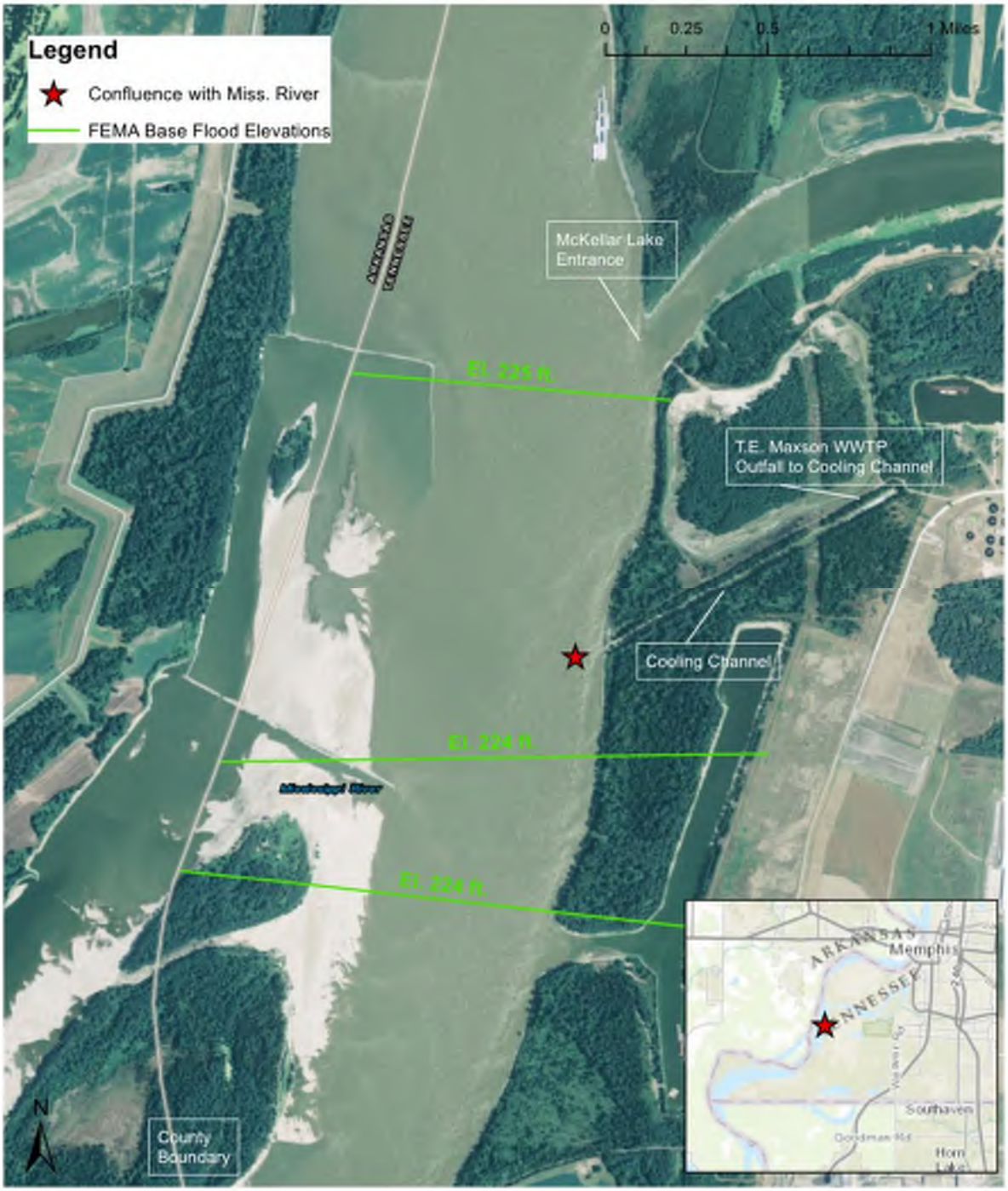


Figure 4-3 25-Year Flood Cooling Channel and Mississippi River Water Surface Elevations

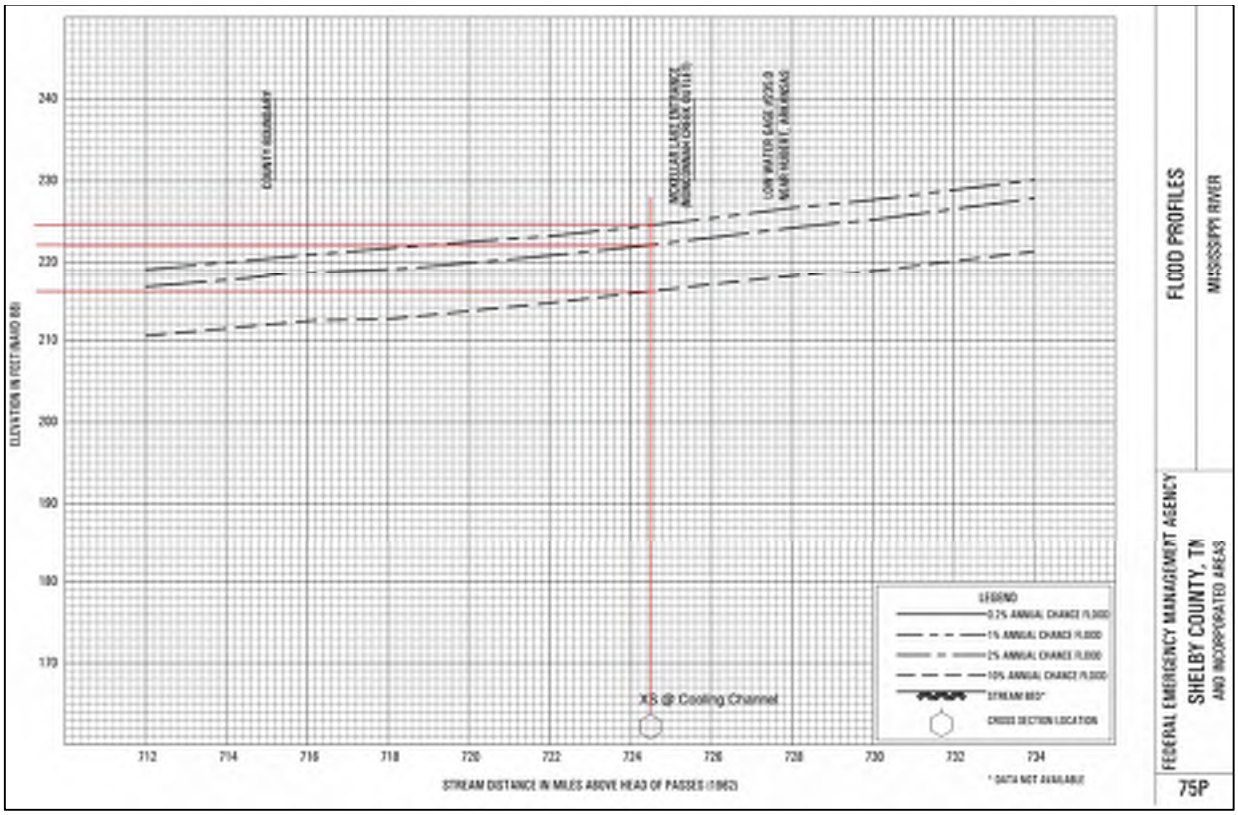


Figure 4-4 Mississippi River Profile

The confluence of the cooling channel with the Mississippi River is located on the east bank about 1 mile downstream of the McKellar Lake Entrance into the Mississippi. The approximate river station of the cooling channel confluence and McKellar Lake entrance is 724.5 miles and 725.6 miles, respectively. The peak flood WSELs for the river stations were taken graphically from the FEMA profile and are included in Table 4-1**.**

To determine the Mississippi River water surface elevation associated with the 25-year peak discharge, the 25-year water surface elevation was interpolated from a stage-discharge rating curve. A degree two polynomial transformation was used in the interpolation to preserve the stage-discharge distribution. **Figure 4-5** shows the interpolation of the stage-discharge rating curve. Therefore, the 25-year recurrent water surface elevation in the Mississippi River in the vicinity of the cooling channel near the T.E. Maxson WWTP is 219.1 ft (NAVD88 Datum).

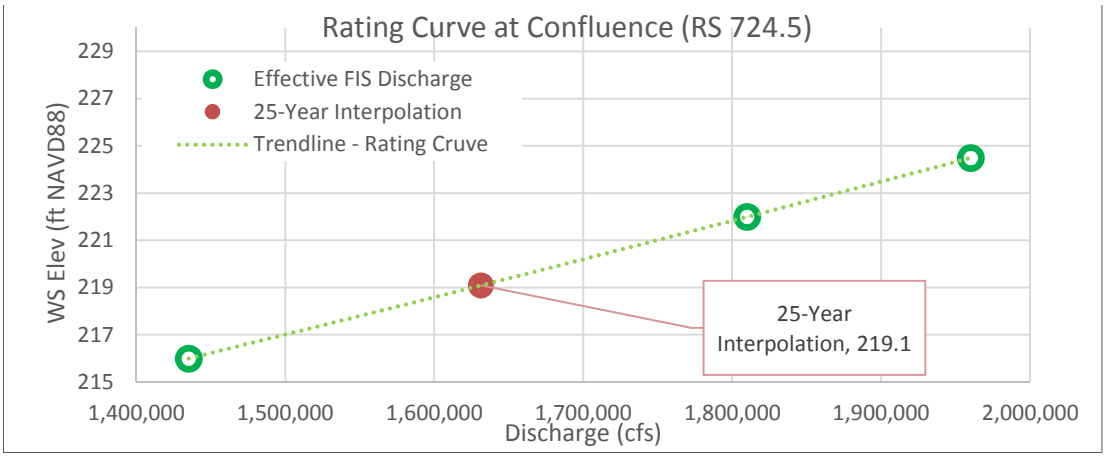


Figure 4-5 Effective Stage-Discharge Rating Curve Mississippi River at Cooling Channel Confluence

4.3 Survey and Field Hydraulic Testing

THY Inc. performed a field survey for this work. They tied into the North American Vertical Datum of 1988 (NAVD88) to determine the vertical elevations at the facility. The survey data was used with depth to water measurements obtained during field hydraulic testing to establish water surface elevation data for a known flow condition. The survey showed a reasonable correlation with the elevations shown on the contract drawings.

Field hydraulic testing was performed on July 8, 2015 from 8:00 am to approximately 1:30 pm. The plant flow rate varied during the test from 66.3 to 68.9 mgd. The return activated sludge (RAS) flow rate during the testing ranged from 19.0 to 20.0 mgd. During the test the influent pump station had to be shut down because the wet well level was too low. After the wet well level reached an acceptable level, the pumps were turned back on at the same flow rate, and the test was completed. In order to simulate high flow rates through the various unit processes, several units were taken out of service during the field testing, including:

- North Comminutor Chamber
- Grit Tanks Nos. 1 and 4
- Fine Screen No. 1
- Primary Clarifiers Nos. 1 and 3
- Bio-Towers Nos. 1 through 6 (all offline)
- Aeration Tanks Nos. N-1/2, N-3/4, N-7/8, N-13/14, S-5/6, S-9/10, S-11/12 and S-13/14
- Secondary Clarifiers Nos. 1-N, 4-N, 1-S and 4-S
- Effluent Pump Station Wet Well Nos. 5-N and 5-S (all offline)

The water surface elevations at key points in the flow path were determined measuring down to the water level from known elevations such as top of wall or channel. Three depth measurements, along with the time of the measurement, were taken for each location and were averaged for each flow rate.

This type of testing is challenging because flows through a wastewater facility can often become unsteady, yielding unexpected water surface elevations. For example, if flow going into a process unit increases, the water level in the tank can increase rapidly because flow going out is less than flow going in. It can take some time before steady state conditions emerge, especially if bottlenecks exist downstream which limit the flow rate out.

Comparison of water surface elevations measured during the field hydraulic test and those generated by the hydraulic model is presented in **Appendix E.** With the understanding that potential unsteady state flow conditions existed during field testing, results from the hydraulic model showed reasonable agreement with field testing. In most cases, the difference between field-measured values and calibrated model-estimated values are within 3–inches. At a few locations, such as the Grit Tank effluent channel, the Primary Clarifier Splitter Box effluent chambers, and the Intermediate Pump Station effluent wet well, larger differences of 7 to 17-inches between field measurements and model predictions were observed. These differences were primarily a result of extremely turbulent water surface elevations during the field stress testing. Additionally, the Primary Clarifier Splitter Box effluent weirs were observed to be completely submerged and had turbulent water surface elevations during field stress testing. Field measurements in these locations are considered unreliable and are not suitable for calibrating the model. Therefore, at these locations in the plant, an uncalibrated hydraulic model was utilized to determine the water surface elevations.

4.4 Hydraulic Capacity Analysis

After field verifying and calibrating the hydraulic model, it was used for determining the reliable and emergency hydraulic capacity of the Maxson WWTP.

The reliable capacity of a process unit is defined as the maximum flow that can be hydraulically passed by each independent process with the largest unit out of service, un-submerged weirs and at least a 3-inch free drop from the weir crest elevation to the downstream water surface elevation.

The emergency capacity of a unit is defined as the maximum flow that can be hydraulically passed by each independent process with all units in service while providing at least a 1-foot freeboard before overtopping tanks and chambers. Note that with 1-foot of freeboard under emergency conditions, frequent splashing and some degree of overflow should always be anticipated.

The plant's RAS flow was assumed to be constant at 20 mgd for all modeled flows, which matches current plant operations. Since RAS is combined with the influent flow in the 102-inch pipe downstream of the intermediate pump station, Model 1 did not include an additional RAS component to their overall flows. Similarly, since RAS is removed from overall flow in the secondary clarifiers, RAS flows are not included in the overall flow downstream of the SCs.

4.4.1 Reliable and Emergency Hydraulic Capacity

Numerous influent flow rates were run through the calibrated model and the respective water surface elevations for each unit process were noted. Flow curves were developed for each unit process based upon the water surface elevations and flow rates, in relation to weir elevations and top of wall (TOW) elevations. For reporting purposes, the established capacity for each process unit is based on the

lowest flow that meets the capacity criteria for that type of unit (e.g., the first of the four primary clarifiers to reach 1-ft of freeboard before overtopping the basin at a given flow rate establishes the emergency capacity of the primary clarifiers).

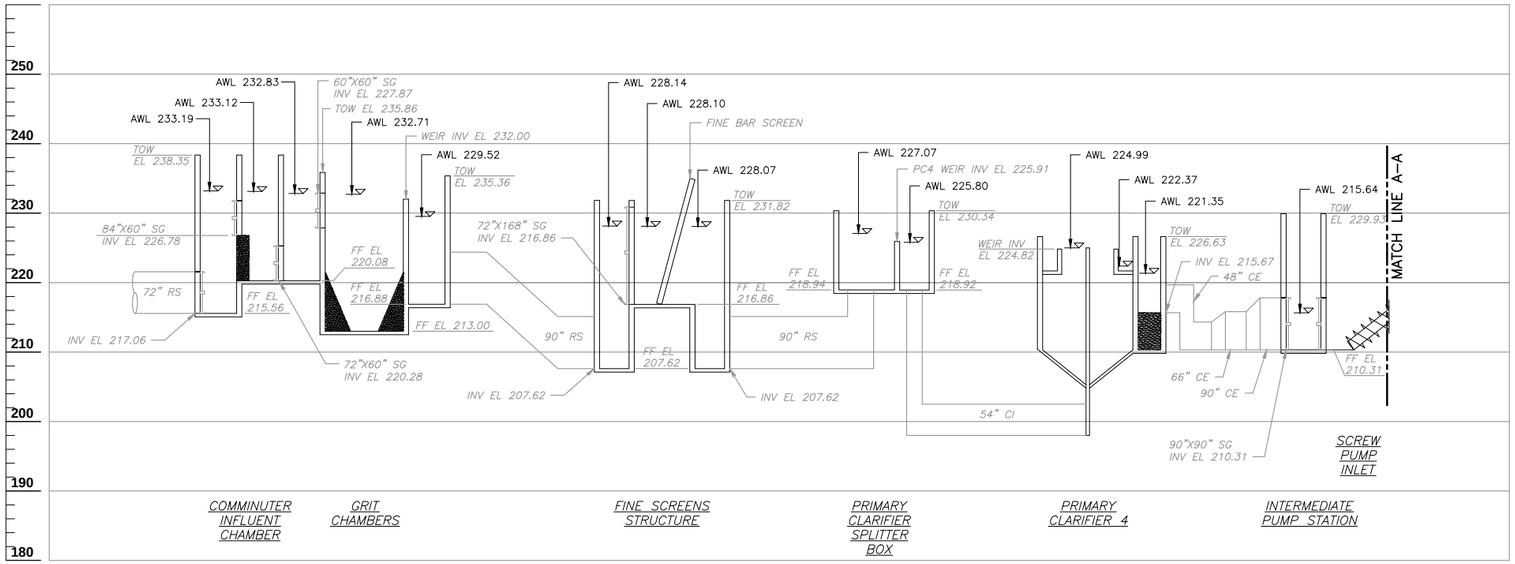
For emergency capacity model runs, all process units were placed in service. For reliable capacity model runs, one train was taken offline in each process area (e.g. primary clarifier No. 1 was taken out of service to establish the reliable hydraulic capacity of the other three clarifiers). For the secondary clarifier and aeration tank analysis, one secondary clarifier and one aeration tank was taken out of service for each process unit on both the north and south activated sludge trains.

In order to establish the reliable hydraulic capacity of the plant, the following process units were taken offline in the model:

- North Comminutor Chamber
- Grit Tank No. 1
- Fine Screen No. 1
- Primary Clarifier No. 1
- Bio-Towers Nos. 1 through 6 (all offline)
- Aeration Tanks Nos. 5-N/6-N and 5-S/6-S
- Secondary Clarifiers Nos. 1-N and 1-S
- Effluent Pump Station Wet Well Nos. 5-N and 5-S (all offline)

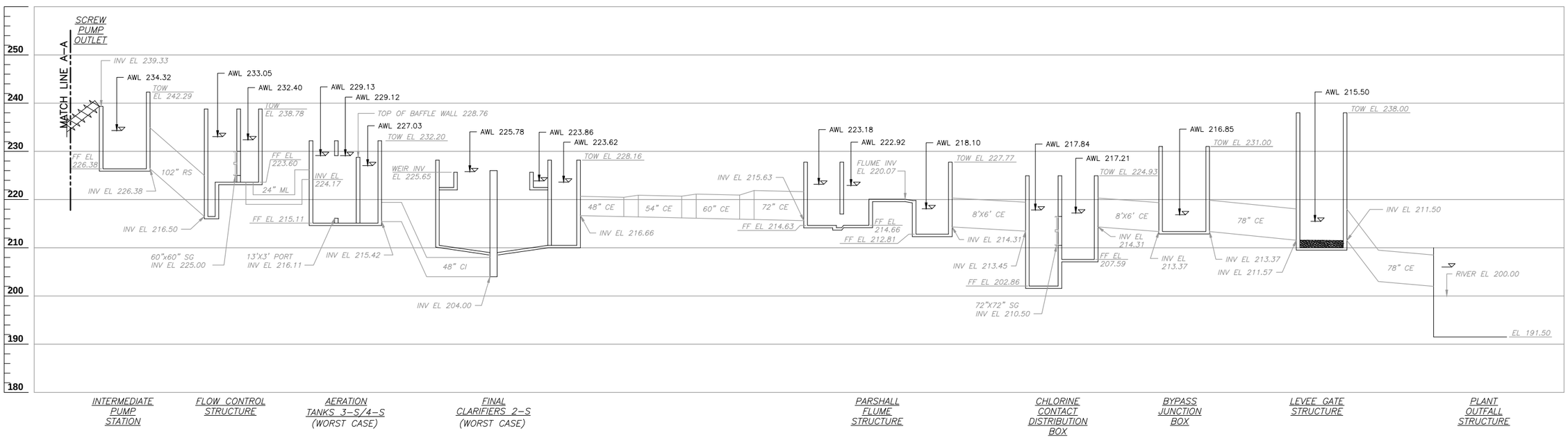
Additionally, for the analysis of the Fine Screens, a 30 percent blinding factor was applied to the three online screens to establish emergency capacity and a 50 percent blinding factor was applied to the two online screens to establish reliable capacity.

The table summarizing the estimated reliable and emergency hydraulic capacity of each process unit, predicted by the model is located in **Appendix E**, along with the the modeled hydraulic capacity curves for each process unit throughout the plant.



NOTES:

1. AVERAGE WATER LEVELS (AWL) COMPUTED FOR AN ASSUMED 90 MGD ADF AND 35 MGD RAS
2. STARTING WATER SURFACE ELEVATION IN COOLING CHANNEL ASSUMED TO BE 200.00 FT.
3. ALL ELEVATIONS REFERENCED TO NAVD88 DATUM.
4. ADF PROFILE ASSUMES 1 AERATION TANK TRAIN IS OUT OF SERVICE ON EACH OF THE AERATION TANK BATTERIES (NORTH AND SOUTH). PROFILE ASSUMES ALL SECONDARY CLARIFIERS ARE IN SERVICE.



REVISION

ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

T.E. MAXSON WWTP

Figure 4-1 SHEET OF

CITY OF MEMPHIS

EXISTING PLANT HYDRAULIC PROFILE

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	1"=10' (VERT)
DESIGN BY	BAH	DATE	X	PROJECT	36694-111641

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

EPA-HQ-2019-004783 002066

10% SUBMITTAL - NOT FOR CONSTRUCTION

Section 5

Disinfection Improvements and Recommendations

5.1 Introduction

The City has been evaluating various disinfection alternatives for use at the Maxson WWTP over the past several years in order to meet requirements in the current draft National Pollution Discharge Elimination System (NPDES) permit. This section summarizes the Maxson WWTP disinfection alternatives evaluation performed by CDM Smith. The complete disinfection alternatives evaluation report is included in **Appendix B**, which includes the results of pilot and bench-scale testing conducted at the Maxson WWTP in 2013 and 2015 and the lifecycle costs for the various disinfection alternatives evaluated.

5.2 Pilot & Bench Testing and Results

Pilot scale testing in 2013 was conducted for sodium hypochlorite, peracetic acid (PAA), and ultraviolet (UV) disinfection to compare and determine disinfection efficacy. During the 2013 testing a portion of the plant's treatment processes were being bypassed, potentially impacting the effluent water quality, and a significant industrial user came off line after the 2013 pilot testing. Supplemental pilot and bench-scale testing performed in 2015 was conducted for PAA, UV, and UV/PAA in combination to determine if there was an improvement in effluent water quality, and thus disinfectant performance, after these changes. The City of Memphis (City) has contracted with CDM Smith to evaluate potential process improvements that could improve effluent quality and process control. Using information from the process analysis for the Maxson WWTP and the design doses developed based on pilot and bench testing, CDM Smith prepared planning level capital, operations and maintenance cost estimates for each disinfection alternative.

The original pilot scale testing began in March 2013, pipe reactors were constructed on location in which plant effluent was treated with either sodium hypochlorite or peracetic acid. UV testing was also performed in a trailer mounted UV disinfection pilot from Trojan Technologies. Control samples were analyzed for color, UV transmittance (UVT) total suspended solids (TSS) *Escherichia coli (E. coli)*, and disinfection by-products (DBPs). Treated samples were analyzed for *E. coli* and disinfection by-products. Testing results with respect to recommended design doses are presented in the disinfection alternatives evaluation report found in **Appendix B**, which is divided into five major sections. Testing objectives, background and permit requirements are described in Section 1, procedures are outlined in Section 2, results and recommendations for design doses are presented in Section 3, and conceptual cost estimates are summarized in Section 4.

The results of the pilot scale testing showed that sodium hypochlorite and PAA could be effective for achieving bacterial inactivation to meet permit compliance for *E. coli*, which includes a monthly geometric mean of 126 colony forming units (cfu)/100 mL, with a daily single grab maximum of 487 cfu/100 mL under current plant operating conditions. In addition to *E. coli* inactivation, DBP formation potential was evaluated for sodium hypochlorite and peracetic acid. Dioxin congeners were detected in the undisinfected effluent and sometimes persisted into the disinfected water. Disinfection did not increase the occurrence or concentration of dioxin congeners. Sodium hypochlorite was also

found to form low concentrations of trihalomethanes (THMs) at the doses that were effective for disinfection. NDMA was not detected in any sample.

The conceptual cost estimates based upon the 2013 pilot testing results showed that the sodium hypochlorite and an optimized UV disinfection system, which requires improvements to the existing secondary treatment process, had the same lifecycle cost of $113,000,000. However, prior to proceeding with the disinfection design phase, the City and CDM Smith agreed that supplemental pilot and bench testing was necessary to determine the impacts the two changes at the Maxson WWTP had on disinfection efficacy. The supplemental pilot-scale testing began in early May 2015 and concluded in early June 2015, while the UV/PAA bench-scale testing was conducted over a week in late September 2015. The supplemental testing had the following objectives:

- Refine the design criteria for PAA disinfection to meet disinfection limits
  - Determine the kinetic model parameters to predict PAA disinfection efficacy across a range of doses and contact times
  - Determine the design dose for average conditions to support calculation of associated operating costs
- Confirm the UV disinfection design dose to support estimates of capital and operating costs
- Quantify and compare disinfection kinetics among several UV and PAA combinations including:
  - PAA alone, UV alone, UV followed by PAA, PAA followed by UV, simultaneous disinfection with UV and PAA.
- Propose a mechanistic model to describe the efficacy of the combined disinfectant

The supplemental PAA pilot testing allowed for the development of a kinetic model to predict PAA disinfection efficacy across a range of doses and contact times. During the analysis of the dataset it was determined that a double exponential decay model provided the best correlation with the dataset, and it was shown to have a reduced spread between the data and the model, when compared to Hom's Model or the standard CT model. Therefore, the double exponential decay model was utilized to determine the necessary CT values at the minimum, average and maximum design conditions. **Table 5-1** summarizes the design criteria for the PAA system.

Table 5-1 Required PAA CTs and Design Points

Flow Conditions	Flow (MGD)	Required Log Inactivation	CT*
Permitted Average	90	3.92	87.1
Peak Hour	170	3.82	74.1
Daily Minimum	50	2.81	22.4

*CT results include a 1.3x safety factor for scaling up to full scale

The results from the recent collimated beam analysis were compared against the historical collimated beam data. It was found that there is no significant difference between the two datasets. Therefore, the water quality at the time of the 2013 sampling and the 2015 sampling yielded nearly identical collimated beam results. The supplemental pilot and bench testing data also showed that a design UVT of 20% would be more reasonable than the UVT value of 35%, which was utilized previously.

The data from the bench testing of a combined UV/PAA disinfectant indicated that the most consistent and positive results occurred with UV followed by PAA. Although the results are promising, further research is required to accurately describe the effect of combined disinfection, and the economic analysis that was performed based on the results did not indicate significant economic savings through application of a combined disinfection system.

Further discussions regarding the use of chlorine disinfection were had between CDM Smith and the City. Use of chlorine disinfection has lower lifecycle costs and similar capital costs to PAA disinfection, however the use of a chlorination disinfection system has additional permitting requirements that include additional testing under Section 3.6.1 of the permit, as follows, making the technology more challenging to implement:

> ***"3.6.1 Additional Permittee Submittals (If Chlorination Disinfection System Selected)***
>
> *Permittee must provide the division with the types/amounts of specific chlorinated byproducts species to be in the Outfall 001 treated effluent and how newly generated byproducts are related to TRC according to the compliance schedule…"*

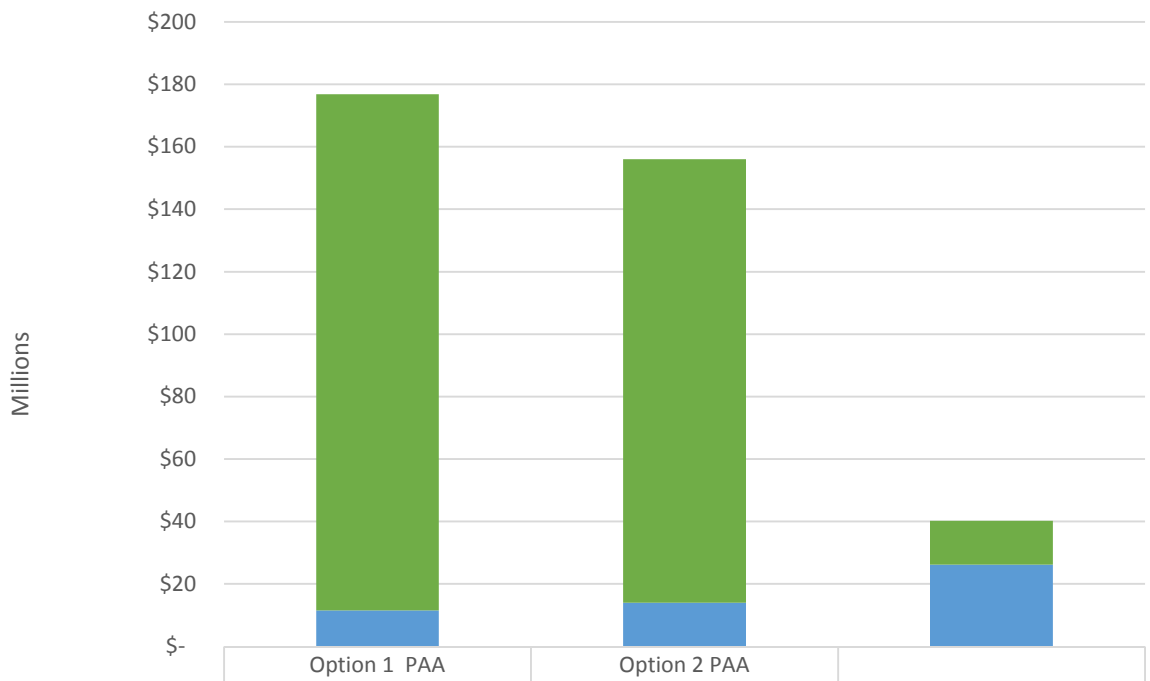
As a result of the additional testing required in the permit, it was determined that chlorine disinfection would no longer be considered.

5.3 Cost Evaluation & Recommendation

Based upon the supplemental testing performed in 2015, the conceptual costs for UV and PAA were revised. Comparative 20-year lifecycle costs for three alternative disinfection systems are illustrated in **Figure 5-1**. The first alternative is a PAA system with a contact tank providing 31 minutes of contact time at average flow, the second is a PAA system providing 31 minutes of contact time at peak flow, and the third is a UV system designed to treat effluent with a 20% UVT.

Providing more contact time at average flow for the PAA system eliminated the need for quenching with sodium bisulfite, although provisions were made to add a sodium bisulfite if it is needed in the future for emergency use. Although the lifecycle costs of the UV alternative is lower than that of the two PAA alternatives, the City of Memphis and CDM Smith discussed the impacts caused by the variability of the low UV transmittance seen in the Maxson WWTP effluent. The variability likely stems from the change in processes and raw materials utilized by industrial users within the City's collection system. In addition, the capital cost required to increase the UVT of the effluent via another process, such as ozone, to make UV a viable option is more than the City can afford to spend. Based upon these discussions it was decided to eliminate UV from the list of disinfection alternatives. Therefore PAA disinfection is the recommended disinfection alternative to be utilized at the Maxson WWTP. Further analysis was performed to find the optimal combination of contact tank size and PAA dose to reduce the lifecycle costs. Results from the detailed cost analysis and the supplemental pilot data indicate that the most cost effective contact tank size to reduce overall lifecycle cost is 489,000 cubic ft. As a result, the most cost effective disinfection alternative is PAA - Option 2.

While PAA disinfection has the highest lifecycle cost, the low capital cost of the PAA disinfection system combined with the avoidance of additional permitting requirements as described above has resulted in PAA disinfection being the selected disinfection alternative for the Maxson WWTP.



	Option 1 PAA 253,000 cubic ft	Option 2 PAA 489,000 cubic ft	20% UVT Design UV System
Total Annual Cost	$165,300,000	$142,000,000	$14,000,000
Total Capital Cost	$11,500,000	$14,000,000	$26,200,000
Lifecycle Costs	$177,000,000	$156,000,000	$40,000,000

Figure 5-1 20-Year Lifecycle Analysis of Three Disinfection Options

5.4 PAA System Basis of Design

CDM Smith has recommended that the City utilize bulk PAA disinfection at the Maxson WWTP. This subsection provides definition for a PAA system including initial equipment sizing, building code implications, modifications to existing buildings and structures, instrumentation and control and electrical modifications. CDM Smith recommends that the City lease the chemical feed, storage and delivery system from a PAA supplier as part of the chemical purchase agreement similar to what is being done at the M.C. Stiles WWTP. It is recommended that the City include the Maxson PAA system in with the PAA supplier procurement package being utilized for the Stiles WWTP, as this will help the City obtain the lowest PAA cost possible. Thus, CDM Smith has coordinated with PeroxyChem as a potential provider in obtaining process equipment sizing and recommendations on the PAA storage and feed system presented in this section.

When the City selects the PAA supplier, the information presented herein should be updated with the specific details of the selected supplier's system. CDM Smith recommends that the City select a PAA supplier during the preliminary design phase of the project. This will allow for the final equipment sizing and placement to be included in the final bid package for general contractors and will provide a competitive pre-selection process.

5.4.1 Peracetic Acid System

The double exponential decay model developed from the results of the pilot and bench testing was utilized to establish the basis of design CT values at minimum, average and peak conditions, which were presented in Table 5-1**.** The optimization of the contact tank yielded a volume of 489,000 cubic feet, which was utilized to establish the contact times and PAA doses at the various flow rates. **Table 5-2** summarizes the design log inactivations, CT values, flow rates, contact times and PAA design dose at the design conditions. The basis of design for the PAA system is summarized in **Table 5-3**.

Table 5-2 Required PAA Doses to Achieve Disinfection Design Criteria

	Required Log Inactivation	Design CT	Flow	Contact Time	Dose
		mg/L*min	MGD	min	mg/L
Peak Conditions	3.92	87.10	170	31	8.36
Average Conditions	3.82	74.10	90	59	6.73
Minimum Conditions	2.81	22.36	50	105	4.50

Table 5-3 PAA Basis of Design Summary

Design Plant Flows	
Minimum Daily Flow	50 mgd
Current Average Daily Flow	70 mgd
Permitted Average Daily Flow	90 mgd
Maximum Daily Flow	155 mgd
Peak Hour Flow	170 mgd
PAA Contact Tank Criteria	
Number of Contact Tanks	1
Contact Tank Configuration	Parallel Halves
Overall Tank Length	298.5 feet
Overall Tank Width	159 feet
Number of Passes on Each Half of the Contact Tank	3
Side Water Depth at Peak Hour Flow (1 ft of water height over weir)	13.5 feet
Width of Each Pass	22 feet
Bottom Slab Elevation	208 feet
Weir Elevation	220.5
Weir Length per Half/Total	40LF/80LF
Tank L:W Ratio	72
Tank H:W Ratio	0.61
Total Tank Volume	489,456 cubic feet
PAA Detention Time	
Minimum Daily Flow	105 minutes
Average Daily Flow	75 minutes
Permitted Average Daily Flow	59 minutes
Maximum Daily Flow	34 minutes
Peak Hour Flow	31 minutes

Table 5-3 PAA Basis of Design Summary, continued

PAA Feed & Pumps Design Criteria	
PAA Chemical Strength[1]	12 to 15%
PAA Specific Gravity	1.16
PAA Doses of Active Ingredient for Feed Rate Calcs.[2]	
Minimum Daily	4.5 mg/L
Average Daily	6.6 mg/L
Permitted Average Daily	6.7 mg/L
Maximum	8.4 mg/L
Total Feed Rates (for 15% solution)	
Minimum flow and average dose	80 gph
Average flow and average dose	110 gph
Permitted average flow and average dose	144 gph
Peak hour flow and maximum dose	342 gph
Minimum Pump Turn Down	4.3:1 (will utilized std hose pump turn down)
Number of Dosing Locations per Half of Tank (Main & Boost) locations)	2
Minimum # of Metering Pumps per Dose Location	2 (1 duty and 1 standby)
Minimum Total # of Metering Pumps	8 (4 duty and 4 standby)
Bulk Storage and Tanks Design Criteria	
Transfer Pumps	2
Fill Station/Piping/Valves	Per Manufacturer
Design Flow for Bulk Storage Calculations (permitted average flow)	90 mgd
Number of Day Tanks	2
Day Tank Size (permitted avg flow and dose, plus 10%)	3,800 gallons
PAA Volume per Truck Load	4,000 gallons
14-day Storage Volume Required at Design Flow x Permitted Ave. Dose	48,500 gallons
14-day Storage Volume Required at Design Flow x Maximum Dose	60,800 gallons
Total Storage Volume Available	52,000 gallons
Proposed Storage Volume Available per Tank	6,500 gallons
Number of Bulk Tanks	8
Proposed Storage Duration Available at Design Flow x Permitted Ave Dose	15 days
Proposed Storage Duration Available at Design Flow x Maximum Dose	12 days

Notes: 1. As active ingredient
2. Dose from PeroxyChem Bench Test (June 2014)

Process and Instrumentation Diagrams for the PAA bulk storage, chemical feed, and contact tank are included at the end of this section.

5.4.1.1 PAA Contact Tank

A new contact tank will be constructed to provide the necessary PAA contact time. The tank will be broken into two halves, the north and south. The design criteria for the tank are summarized in Table

5-3. Each half of the contact tank will have two PAA dose points. The main point will be at the head of each half of the contact tank, while a second dose point is included roughly two-thirds through each half of the tank in order to boost the PAA concentration to prevent regrowth.

Each half of the tank includes a 40 foot long effluent weir, which will include two ultrasonic level elements (one duty, one standby). The level elements are utilized to determine the height of water over the effluent weir and thus, the flow rate for that half of the tank. The flow readings for each half of the tank will be added together and will be utilized as the effluent flow rate.

The contact tank includes an effluent channel downstream of the tank effluent weirs, which serves two purposes. The first is to convey flow to the west side of the contact tank, and the other is to provide supplemental storage volume for the effluent pump station wet well. The effluent channel is 15 feet wide and 425 feet long. CDM Smith determined that the new effluent channel to the PAA CT will have enough storage capacity to provide sufficient cycling of the effluent pumps without considering the volume of the new 102-inch discharge main nor the effluent pump station wet well. Therefore, short cycling should not be a concern with the effluent PS. The cycle time for the existing pumps is conservatively two starts per hour. The maximum flow per effluent pump is approximately 43,000 gpm which would require a water depth of 6.7 feet in the PAA CT effluent channel. The proposed water depth would be 11 feet, providing sufficient storage for the operation of the Effluent Pump Station.

5.4.1.2 Chemical Off-loading and Storage

Peracetic acid will be delivered on site by a truck with a 53-foot trailer. The truck will deliver 4,000 gallons per delivery. With the daily chemical use anticipated to be 3,456 gallons per day, approximately one delivery per day will be required.

The PAA system will utilize a new chemical unloading and bulk storage area in the southwest corner of the WWTP. See **Section 6** for site plans locating the PAA system. The OPCC assumes that the PAA supplier will supply a turn-key system for the storage and feed of the PAA. The CMAR project will provide emergency eyewash/shower stations and washdown stations, a chemical tank pad and feed building under the CMAR contract.

Eight 6,500-gallon linear high density polyethylene (LHDPE) bulk storage tanks and two 4,000-gallon LHDPE day tanks are proposed as part of the chemical storage and delivery system. The tanks will be provided with the following minimum features:

- Leak detection sensors
- Radar level transmitter and a high-high conductivity level switch
- Combination pressure and vacuum relief vents
- Site gauges
- Manway hatches
- Fiberglass reinforced polymer (FRP) ladders with safety cages
- Isolation valves
- Vent return lines

- Emergency relief valve vented to atmosphere

Two chemical transfer pumps will be used to transfer PAA from the bulk storage tanks to the day tanks.

5.4.1.3 Chemical Feed System

The contact tank is divided into two halves, a north and south pass. Each pass will have a dedicated main dosing point, and a second dosing point in order to boost PAA concentration, should that be necessary. Each dosing point will have dedicated skid-mounted, pumps (one duty and one standby) and an induction mixer for dosing PAA. Features of the chemical feed skids will include:

- Self-contained skids with leak-detection to detect PAA leaks in the building
- Local control panel for operator interface
- Pump failure alarms
- PAA flow measurement devices for tracking chemical feed rates
- Microprocessor based motor speed control unit to modulate chemical feed rate and control the pumps
- Calibration column

The pumps will convey PAA from the day tank to the induction mixers located at each dose point.

5.4.2 Civil/Site Work

In order to implement the PAA feed and storage system, the existing roads in the southwest corner of the WWTP will need to be modified, and the new truck unloading and chemical bulk storage areas will need to be constructed. See the Site Plans included in **Section 6** for a site plan of the system. The PAA supplier will provide chemical piping from the PAA feed building to the PAA contact tank. In addition, chemical containment will be provided, with leak detection, for the piping along the entire piping run.

5.4.3 Architecture

The PAA feed building will be constructed to store the metering pump skids, tepid water system, and electrical & control gear. This section provides a brief summary of the applicable building codes for the PAA feed building. A complete building code review will need to be conducted early in the design phase of the project.

Codes referenced:

- 2012 International Building Code (IBC)
- 2009 International Fire Code (IFC)

A 15-percent PAA solution is classified in accordance with the International Fire Code as possessing the following physical properties (maximum numbers are for a chemical in a closed system):

- Combustible liquid Class III-A H-2 or H-3 occupancy if over 330 gallons
- Organic Peroxide Class IV

- Oxidizer Solid/Liquid Class II H-3 Occupancy if over 25 gallons

A 15-percent PAA solution is also classified in accordance with the International Fire Code as possessing the following Health properties (maximum numbers are for a chemical in a closed-system):

- Corrosive H-4 occupancy if chemical volume is over 500 gallons
- Toxic H-4 occupancy if chemical volume is over 50 gallons

In regards to the exterior storage, if the amount exceeds 100 gallons, storage containers must have a minimum 35-ft setback from buildings, lot lines, public right of ways and means of egress (Table 6304.2.1 and 6304.1.2 in the 2009 International Fire Code).

Within a closed system; if the amount of PAA exceeds the amounts listed above, H occupancy classification will be triggered. The feed building will only house the metering pumps for the four PAA application points, and the piping that is associated with each metering pump. The design of the piping system for the metering pumps will be such that it will stay under the IFC Oxidizer Solid/Liquid Class II PAA threshold volume of 25 gallons, which means the PAA feed room will not be classified as an H occupancy.

5.4.4 Structural

A new PAA feed and control building will be constructed to house the PAA metering pumps, the tepid water system, and the electrical and controls equipment. Each set of equipment will be located in a dedicated room within the building. The footprint of the building is approximately 30 ft. wide by 30 ft. long and will consist of slab on grade foundation, with cast-in-place concrete post and beam construction with concrete block infill walls to match construction of the surrounding existing buildings. The roof will be single-sloped and constructed of precast hollow-core concrete structural slabs, with built-up membrane roofing and external gutters and downspouts. The door, frame and hardware for the PAA feed room will be of fiberglass reinforced plastic (FRP) construction. All other doors, frames and hardware in the building will be painted steel. The metering pumps will come preassembled on a skid system, which will have its own containment system.

The day and bulk storage area will be located at least 35 feet east of the PAA feed building, and will consist of a storage containment area, and a truck unloading area. The storage area will be constructed as a slab on grade with containment walls to contain a chemical spill, should one occur. An elevated FRP walkway system will be provided in order to provide access to the tanks, and their shut off valves even in the event of a spill. A PAA resistant coating system will be applied within the containment area to protect the concrete. The truck unloading area will be able to hold the volume of a chemical delivery tanker, estimated at 4,000 gallons, and will also have a PAA resistant coating system applied.

5.4.5 Electrical

Power to the disinfection facility will be derived from the proposed new 23kV distribution loops originated from the proposed new substation. The loops consist of a normal circuit and an emergency one for redundancy. The estimated load of the PAA system equipment and associated miscellaneous equipment is approximately 180KVA. The electrical system for the PAA facility consists of two 225kVA, 23kV-480Y/277V, pad-mounted transformers located outside the PAA chemical feed building; a 480Y/277V, 400A automatic transfer switch (ATS), a 480Y/277V 400A panelboard, a 30kVA step-down dry-type transformer, and a 208Y/120V, 100A panelboard, all located in the

electrical room within the PAA feed building. The electrical room will be air-conditioned to ensure the performance of the electrical and control equipment inside.

The control equipment in the electrical room include a PLC and Operator Interface Terminal (OIT) panel for connectivity to the plant wide SCADA system and to calculate the effluent flow rate at the PAA CT effluent weirs, and the PAA system control panel, which is provided by the PAA provider, and will power and control all the PAA equipment.

5.4.6 Instrumentation and Control

Instrumentation and Control (I&C) improvements are required in order to implement the PAA system. I&C is important to the operation of the packaged PAA system and careful coordination is required for interfacing the PAA system with the upgrades to the plant SCADA system being implemented in this project. The process and instrumentation diagrams for the PAA process are included at the end of this section. The PAA system will be controlled by a PLC which will allow for all components to be automatically controlled and will provide the ability to alert the operator to process problems. An operator interface will provide the operator with means of monitoring and controlling the PAA system. The interface will be located in a new programmable logic controller (PLC).

All instrumentation and controls being furnished with the leased PAA system will be the standard offering from the PAA system supplier. Ethernet compatibility will be specified and will allow the PAA system to be controlled and monitored by the SCADA system via PLC. A PLC panel with an OIT will be provided in the electrical room to allow operators to interface with the plant wide SCADA system. The new PLC will allow dedicated monitoring and flow pacing signals to the PAA system. The PLC will interface to the existing plant control system via Ethernet.

5.4.7 HVAC/Plumbing

Potable water lines will need to be run to the new PAA feed and control building. Potable water will be utilized for the tepid water system and for hose down purposes. A new 300 gallon tepid water skid will be located in the PAA feed and control building mechanical room. Given the furthest emergency shower/eyewash station is more than 100 feet away, a tepid water loop and recirculation pump is required per code. The tepid water system is currently slated to have a duty/standby recirculation pump and booster pump.

Ventilation of the PAA feed and control building will be determined during preliminary design. Heating and cooling will be provided in order to maintain conditions for the equipment and operations staff.

Section 6

Secondary Process Upgrade Recommendations

6.1 Introduction

Included in the recommendations of the 2013 report were improvements to expand the secondary treatment process to improve the effluent water quality. These improvements would facilitate implementing disinfection into the process and provide for future biological capacity to treat up to 90 million gallons per day (MGD) average daily (AD) flows.

The existing secondary treatment process is comprised of biotowers, aeration basins and secondary clarifiers. **Table 6-1** provides a summary of the existing secondary treatment process units.

Table 6-1 Existing Secondary Treatment Process Units

Process Unit	Number Installed	Description
Biotower Pumps	10	Each pump rated at 23,000 gpm at 43 ft; variable speed
Biotowers	6	Diameter of 135 ft; media depth of 21 ft; wood media with specific area of 14 sf/ft3
Aeration Basins	14	10 tanks- two pass, 250 ft x 24.25 ft per pass, 15.25 ft sidewater depth 4 tanks- two pass, 225 ft x 24.75 ft per pass, 15.25 ft sidewater depth
Blowers	6	Each blower rated at 35,500 scfm @ 7.5 psig
Secondary Clarifiers	8	Diameter of 135 ft; 15 ft sidewater depth
RAS Pumps	6	Each pump rated at 12,000 gpm at 6 ft (max flow condition)

The existing biotowers can be operated in either roughing filter mode or as activated biofilters (ABF). When operating as ABF, return activated sludge (RAS) from the aeration basins is conveyed to the biotower pump station, where it is blended with primary effluent and pumped to the biotowers.

Two alternatives to provide the desired biological treatment capacity up to 90 MGD were identified in the 2013 report. Improvements identified in Alternative 1 included removing the existing biotowers and constructing additional aeration basins and secondary clarifiers where necessary.

Alternative 2 included upgrading the existing biotowers, adding odor control for the biotowers, modifying the biotowers by raising the floors by 3 feet to accommodate room in the existing hydraulic line and constructing intermediate clarifiers downstream of the biotowers. When plant hydraulics were calculated to determine hydraulic impacts of adding the proposed process units to the existing system, it was determined that there is insufficient hydraulic capacity to add the proposed intermediate clarifiers. Additionally, raising the floors of the biotowers by 3 feet would require extensive modifications. These issues led to Alternative 2 being removed from consideration for further evaluation.

Although Alternative 2 was removed from consideration, CDM Smith and the City of Memphis felt there was potential for reusing the existing biotowers as opposed to removing them or abandoning them in place. A new alternative, Alternative 3, was then developed to include upgrading the biotower

media, addition of a new RAS reaeration basin, replacement of the existing course bubble diffusers with fine bubble diffusers, and new secondary clarifiers.

This section presents the design criteria, considerations and proposed improvements for Alternative 1 and Alternative 3. **Subsections 6.2, 6.3 and 6.4** describe the design criteria and considerations that are required for both Alternatives. **Subsections 6.5 and 6.6** discuss the improvements specific to Alternative 1 and Alternative 3, respectively.

6.2 Civil and Geotechnical Design Criteria

The general civil and geotechnical criteria to be considered for both Alternatives involve site grading and drainage, access drive relocation and/or reconstruction and geotechnical exploration. Alternative 1 will also involve filling approximately 6.5 acres of the site, in an area that may contain wetlands.

Drainage from the Maxson WWTP is collected through a series of storm drain inlets and discharge into a low-lying area located just west of Biotower 1. This general drainage pattern will be maintained with either Alternative.

Both Alternatives involve the relocation of a portion of the existing site drives to make for the construction of the new PAA Contact Tank. Also, both Alternatives will include an analysis of the existing access drives to and from the proposed PAA bulk storage pad to determine what modifications are needed to accommodate the increased demands of the PAA delivery trucks.

The geotechnical work is intended to address the following key issues:

- Depth and condition of any existing fill associated with past site activities
- Presence of soft, compressible or excessively wet soils
- Presence of liquefiable soils
- Pavement thickness and subgrade conditions of the site drives
- Groundwater depth

The soil borings, laboratory analyses and engineer analysis will provide the following information:

- Foundation recommendations, including bearing capacity and anticipated settlement
- Deep foundation recommendations as necessary
- Seismic site classification per the International Building Code
- Liquefaction analysis
- Site excavation and placement of fill, including an evaluation of the suitability for use of existing on-site soils
- Pavement recommendations based on specific traffic projection and a design life

6.2.1 Permits

The following Tennessee Department of Environment and Conservation (TDEC) permits are associated with the site work required for this project.

- National Pollution Discharge Elimination System (NPDES) Stormwater Construction Permit

The project will fall under the TDEC's Stormwater Construction Permit program and will require the submittal of a Notice of Intent and a site-specific Storm Water Pollution Prevention Plan (SWPPP).

- Aquatic Resources Alteration Permit (ARAP)

If it is determined that the fill associated with Alternative 1 will impact wetlands, an ARAP may be required.

6.3 Architectural Design Criteria

The following architectural design criteria will be incorporated for improvements constructed under both Alternatives.

6.3.1 Design Considerations

CDM Smith architectural design philosophy is rooted in a long history of environmental design. As with all projects, the architectural design for the Maxson Expansion project will be approached in a holistic, energy-efficient and environmentally responsive manner. Material selections are based on life cycle operation, maintenance, durability, security and compatibility with the aesthetics of other buildings on site.

6.3.2 Building Codes and Regulations

The applicable codes for the Architectural portions of the Maxson Expansion project shall include the following (including local amendments):

- 2009 International Building Code: Chapters 14-26 and 34 requirements will be enforced from the 2012 IBC
- 2012 International Existing Building Code
- 2009 International Plumbing Code
- 2009 International Mechanical Code
- 2009 International Fire Code
- 2012 International Energy Conservation Code
- 2009 Accessible and Usable Buildings and Facilities Standard (ICC/ANSI A117.1)
- Americans with Disabilities Act (ADA)
- 2006 NFPA Life Safety Code 101
- 2008 National Electric Code

- Occupational Safety and Health Administration (OSHA)

6.3.3 Building Construction

New building construction will consist of cast-in-place concrete post and beam construction with concrete block infill walls to match construction of the surrounding existing buildings. Roofs will be single-sloped and constructed of precast hollow-core concrete structural slabs, with built-up membrane roofing and external gutters and downspouts. All exterior personnel doors and frames will be of fiberglass reinforced plastic (FRP) construction.

6.3.4 New Buildings

New buildings to be constructed under both Alternatives include:

- Peracetic Acid (PAA) Chemical Feed Building – approximately 40-feet long by 20-feet wide
- Main Electrical Substation – approximately 30-feet wide by 60-feet long

New buildings to be constructed under Alternative 1 include:

- Blower Building – Includes large mechanical area for the blower units and associated equipment; electrical room hosing switchgear and Motor Control Centers (MCCs); and a small office space. Building will be approximately 75-feet long by 45-feet wide.

New buildings to be constructed under Alternative 3 include:

- Electrical Building – Approximately 40-feet wide by 80-feet long

6.4 Structural Design Criteria

6.4.1 Building Codes and Regulations

The applicable codes for the Structural portions of the Maxson Expansion project shall include the following (including local amendments):

- 2012 International Building Code
- 2012 International Existing Building Code
- 2012 International Residential Code
- 2008 National Electrical Code
- 2009 International Mechanical Code
- 2009 International Gas Code
- 2009 International Plumbing Code
- 2009 International Energy Conservation Code

6.5 Subsurface Utility Engineering

Verification of existing yard piping will take place in two phases. The first phase will involve an area sweep using ground penetrating radar (GPR) to identify the existence of utilities that are not reflected

in the record drawings. The areas to be swept for each Alternative are described in the following sections. It may be determined in the field that some pipes are not detectable due to depth of cover or soil condition being not conducive to GPR technology. In those cases alternative methods of location, including radiolocation or acoustic locating, should be employed. These methods are included in Level B exploration.

The second phase will include Level A exploration, or physically exposing the pipe for verification of horizontal and vertical location, size and material. Anticipated locations of Level A locales are indicated on the drawings.

6.6 Electrical System Improvements

The existing plant electrical system consists of: a 23kV substation "S" with two circuits (one normal and one emergency) from Memphis Light, Gas and Water (MLGW); a 23kV loop distribution system to reach various plant loads; and power distribution motor control centers (MCCs) and panelboards to various loads. The estimated additional load for the proposed process improvements will be between 2,250kVA and 6,000kVA, depending on the selected Alternative. The existing plant electrical system does not have enough capacity to accommodate the new load. This will require the installation of a new 23kV substation with a main-tie-main configuration to handle both the existing plant load, via the existing substation "S", and the new process loads. New feeders (one normal and one emergency, preferably installed underground) will be requested from MLGW for the new substation. Coordination with MLGW has been initiated by the City and the design team, with the first meeting scheduled for February 10, 2016. A new substation building will be located across the service road from the existing substation building.

A new 23kV underground distribution system originating from the new substation will be constructed to reach the service transformers and the downstream MCCs and panelboards. It will consist of medium voltage cables, concrete-encased ductbanks, manholes and pad-mounted switchgears similar to the plant's existing medium voltage distribution system.

Due to the conflict with the proposed process facilities on site, some of the electrical infrastructure, including the underground MV cables, ductbanks, manholes, pad-mounted switchgears and site lighting, will need to be relocated.

6.7 Alternative 1 Improvements

6.7.1 Process Improvements

The existing secondary treatment process can reliably treat approximately 58 MGD of flow on an annual average daily basis if the biotowers are removed from the process. In order to meet the desired 90 MGD capacity, a new activated sludge treatment process train would be required. As described previously in the report, the Alternative 1 initial design would be set to provide only 82 MGD of average day biological capacity with the ability to add the remainder of the capacity in a future phase of work.

The existing biotowers, specifically when operated as activated biofilter mode (ABF), provide a means of removing readily biodegradable COD (rbCOD) prior to the aeration basins; this removal provides bioselection of the bacteria grown in the aeration basins, particularly the minimization of the growth of filamentous organisms. An alternative means of bioselection will be needed for both the existing and new process trains to control filamentous organism growth to maximize clarifier capacity. New

anaerobic bioselectors are recommended to be installed for this purpose. The design criteria used to develop the recommendations in this alternative are detailed in **Appendix C**.

Primary effluent from the intermediate pump station will be conveyed to a new splitter box, which will combine the primary effluent with RAS prior to the biological treatment process. The splitter box will contain adjustable weir gates to split the flow to the proposed biological treatment processes. This box is further described in **Section 7** of this report.

A new three-cell bioselector will be constructed for the existing process train. Additionally, each existing aeration basin will include a swing zone that can be used either anaerobically or aerobically, depending on the temperature of the wastewater. New mixers will be provided in the swing zones to accommodate anaerobic operation to keep solids in suspension.

The new biological treatment process train will consist of a three-cell bioselector which will receive mixed liquor from a new splitter box to provide bioselection prior to the new aeration basins. The new aeration basins will be equipped with swing zones to operate aerobically or anaerobically. New coarse-bubble diffused air systems and single-stage centrifugal blowers are proposed for aerating the new aeration basins. Mixed liquor will discharge over a fixed weir plate into a common discharge channel. This channel will also be equipped with coarse bubble diffusers for additional mixing.

Flow from the aeration basin discharge channel will be conveyed to the secondary clarifier flow splitter box. This splitter box will contain adjustable weir gates to split flow three proposed 135-foot diameter secondary clarifiers, with a fourth gate installed to accommodate future expansion. Each clarifier will be equipped with a spiral scraper mechanism and a dedicated diaphragm pump for scum pumping.

Settled mixed liquor will be conveyed from the bottom of clarifiers to a waste activated sludge (WAS) and RAS pump station. The pumps will be located on a common suction manifold, with valves provided to dedicate a RAS pump to each clarifier. A single pump will handle WAS for all three clarifiers.

Odor control has been evaluated as an additive alternate in the CDR and in the opinions of probable construction costs. Odor control for Alternative 1 would include covering the Intermediate Pump Station and the two new bioselectors, providing ductwork for foul air conveyance, and bioscrubbers to treat the foul air. **Table 6-2** summarizes the proposed process unit improvements included in Alternative 1.

Table 6-2 Summary of Improvements – Alternative 1

Parameter	Unit	Value
BIOSELECTORS		
Number of bioselectors	EA	9
Cells per bioselector	EA	3
Bioselector volume, each unit	MG	0.37
Number of mixers, total	EA	9
Mixer horsepower, each unit	hp	2.0

Table 6-2 Summary of Improvements – Alternative 1, continued

Parameter	Unit	Value
AERATION BASINS		
Number of basins	EA	3
Total volume, each basin (swing zone aerobic/swing zone anaerobic)	MG	8.24/7.47
Diffuser type	--	Coarse Bubble
Blower type	--	Centrifugal
Number of blowers, total (duty/standby)	EA	4/1
Blower horsepower, each unit	hp	1000
Blower capacity, each unit	scfm	19,200
SECONDARY CLARIFIERS		
Number of clarifiers	EA	3
Diameter	ft	135
Sidewater depth	ft	18
Solids loading rate (average/max day)	lb/d/sf	19.3/30.5
RAS PUMPING		
Number of pumps (duty/standby)	EA	3/1
Pump horsepower, each unit	hp	75
Pump capacity, each pump	gpm	5,600
WAS PUMPING		
Number of pumps (duty/standby)	EA	1/1
Pump horsepower, each unit[1]	hp	50
Pump capacity, each unit	gpm	1,300

1. Assumes 24 hours per day wasting.

Drawing GS-C-6 provides a site plan of the proposed improvements included in Alternative 1 and **Drawing GP-G-14** presents the corresponding Process Flow Diagram (PFD). **Drawings I-2** through **I-6** present the Process and Instrumentation Diagrams (P&IDs) for the proposed improvements included in Alternative 1.

6.7.2 Structural Considerations – Existing Aeration Basins

The structural modifications at the existing aeration basins include the addition of mixers, davit cranes to lift the mixers and wall penetrations into the pipe gallery. Preliminary analysis of the existing walkways indicate there are options which are structurally viable to accommodate the mixers and davit cranes. The most likely option will be to reduce the width of the walkway and mount the davit cranes directly on top of the existing wall. The walkway itself has very little capacity to support additional loads without the addition of a support below, extending to the foundation. Without additional support, the davit crane capacity will be limited to 500 pounds.

6.7.3 Civil and Geotechnical Improvements

6.7.3.1 Site Grading and Drainage

Alternative 1 involves the filling of approximately 6.5 acres of the site west of the Biotowers. This will necessitate the extension of the main 36-inch storm drain outlet pipe approximately 500 feet to the southwest beyond the proposed fill area.

The proposed fill area will be investigated for the presence of wetlands to determine if mitigation efforts will be required. The fill area will require an additional 120,000 to 150,000 cubic yards of engineered fill.

6.7.3.2 Access Drives

In addition to the drive relocation associated with the PAA Contact Tank, Alternative 1 includes the addition of approximately 2,100 linear feet of new access drives around the proposed treatment facilities.

6.7.3.3 Geotechnical Investigations

The geotechnical investigation for Alternative 1 is estimated to require approximately seventy-five (75) soil borings, summarized in **Table 6-3**. In addition to these borings, geotechnical investigations of any proposed borrow areas will be required.

Table 6-3 Geotechnical Boring Requirements – Alternative 1

Boring Locations	Estimated Number of Borings	Estimated Depth (feet)
At Proposed Structures/Buildings	44	30 – 100
At Proposed Pipes	18	10 – 20
In Existing Pavement	7	5
In Proposed Pavement	4	5

6.7.4 Yard Piping Improvements

6.7.4.1 Subsurface Utility Engineering

GPR for this Alternative will be broken down by major structures to be constructed. Size of the areas to be explored are as follows:

- Anaerobic Selector – approximately 4 acres
- Secondary Clarifiers – approximately 8 acres
- PAA Contact Tank – approximately 2 acres

Drawing GS-C-7 identified thirty-three (33) Level A locales. For budgeting purposes it is recommended that fifty (50) locales be allocated for this Alternative.

6.7.4.2 Piping Modifications

Piping modifications will include, but are not limited to, cutting, capping, removal, abandonment, relocation, tapping and connecting. **Drawing GS-C-7** presents the proposed yard piping improvements listed below.

Anaerobic Selector Area

- Remove and replace 100 feet 2.5-inch PVC water line
- Remove 50 feet of 6-inch PVC water line and replace with 65 feet of 6-inch PVC
- Remove 510 feet of 18-inch ductile iron sludge forcemain and replace with 550 feet of 18-inch PVC
- Remove 690 feet of 24-inch ductile iron return sludge line and replace with 710 feet of 24-inch ductile iron. Bedding for these pipes will require approximately 210 cubic yards of flowable fill. This work would also require approximately 340 feet of plywood sheeting to protect and not disturb the existing 24-inch sanitary line
- Cut and cap 102-inch PCCP
- Connect to existing 102-inch PCCP and install approximately 80 feet of 102-inch PCCP to the new Intermediate Pump Station Junction Box
- Install 250 feet of 84-inch influent PCCP from the Intermediate Pump Station Junction Box to the proposed Aerobic Basin Flow Splitter Box

Secondary Clarifier Area

- Install 75 feet of 48-inch AA-SST
- Install 560 feet of 42-inch SCE-PCCP
- Install 200 feet of 54-inch SCE-PCCP
- Install 360 feet of 48-inch RAS-DIP
- Install 1450 feet of 54-inch MLSS-PCCP

PAA Contact Tank Area

- Install 630 feet of 66-inch SCE-PCCP
- Install 300 feet of 84-inch SCE-PCCP
- Install 400 feet of 102-inch EFF-PCCP

It is preferable to not disturb existing gravity lines, and while it is assumed at this time that existing gravity lines will not be disturbed, once utility locales and final pipe routing are completed relocation and/or rerouting of existing gravity lines may be required.

6.7.4.3 Minimum Cover

Minimum cover for all pipe shall be 36 inches. Table 6-4 provides minimum cover to overcome buoyancy for various pipes where calculations indicate a required depth greater than 36 inches.

Table 6-4 Minimum Cover for Yard Piping – Alternative 1

Nominal Size (inches)	Material	Minimum Cover of Saturated Soil (inches)
48	SST	44.1
85	PCCP	40.7
114	PCCP	57.4

6.7.5 Electrical

The electrical load for the proposed Alternative 1 improvements is estimated to be 6,000 kVA. Power to the new process equipment will be delivered by new 23kV distribution loops originating from the new substation. The new distribution loops will include one normal circuit and one emergency circuit for redundancy.

The electrical system for the new treatment train blowers (five 1,000 hp units) consists of two 5,000 kVA , 23 kV-4160 V, pad-mounted transformers located outside the proposed blower building and one a 4160V, 1,200A MCC with a main-tie-main configuration. The electrical room will be air conditioned to ensure performance of the electrical and control equipment located inside.

A second electrical system, consisting of two 1,500kVA, 23kV-480Y/277V, pad-mounted transformers and a 480Y/277V, 2,000A MCC with a main-tie-main configuration located inside the blower building, will be provided for all other mechanical equipment associated with the Alternative 1 improvements. These equipment include mixers and channel air blowers in the anaerobic selectors for the existing train, mixers at the swing zones for the existing aeration basins, mixers in the anaerobic selector for the new treatment train, mixers in the swing zones for the new treatment train, the channel air blowers for the new treatment train, the clarifier drives and scum pumps for the secondary clarifiers in the new treatment train, RAS WAS pumps for the new treatment train and the PAA disinfection facility. A 75 kVA step-down dry-type transformer and a 208Y/120V, 200A panelboard will also be located in the blower building. **Figure 6-1** presents the electrical one-line diagram and **Figure 6-2** presents the electrical site plan for the proposed improvements included in Alternative 1.

6.7.6 Plant Hydraulics

The calibrated hydraulic model for the existing plant was modified to reflect the modifications for Alternatives 1 and 3 at the Maxson WWTP. Both Alternatives were evaluated for the maximum day (MD) design flow of 156 MGD through the entire plant, and a total RAS flow of 47 MGD through the aeration tanks and secondary clarifiers.

All hydraulic modifications for the two design alternatives occur downstream of the Intermediate Pump Station; therefore, the hydraulic model for the front end of the plant (from the Influent Pump Station to the upstream side of Intermediate Pump Station), was modified only to reflect the increased design flow conditions for each. For each alternative, all treatment basins were assumed to be in service for at MD flow and a 30-percent blinding factor was applied to the fine screens.

The following assumptions were made for this analysis:

- Steady state flow conditions exist throughout the plant.

- Dimensions and flow paths in units were constructed as per the contract drawings (1970 through 2011) and input from plant staff.
- Elevations were adjusted per survey data.
- The downstream water surface elevation in the Cooling Channel at the plant's outfall was assumed to be 206.00 ft (NAVD88 datum). This level was determined to be the highest water surface elevation that would allow the MD flow to flow by gravity in each design alternative without overflowing basins or requiring use of the Effluent Pump Staiton.
- The water surface elevation in the Intermediate Pump Station influent wet well was assumed to be 215.64 ft, the level observed during the first round of field stress testing at the plant on July 8, 2015. It is understood that this level is variable and can be modified based on operating conditions at the pump station.

For Alternative 1, hydraulics were assessed for a maximum day (MD) design flow of 156 MGD through the entire plant, and RAS flows of 33 MGD and 14 MGD through the aeration tanks and secondary clarifiers of the existing North Treatment Train and proposed South Treatment Train, respectively. The preliminary hydraulic profile is included as **Drawing GP-G-20** and **GP-G-21**.

Flow follows the existing plant's flow path from the Comminuter Influent Chamber to the upstream side of the Intermediate Pump Station. A proposed Flow Diversion Box built adjacent to the north wall of the Intermediate Pump Station effluent box would then split flow downstream of the pump station, sending approximately 71-percent of the flow to the North Treatment Train, including a new Anaerobic Selector, the existing Flow Control Structure, the existing Aeration Tanks and the existing Secondary Clarifier batteries. The remaining 29-percent of flow would be diverted to the proposed south treatment train, including three new Aeration Tanks, and three new Secondary Clarifiers.

Effluent from the Secondary Clarifiers in the existing North Train and the proposed South Train would combine in the influent junction box at the upstream end of the proposed PAA Contact Basin. From here, the combined flow would split between two contact channels, and then recombine at the downstream end of the basin before flowing back to the original plant effluent piping downstream of the existing Bypass Junction Box.

For Alternative 1, several hydraulic modifications would be built to accommodate the MD flow through the new treatment units on the North Train, including the following:

- A new 102-inch pipe will carry the North Train's flow from the Flow Diversion Structure to the Anaerobic Selector's influent chamber. The existing 102-inch pipe at the Intermediate Pump Station's effluent box would remain in place, isolated by a gate, which could be opened to bypass the Anaerobic Selector, if necessary.
- The existing RAS lines would be diverted from their existing path to the Anaerobic Selector's influent chamber, where it would combine with influent from the Flow Diversion Structure.
- Two new 84-inch pipes will connect the Anaerobic Selector's effluent chamber and would carry the MLSS flow to the existing 102-inch pipe, upstream of the existing Flow Control Structure.
- Downstream of the existing Secondary Clarifier batteries, the Parshall Flume Structure would be modified by demolishing the flume and connecting the effluent culvert piping to the

Secondary Clarifier Junction Chamber, renamed the Clarifier Effluent Junction Box (see **Section 7** for further information).

- Due to hydraulic constrains observed in the existing Chlorine Contact Distribution Box, this structure would be completely replaced by a larger Clarifier 5N-S Junction Box.
- The existing Bypass Junction Box would be converted into a two-chamber Disinfection Junction Box structure to divert the Secondary Clarifier from the North Train to the PAA Contact Basin.

6.8 Alternative 3 Improvements

6.8.1 Process Improvements

The existing biotowers are currently equipped with wood slat media with a specific surface area of approximately 14 ft^2/ft^3, with volumetric loading on the order of 20 lb BOD_5/1,000 ft^2/day of media surface based on the current maximum month design condition. This volumetric loading is considered very high for the existing biotower media. The existing media is also in poor condition. Considering both these conditions, it is recommended that the existing media be replaced. Plastic module media, with a specific surface area of approximately 30 ft^2/ft^3, would be more efficient and provide over twice the biofilm area and treatment capacity as the existing wood media.

The biotower effluent is then further treated in the aeration basins. The aeration basin capacity would need to be increased in order to treat the organic loading associated with the desired 90 MGD flows. The capacity would be increased through the construction of a new RAS reaeration basin. This new basin would receive RAS and condition the sludge before coming into contact with effluent from the biotowers. This conditioning minimizes the concentration of mixed liquor suspended solids (MLSS) in the secondary clarifier influent.

The proposed RAS reaeration basin would be equipped with a fine bubble diffused air system. The existing blower capacity has been determined to be adequate with no need for additional capacity to handle the new basin. This alternative would also include the construction of two new secondary clarifiers, each designed to match the existing 135-foot diameter clarifiers. These new clarifiers would replace the two existing, non-operational 120-foot diameter clarifiers.

The 1997 *Recommendations for Odor and Corrosion Control for the Memphis Wastewater Collection and Treatment System* identified the biotowers as generating liquid process odors that escape the plant boundary. It is recommended to increase the ventilation for the new plastic media to maximize soluble BOD_5 removal and either divert the air to a stack, appropriately sized to reduce the likelihood of offsite odor complaints or, as an additive alternate, to address odor removal at the Biotowers. These items are identified as additive alternates in this section and in subsequent opinions of probable construction cost. These additive alternate items include:

- A new biofilter system consisting of a completely enclosed, concrete structure. Four biofilter cells would be provided with plastic media. Air entering the system is preconditioned using a cross-flow humidifier. The remaining odorous compounds are biologically oxidized to carbon dioxide, water and inorganic salts when passing through the media. Clean air is discharged to the atmosphere via an exhaust fan.
- Installation of covers and an air recycle system on each biotower. The covers would include dampers to allow in fresh make-up air.

- New water distribution arms.
- An interior coating system or improved mortor to protect against corrosion.
- FRP ductwork around each biotower to allow for even draw-off of the air connected to both the recycle systems and the proposed odor control system.

Table 6-5 summarizes the proposed process unit improvements included in Alternative 3.

Table 6-5 Summary of Improvements – Alternative 3

Parameter	Unit	Value
BIOTOWERS		
Number of biotowers, total	EA	6
Number of biotower air recycle blowers, total (duty/standby)	EA	6/2
Air recycle blower capacity, each unit	cfm	21,000
BIOFILTERS		
Number of biofilters	EA	1
Cells per biofilter	EA	4
Media volume, total	cf	105,000
Number of crossflow humidifiers, total	EA	4
Number of recirculation pumps, total	EA	4
Recirculation pump horsepower, each unit	hp	5
Number of exhaust fans, total	EA	4
Exhaust fan horsepower, each unit	hp	100
Exhaust fan capacity, each unit	cfm	45,000
RAS REAERATION BASIN		
Number of basins	EA	1
Total volume	MG	3.5
Diffuser type	--	Fine Bubble
SECONDARY CLARIFIERS		
Number of clarifiers	EA	2
Diameter	ft	135
Sidewater depth	ft	18
Solids loading rate (average/max day)	lb/d/sf	19.7/29.2
RAS PUMPS		
Number of pumps (duty/standby)	EA	2/2
Pump capacity, each unit	gpm	6,250
Pump horsepower, each unit	hp	100

Drawing GS-C-9 provides a site plan of the proposed improvements included in Alternative 3 and **Drawing GP-G-15A and GP-G-15B** present the corresponding Process Flow Diagrams for the additive alternates and the base bid. **Drawings I-7** through **I-10** present the Process and Instrumentation Diagrams for the proposed improvements included in Alternative 3.

6.8.2 Structural Considerations – Existing Biotowers

The structural modifications to the bottoms of the structures is limited by the presence of 14-inch by 18-inch columns around the perimeter of the bottom. The bottom 4 feet, 6 inches of the walls are 14 inches thick, and are 8 inches thick above this point. The column reinforcing only extends approximately 2 feet from the bottom. There is no practical way to extend the column reinforcing while maintaining the stability of the structure. Lightweight grout fill or lightweight "geofoam" with a concrete cap can be added to the bottom. However this will reduce the area of the openings around the perimeter.

Concrete rehabilitation of the biotowers will be needed. The visible portions of the concrete appear to have moderate to severe biological attack. The exposed concrete at the top of the walls has exposed aggregate and severe loss of cement paste. We anticipate the condition of the concrete at the top of the structure is worse than the condition at the bottom. The recommendation is to clean and remove all unsound concrete and restore the concrete to its original thickness. We anticipate an average depth of concrete restoration to be 1". The additive alternate would include using a structural repair mortar with a calcium aluminate cement product such as Sewpercoat by Kerneos. Calcium Aluminate cements have both structural properties of Portland cement and are able to resist corrosion from acids down to a pH of 4.

The additive alternate for Alternative 3 also includes adding an aluminum dome a protective coating applied to the exposed surfaces. Preliminary analysis of the addition of the aluminum dome cover indicates the structure has adequate strength to support the cover and the associated increased wind and seismic loads.

6.8.3 Civil and Geotechnical Improvements

6.8.4.1 Site Grading and Drainage

Alternative 3 involves the construction of facilities within the existing filled areas of the plant site. No significant filling or grade changes will be required, nor will the existing drainage patters or drainage infrastructure be significantly altered.

6.8.4.2 Access Drives

The only changes to existing plant access drives will be the drive relocation and/or reconstruction associated with the PAA Contact Tank and delivery route.

6.8.4.3 Geotechnical Investigations

The geotechnical investigation for Alternative 3 is estimated to require approximately sixty (60) soil borings, as summarized in **Table 6-6**.

Table 6-6 Geotechnical Boring Requirements – Alternative 3

Boring Locations	Estimated Number of Borings	Estimated Depth (feet)
At Proposed Structures/Buildings	34	30 – 100
At Proposed Pipes	16	10 – 20
In Existing Pavement	6	5

6.8.5 Yard Piping Improvements

6.8.5.1 Subsurface Utility Engineering

GPR for this Alternative will be broken down by major structures to be constructed. Size of the areas to be explored are as follows:

- Biotowers 1 through 4 – approximately 4 acres
- Biotowers 5 and 6 – approximately 2 acres
- RAS Reaeration Basin – approximately 2 acres
- PAA Contact Tank – approximately 3 acres

Drawing GS-C-10 identifies thirty-one (31) Level A locales. For budgeting purposes it is recommended that fifty (50) locales be allocated for this Alternative.

6.8.5.2 Piping Modifications

Piping modifications will include, but are not limited to, cutting, capping, removal, abandonment, relocation, tapping and connecting. **Drawing GS-C-10** presents the proposed yard piping improvements listed below.

Biotowers 1 through 4, 5 and 6 Areas (lengths are doubled to account for recycle and return lines)

- Install 2,400 feet of 54-inch OAD-FRP
- Install 4,900 feet of 32-inch OAD-FRP
- Cut and cap 102-inch PCCP
- Install 80 feet of 102-inch PCCP connecting the existing 102-inch PCCP and the proposed Intermediate Pump Station Diversion Box

RAS Reaeration Basin Area

- Remove 1000 feet of 24-inch RAS-DIP
- Remove 500 feet of 18-inch sludge DIP
- Install 1400 feet of 18-inch sludge-DIP
- Tie in the diffuse aeration system in the new basin to the existing air piping

PAA Contact Tank Area

- Cut and cap 72-inch PCCP clarifier effluent
- Install 130 feet of 72-inch PCCP and tie into existing 72-inch PCCP
- Install 1,500 feet of 36-inch RAS-DIP
- Install 400 feet of 102-inch EFF-PCCP

- Install 300 feet of 84-inch SCE-PCCP

It is preferable to not disturb existing gravity lines, and while it is assumed at this time that existing gravity lines will not be disturbed, once utility locales and final pipe routing are completed relocation and/or rerouting of existing gravity lines may be required.

6.8.5.3 Minimum Cover

Minimum cover for all pipe shall be 36 inches. **Table 6-7** provides minimum cover to overcome buoyancy for various pipes where calculations indicate a required depth greater than 36 inches.

Table 6-7 Minimum Cover for Yard Piping – Alternative 3

Nominal Size (inches)	Material	Minimum Cover of Saturated Soil (inches)
54	FRP	47.5
102	PCCP	50.7

6.8.6 Electrical

The electrical load for the proposed Alternative 3 improvements is estimated to be 2,250kVA. Power to the new process equipment will be delivered through new 23 kV distribution loops originating from the new substation. The new distribution loops will include one normal circuit and one emergency circuit for redundancy.

The electrical system for the proposed biofilter facility consists of two 1,500 kVA, 23 kV-480Y/277 V, pad-mounted transformers located outside the proposed electrical building, one 480Y/277 V, 2,000 A motor control center (MCC) with a main-tie-main configuration, one 75kVA step-down dry-type transformer and one 208Y/120 V, 200 A panelboard, all of which will be located in the new electrical building. The electrical room will be air conditioned to ensure performance of the electrical and control equipment located inside.

The electrical system for the proposed RAS Pump Station consists of two 500 kVA, 23 kV-480Y/277 V, pad-mounted transformers and a 480Y/277V, 800A motor control center (MCC) in NEMA 3R enclosure with main-tie-main configuration located outside the RAS Pump Station.

Figure 6-3 presents the electrical one-line diagram and **Figure 6-4** presents the electrical site plan for the proposed improvements included in Alternative 3.

6.8.7 Hydraulic Analysis

The basis for analysis described in Alternative 1 is similar for Alternative 3. The Alternative 3 hydraulics were assessed for a MD design flow of 156 MGD through the entire plant and a RAS flow of 47 MGD between the existing aeration tanks and the secondary clarifiers. **Drawing GP-G-22** shows the Hydraulic Profile of this design alternative at MD flow.

Similar to Alternative 1, Alternative 3's flow follows the existing plant's flow path from the Comminuter Influent Chamber to the upstream side of the Intermediate Pump Station. A new Flow Structure built adjacent to the north wall of the Intermediate Pump Station effluent box will convey flow through a new section of 102-inch pipe before connecting to the existing 102-inch piping upstream of the existing Flow Control Structure. From the Flow Control Structure, flow will follow its existing path to the existing Aeration Tanks. Downstream of the existing Aeration Tank batteries,

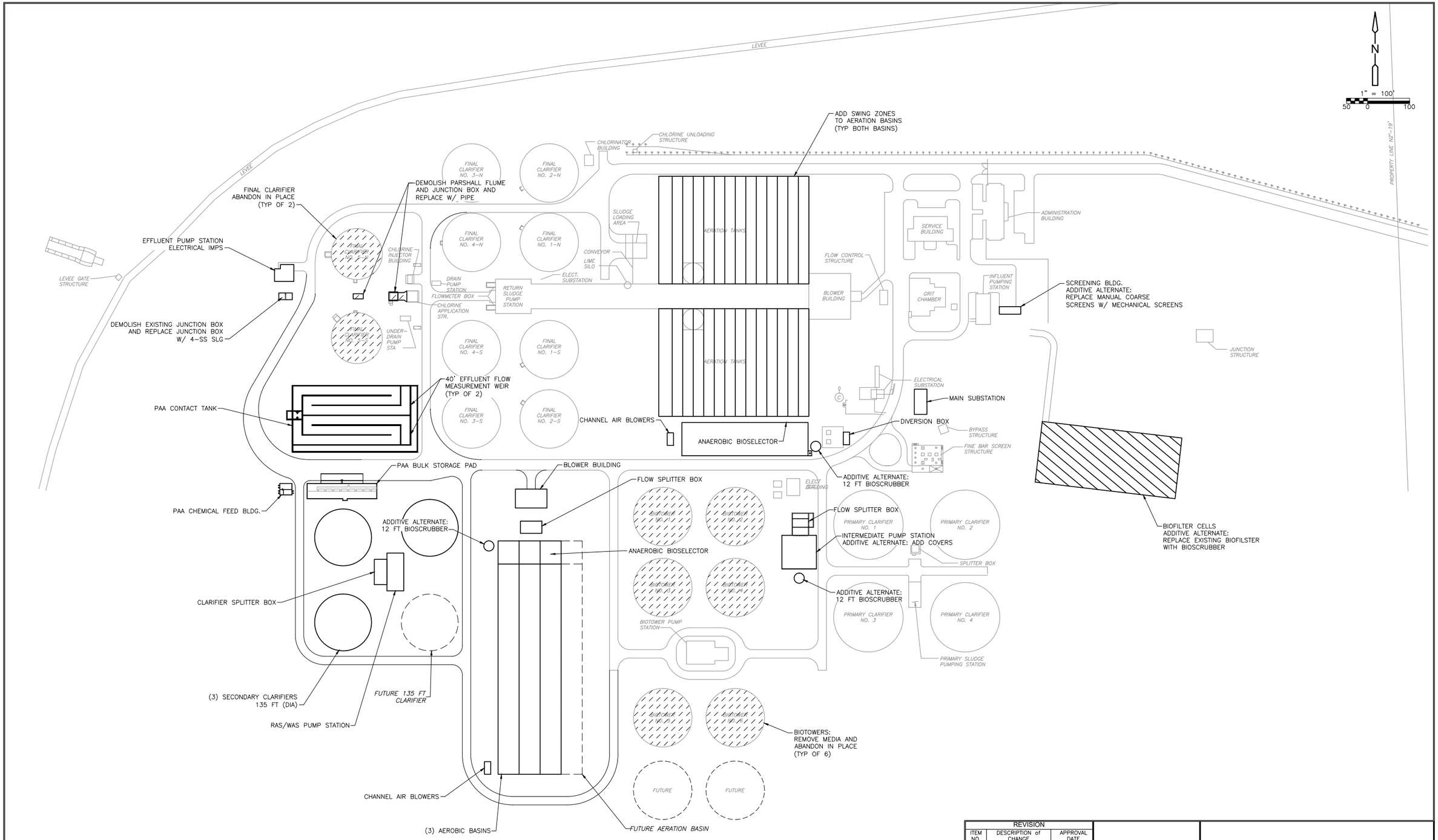
mixed liquor flow will then be split between a total of ten Secondary Clarifiers, including the existing eight Secondary Clarifiers and two proposed Secondary Clarifiers.

Effluent from the eight existing Secondary Clarifiers will combine upstream of the modified Parshall Flume Structure in the proposed Clarifier Effluent Junction Box. Effluent from the two proposed Secondary Clarifiers will join the flow path further downstream, at the proposed Clarifer 5N-S Junction Box, where the existing Chlorine Contact Distribution Box is located. From this point on, the combined flow will be conveyed to the proposed Disinfection Junction Box, where it will be diverted to the PAA Contact Basin. Similar to Alternative 1, the combined Secondary Clarifier effluent flow would split the between two contact channels, and then recombine at the downstream end of the basin before flowing back to the original plant effluent piping downstream of the existing Bypass Junction Box.

For Alternative 3, hydraulic modifications are also necessary to accommodate the MD flow through the new treatment units, including the following:

- A new section 102-inch pipe will carry the North Train's flow from the Intermediate Pump Station Flow Structure to the existing 102-inch pipe, upstream of the existing RAS flow junction point.
- Similar to Alternative 1, the Parshall Flume Structure would be modified by demolishing the flume and connecting the effluent culvert piping to the Secondary Clarifier Junction Chamber, renamed the Clarifier Effluent Junction Box.
- The existing Bypass Junction Box would be modified into a two-chamber Disinfection Junction Box structure to divert the Secondary Clarifier from the North Train to the PAA Contact Basin.

See **Section 7** for further information regarding the junction box/parshall flume information.



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PROCESS UPGRADES ALT-1

MEMPHIS, TN

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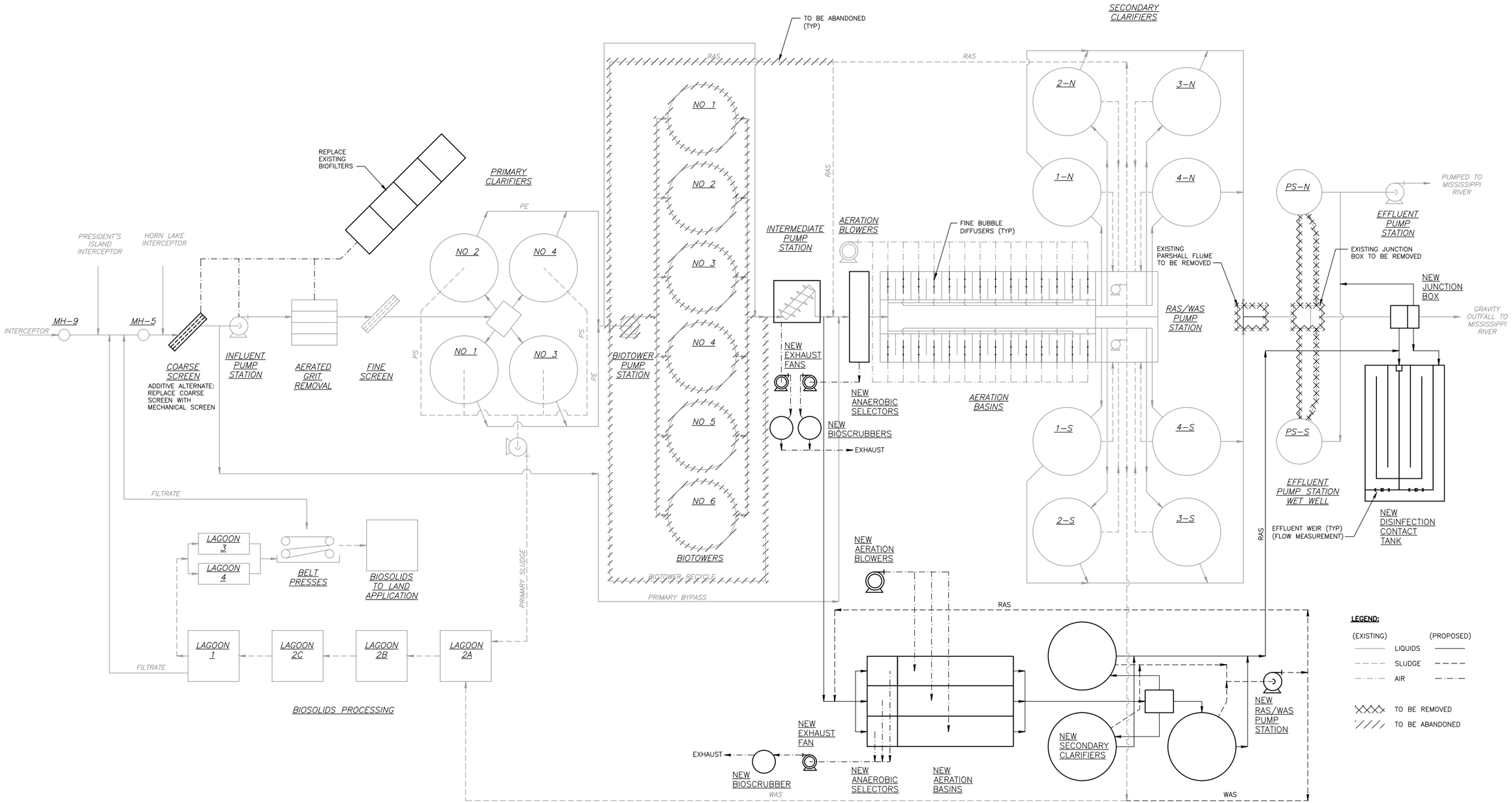

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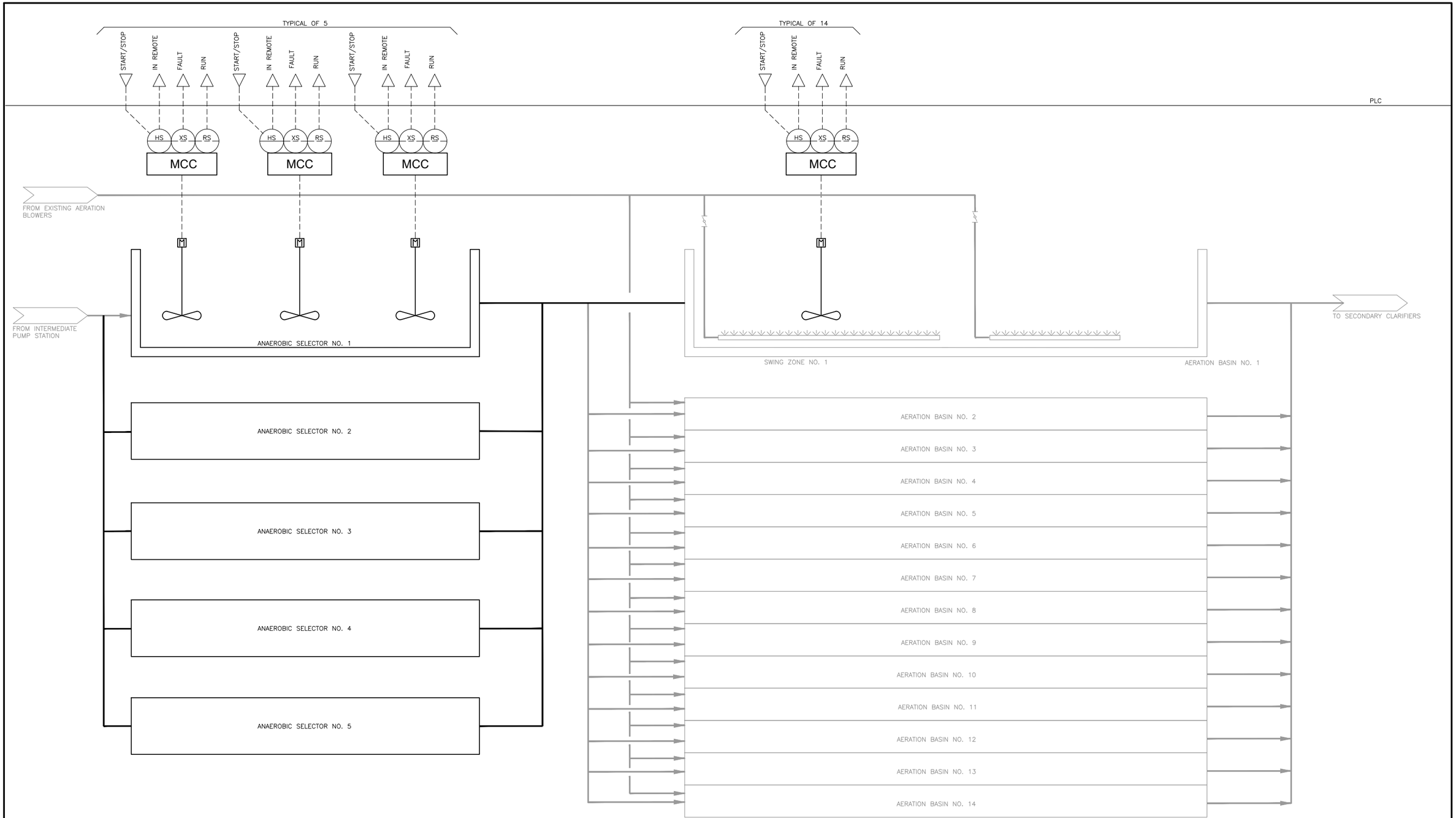

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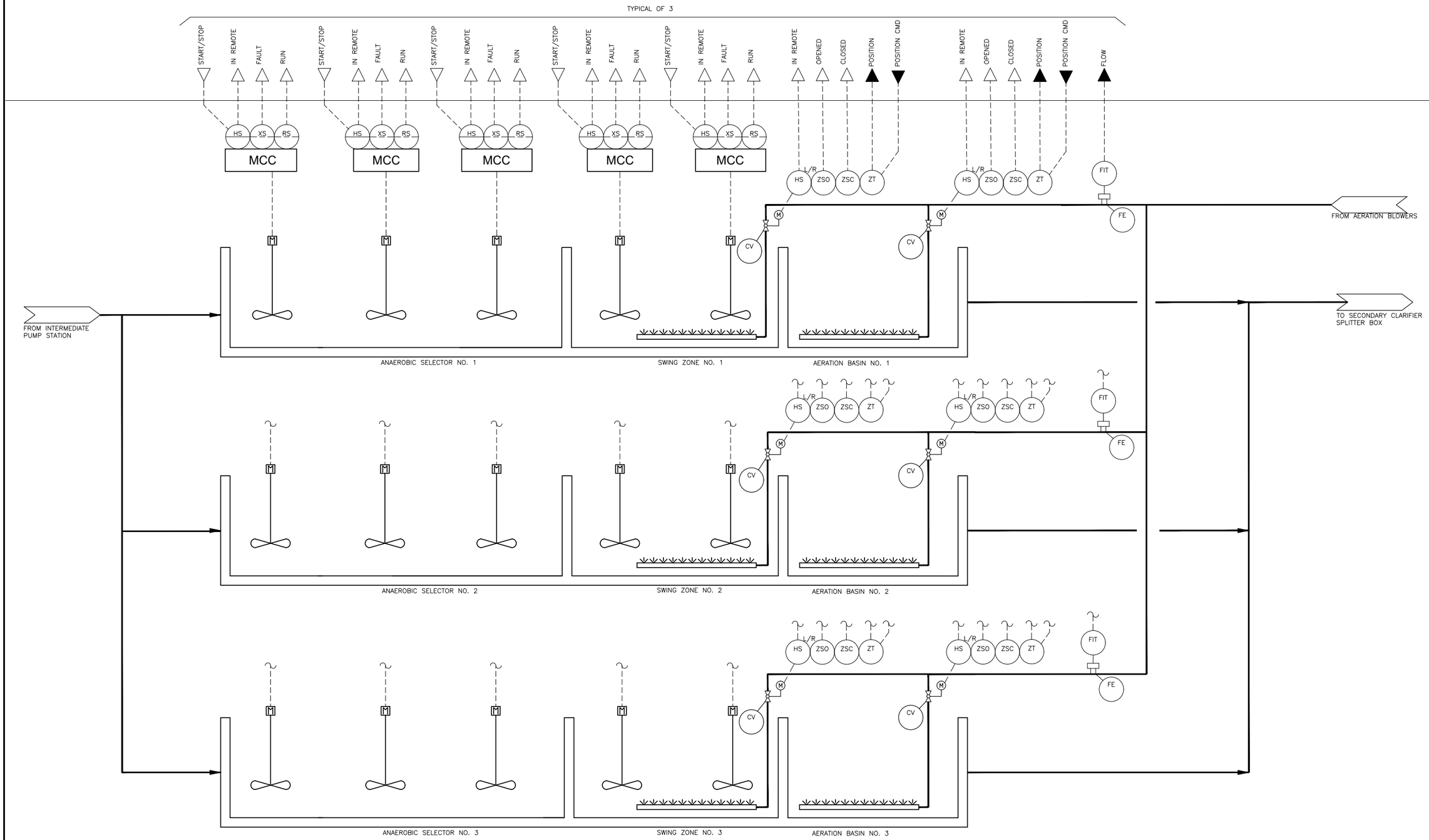

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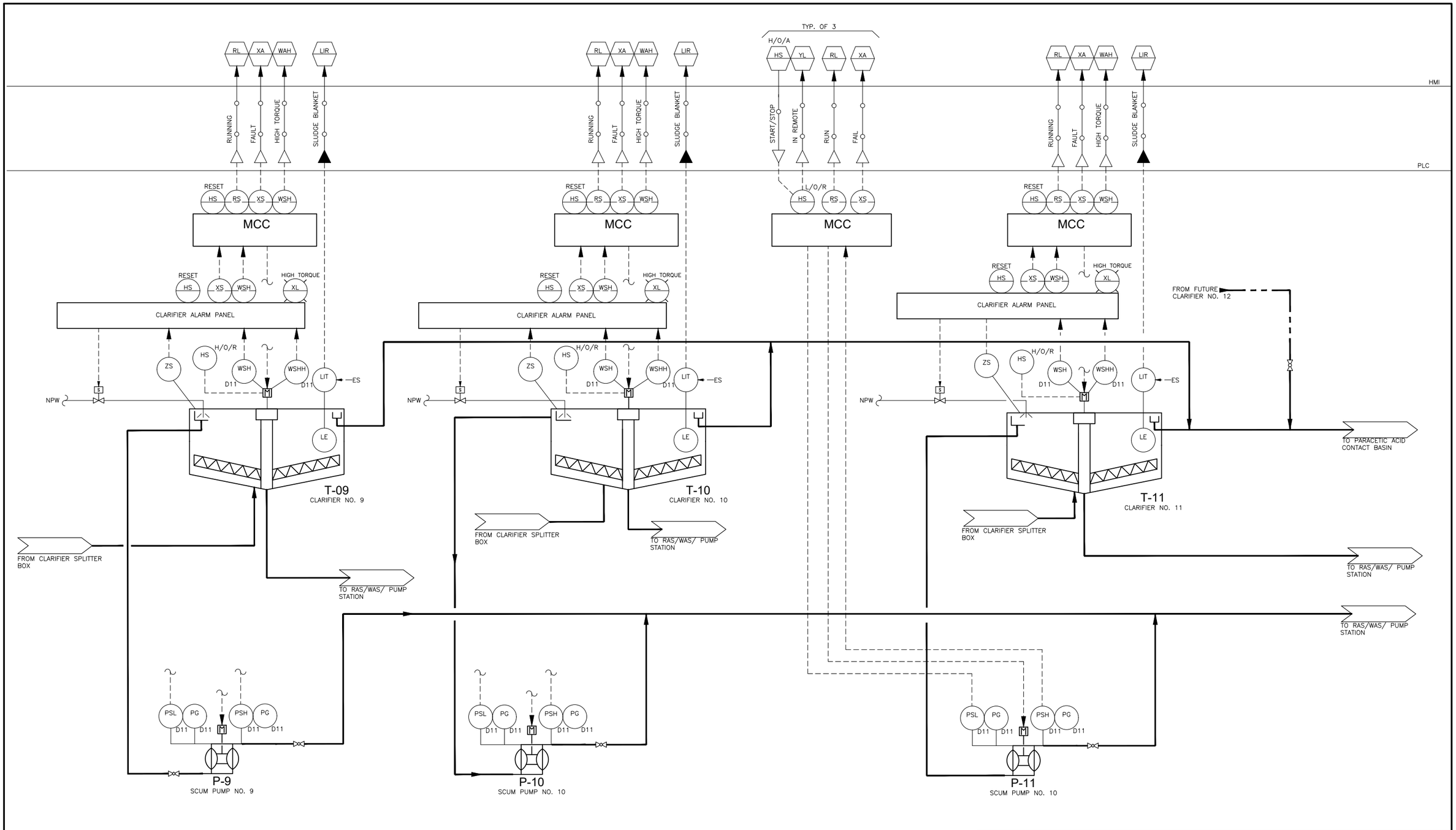

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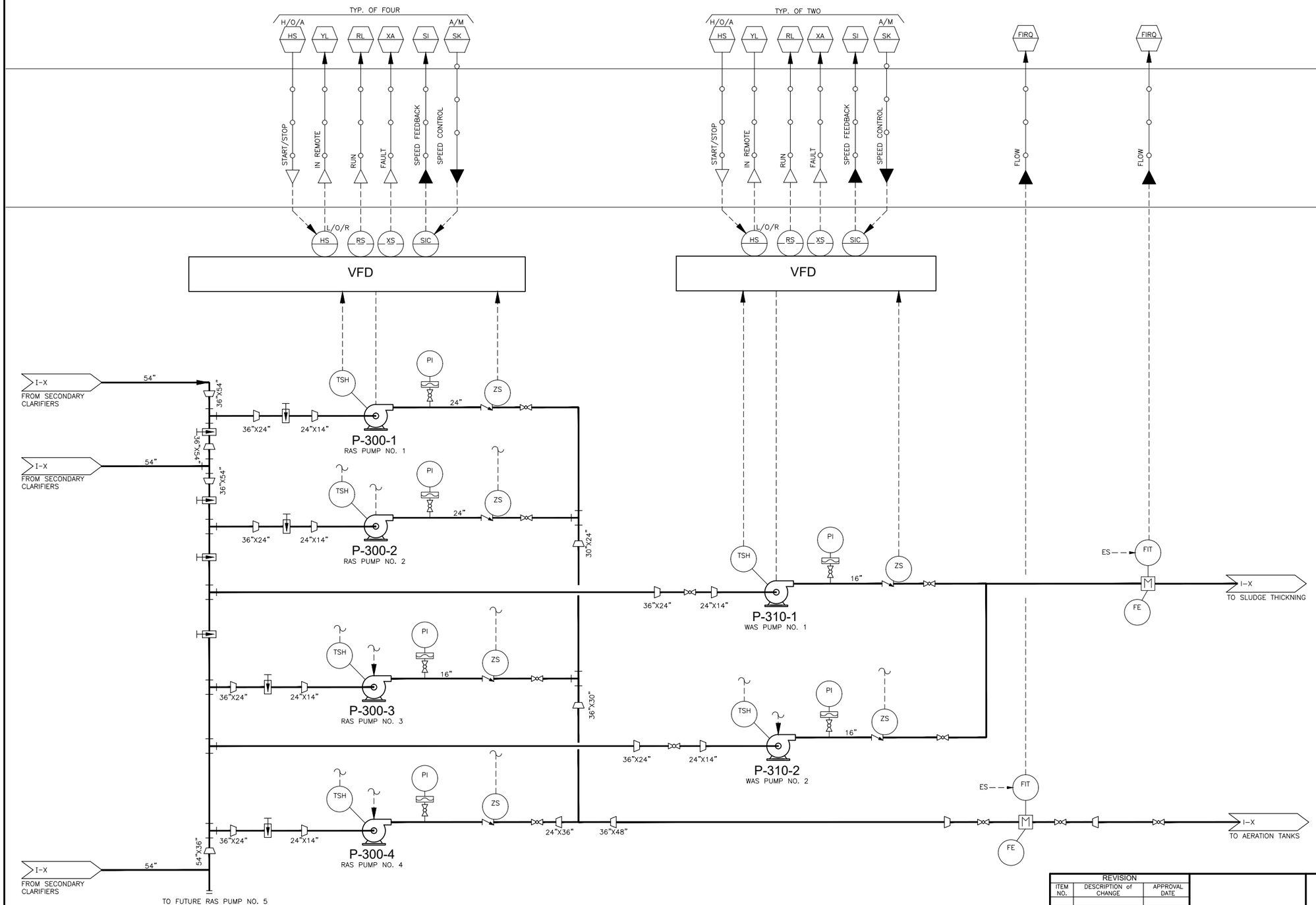

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RAS/WAS PUMP STATION

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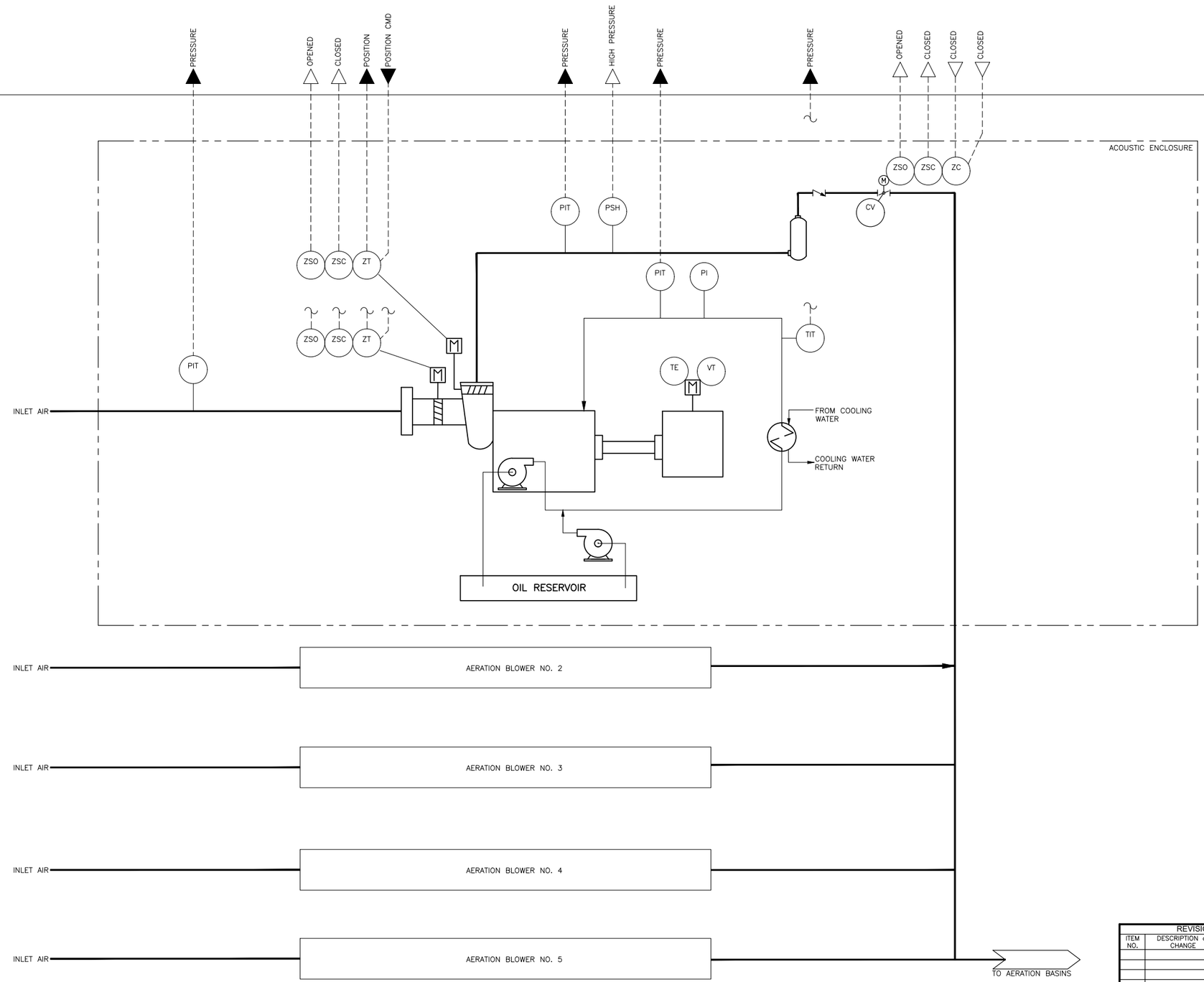

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AERATION BLOWERS

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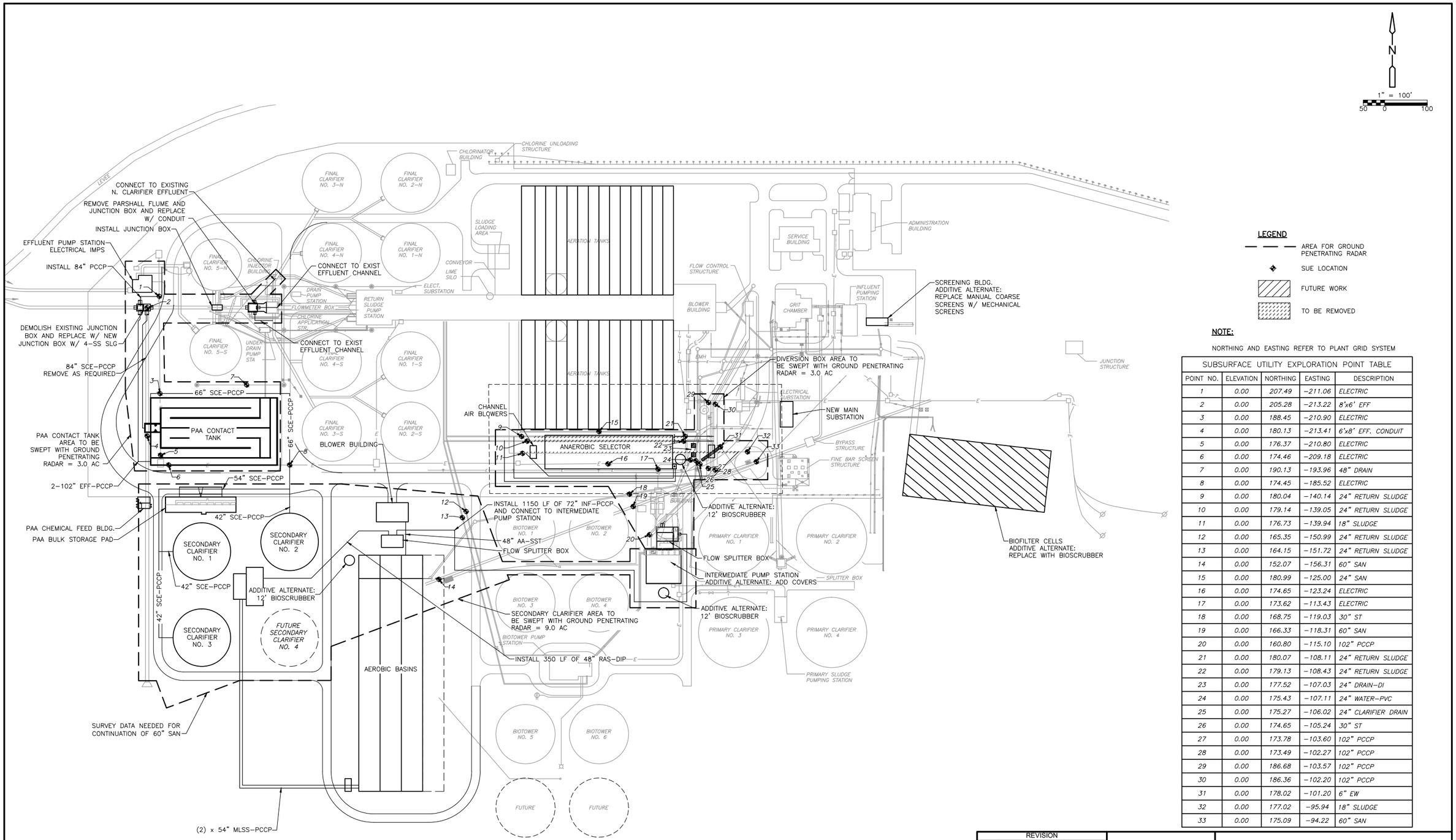

LEGEND

- AREA FOR GROUND PENETRATING RADAR
- SUE LOCATION
- FUTURE WORK
- TO BE REMOVED

NOTE:

NORTHING AND EASTING REFER TO PLANT GRID SYSTEM

SUBSURFACE UTILITY EXPLORATION POINT TABLE

POINT NO.	ELEVATION	NORTHING	EASTING	DESCRIPTION
1	0.00	207.49	-211.06	ELECTRIC
2	0.00	205.28	-213.22	8'x6' EFF
3	0.00	188.45	-210.90	ELECTRIC
4	0.00	180.13	-213.41	6'x8' EFF. CONDUIT
5	0.00	176.37	-210.80	ELECTRIC
6	0.00	174.46	-209.18	ELECTRIC
7	0.00	190.13	-193.96	48" DRAIN
8	0.00	174.45	-185.52	ELECTRIC
9	0.00	180.04	-140.14	24" RETURN SLUDGE
10	0.00	179.14	-139.05	24" RETURN SLUDGE
11	0.00	176.73	-139.94	18" SLUDGE
12	0.00	165.35	-150.99	24" RETURN SLUDGE
13	0.00	164.15	-151.72	24" RETURN SLUDGE
14	0.00	152.07	-156.31	60" SAN
15	0.00	180.99	-125.00	24" SAN
16	0.00	174.65	-123.24	ELECTRIC
17	0.00	173.62	-113.43	ELECTRIC
18	0.00	168.75	-119.03	30" ST
19	0.00	166.33	-118.31	60" SAN
20	0.00	160.80	-115.10	102" PCCP
21	0.00	180.07	-108.11	24" RETURN SLUDGE
22	0.00	179.13	-108.43	24" RETURN SLUDGE
23	0.00	177.52	-107.03	24" DRAIN-DI
24	0.00	175.43	-107.11	24" WATER-PVC
25	0.00	175.27	-106.02	24" CLARIFIER DRAIN
26	0.00	174.65	-105.24	30" ST
27	0.00	173.78	-103.60	102" PCCP
28	0.00	173.49	-102.27	102" PCCP
29	0.00	186.68	-103.57	102" PCCP
30	0.00	186.36	-102.20	102" PCCP
31	0.00	178.02	-101.20	6" EW
32	0.00	177.02	-95.94	18" SLUDGE
33	0.00	175.09	-94.22	60" SAN

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YARD PIPING PLAN ALT-1

MEMPHIS, TN

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DESIGN BY DESIGNBY DATE BY_DATE PROJECT 36694-111641

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DEP. CITY ENGINEER DATE CITY ENGINEER DATE

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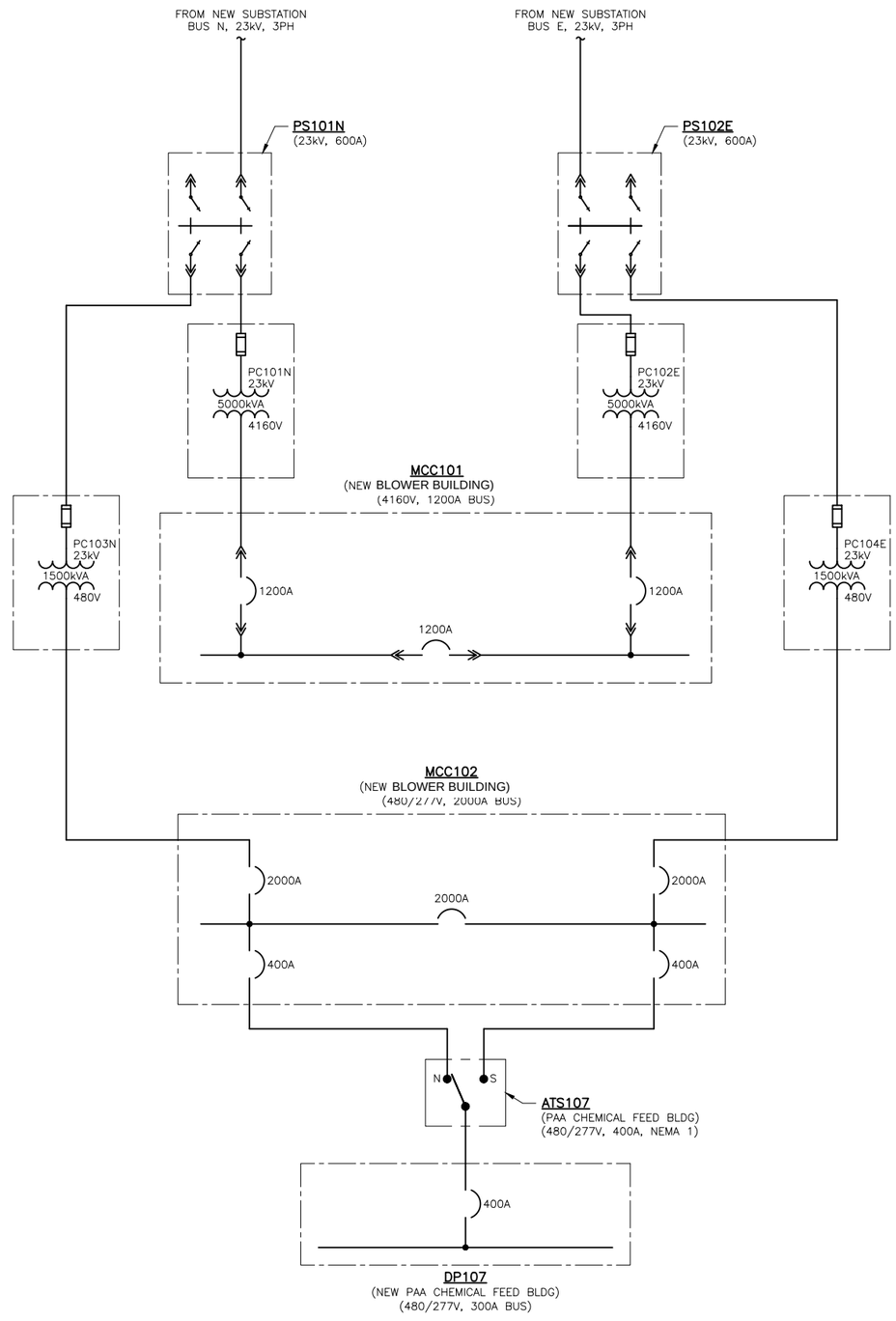

ALTERNATE NO. 1

ONE LINE POWER DIAGRAM

NTS

CDM Smith

Figure 6-1
EPA-HQ-2019-004783 002102
TEMAXSON WWTP
ALTERNATE NO. 1 ONE LINE POWER DIAGRAM
JANUARY 2016

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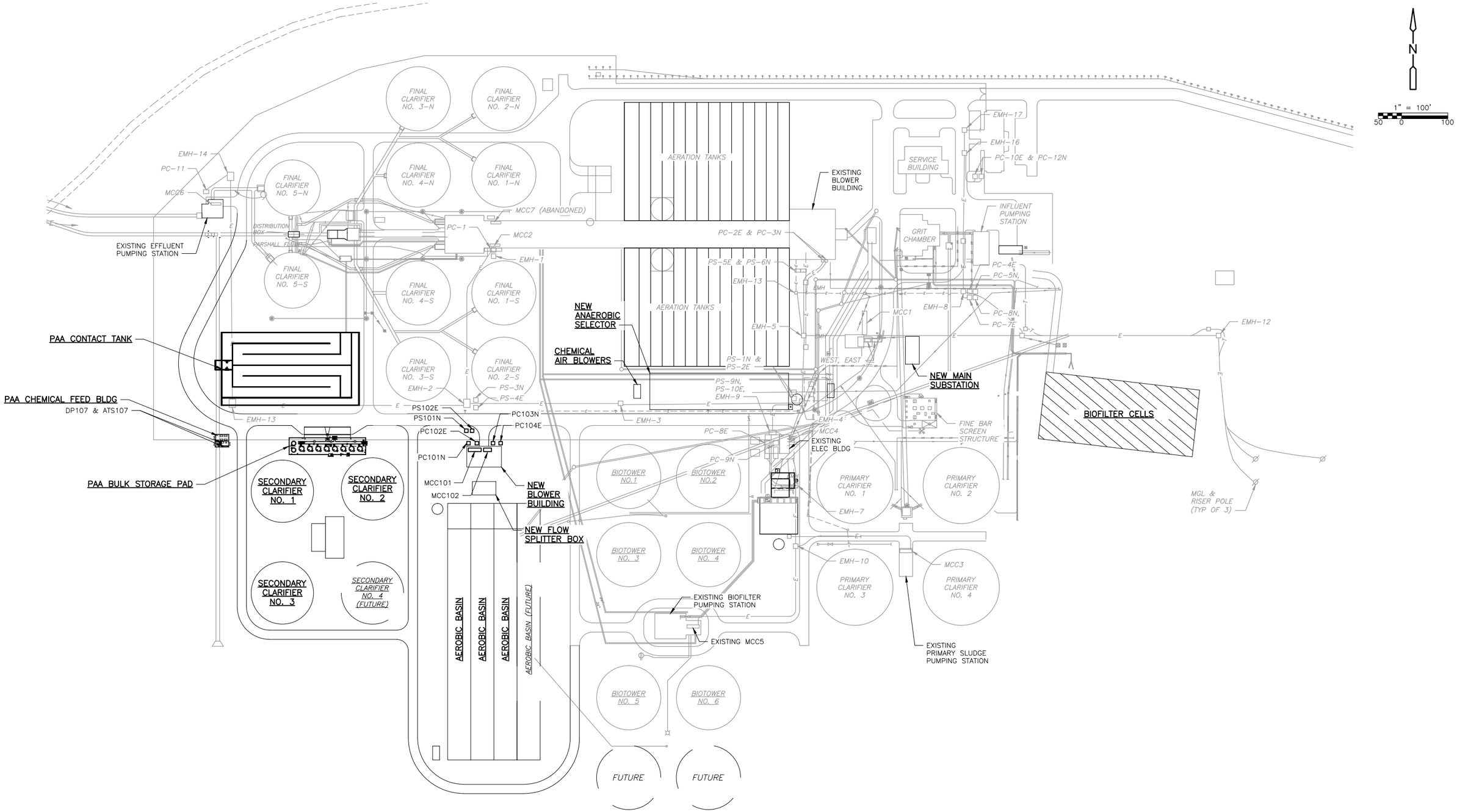
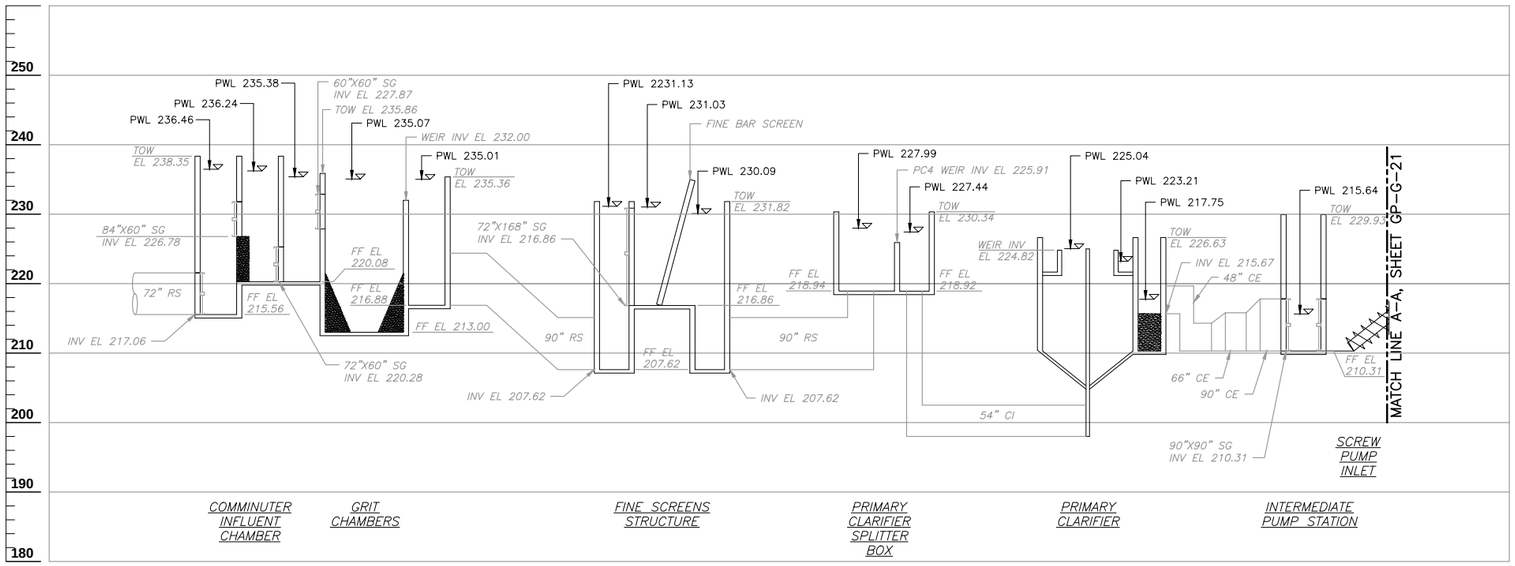


PLAN

CDM Smith

Figure 6-2
EPA-HQ-2019-004783 002103
H.L. MAXSON WWTP
ALTERNATE NO. 1 ELECTRICAL SITE PLAN
JANUARY 2016



PROFILE

NOTES:

1. PEAK WATER LEVELS (PWL) COMPUTED FOR AN ASSUMED 156 MGD TOTAL FLOW.
2. STARTING WATER SURFACE ELEVATION IN INTERMEDIATE PUMP STATION WET WELL ASSUMNED TO BE 215.64 FT.
3. ALL ELEVATIONS REFERENCED TO NAVD88 DATUM.
4. PROFILE ASSUMES ALL PRIMARY CLARIFIERS ARE IN SERVICE.
5. HEADLOSS THROUGH FINE SCREENS CALCULATED WITH A 30% BLINDING FACTOR.

REVISION

ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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CITY OF MEMPHIS

ALTERNATE 1

HYDRAULIC PROFILE I

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	1"=10' (VERT)
DESIGN BY	BAH	DATE	X	PROJECT	36694-111641

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T.E. MAXSON WWTP

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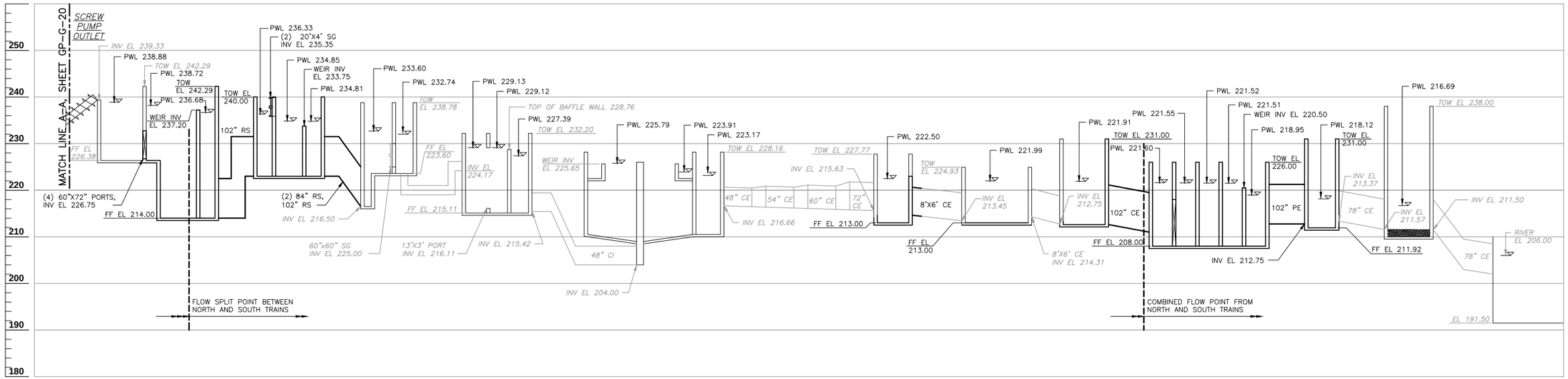
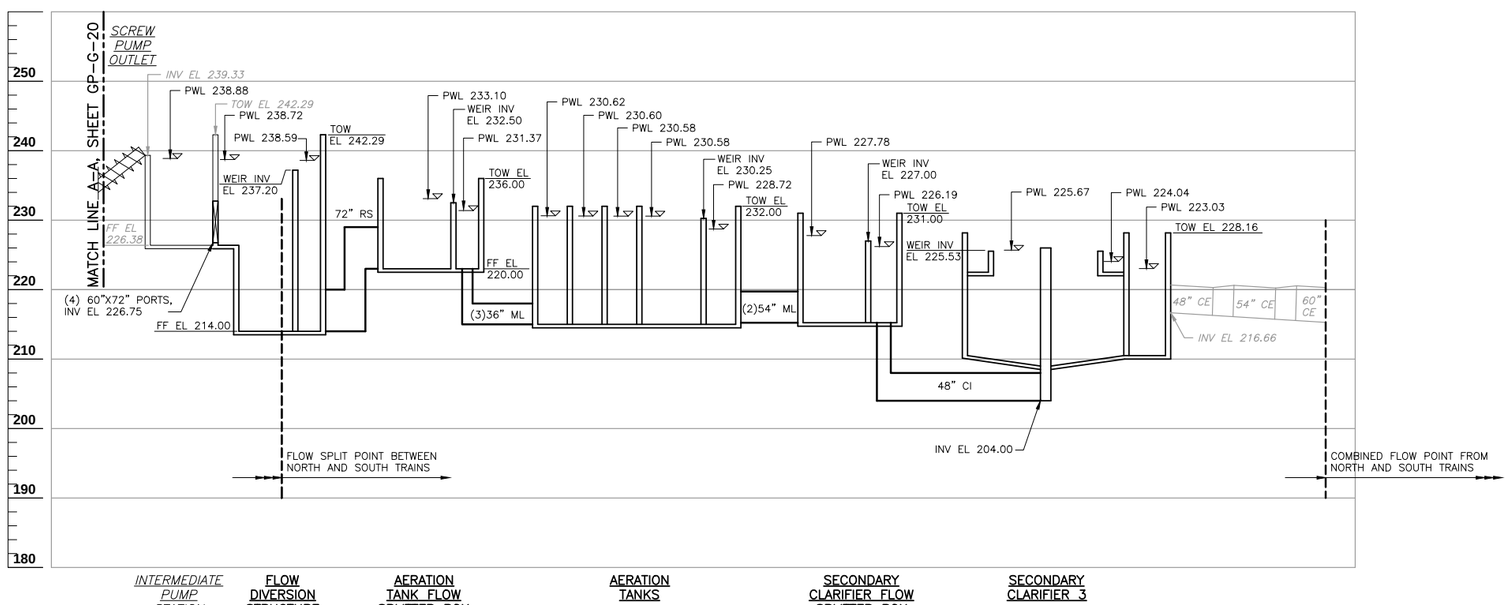


NORTH TRAIN

PROFILE



SOUTH TRAIN

PROFILE

NOTES:

1. PEAK WATER LEVELS (PWL) COMPUTED FOR AN ASSUMED 156 MGD TOTAL FLOW WITH AN ASSUMED 33 MGD RAS FLOW IN THE EXISTING TREATMENT TRAINS AND AN ADDITION 14 MGD RAS FLOW IN THE NEW TREATMENT TRAIN.
2. STARTING WATER SURFACE ELEVATION IN COOLING CHANNEL ASSUMED TO BE 206.00 FT.
3. ALL ELEVATIONS REFERENCED TO NAVD88 DATUM.
4. ALL SECONDARY CLARIFIERS AND AERATION TANKS ARE IN SERVICE.

REVISION

ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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Tel: (901) 322-8710

T.E. MAXSON WWTP

DRAWING: GP-G-21 SHEET OF

CITY OF MEMPHIS

ALTERNATE 1

HYDRAULIC PROFILE II

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	1"=10' (VERT)
DESIGN BY	BAH	DATE	X	PROJECT	36694-111641

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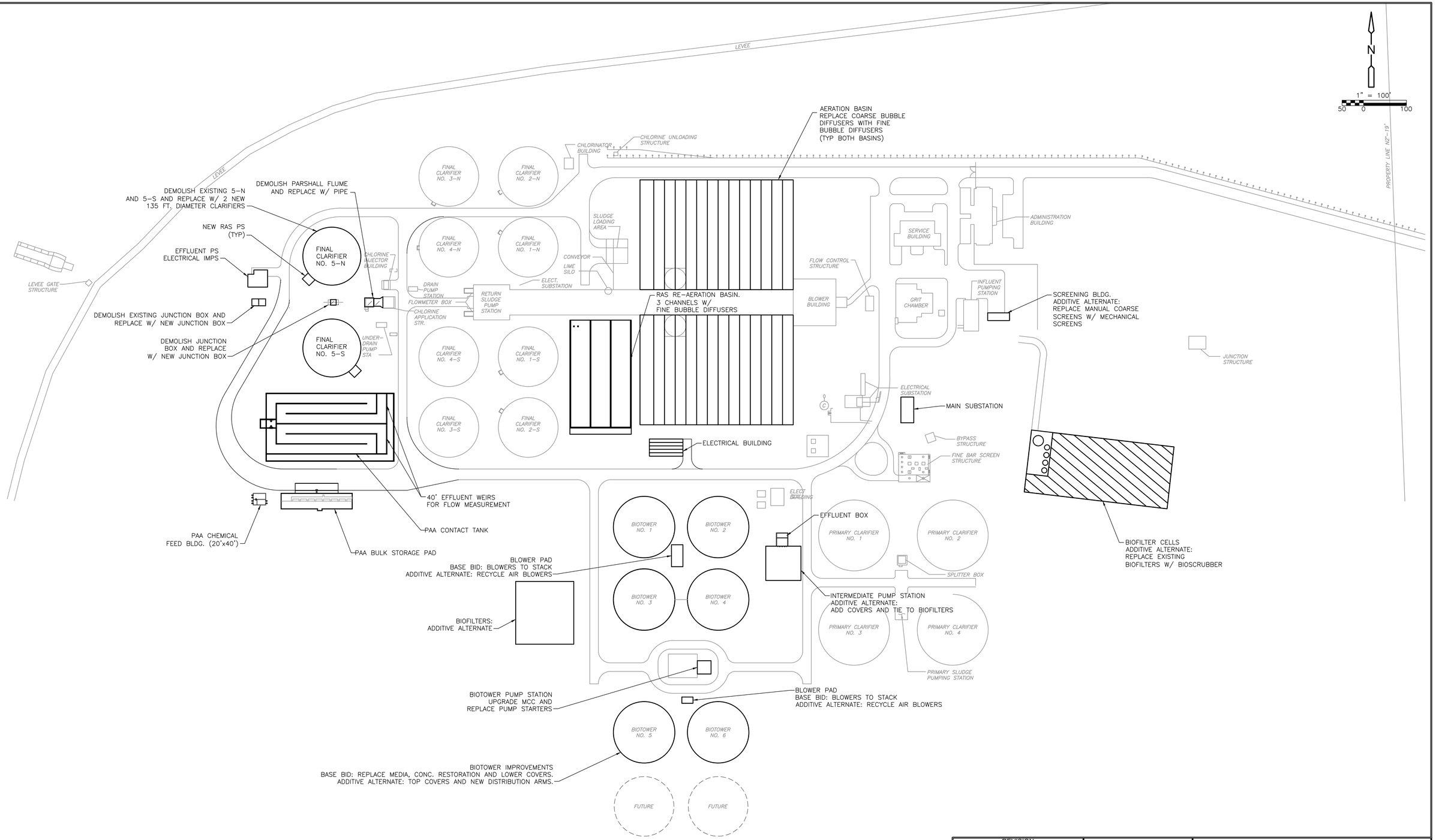

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DRAWING: GS-C-9 SHEET OF

CITY OF MEMPHIS

PROCESS UPGRADES ALT-3

MEMPHIS, TN

SURVEY	SURVEYBY	DATE	BY_DATE	BOOK	BOOK
DRAWN BY	DRAWNBY	DATE	BY_DATE	SCALE	1"=100'
DESIGN BY	DESIGNBY	DATE	BY_DATE	PROJECT	36694-111641

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DEP. CITY ENGINEER DATE CITY ENGINEER DATE

DEPARTMENT HEAD DATE

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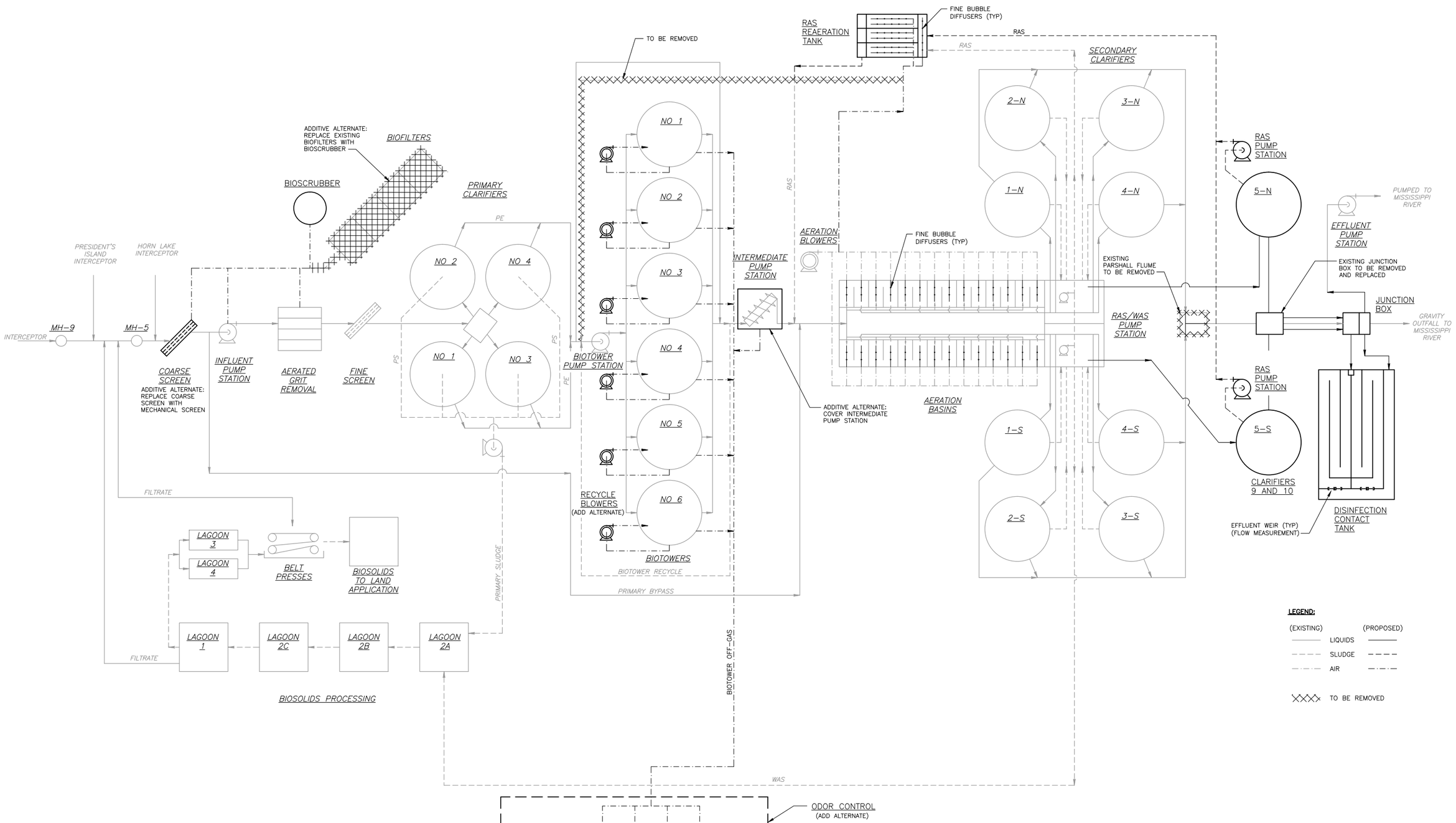

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ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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DRAWING: **GP-G-15A** SHEET OF

CITY OF MEMPHIS

ALTERNATIVE 3 PROCESS FLOW DIAGRAM W/ ADD ALTERNATES

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	NOT TO SCALE
DESIGN BY	BMK	DATE	X	PROJECT	36694-111641

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DEP. CITY ENGINEER DATE CITY ENGINEER DATE

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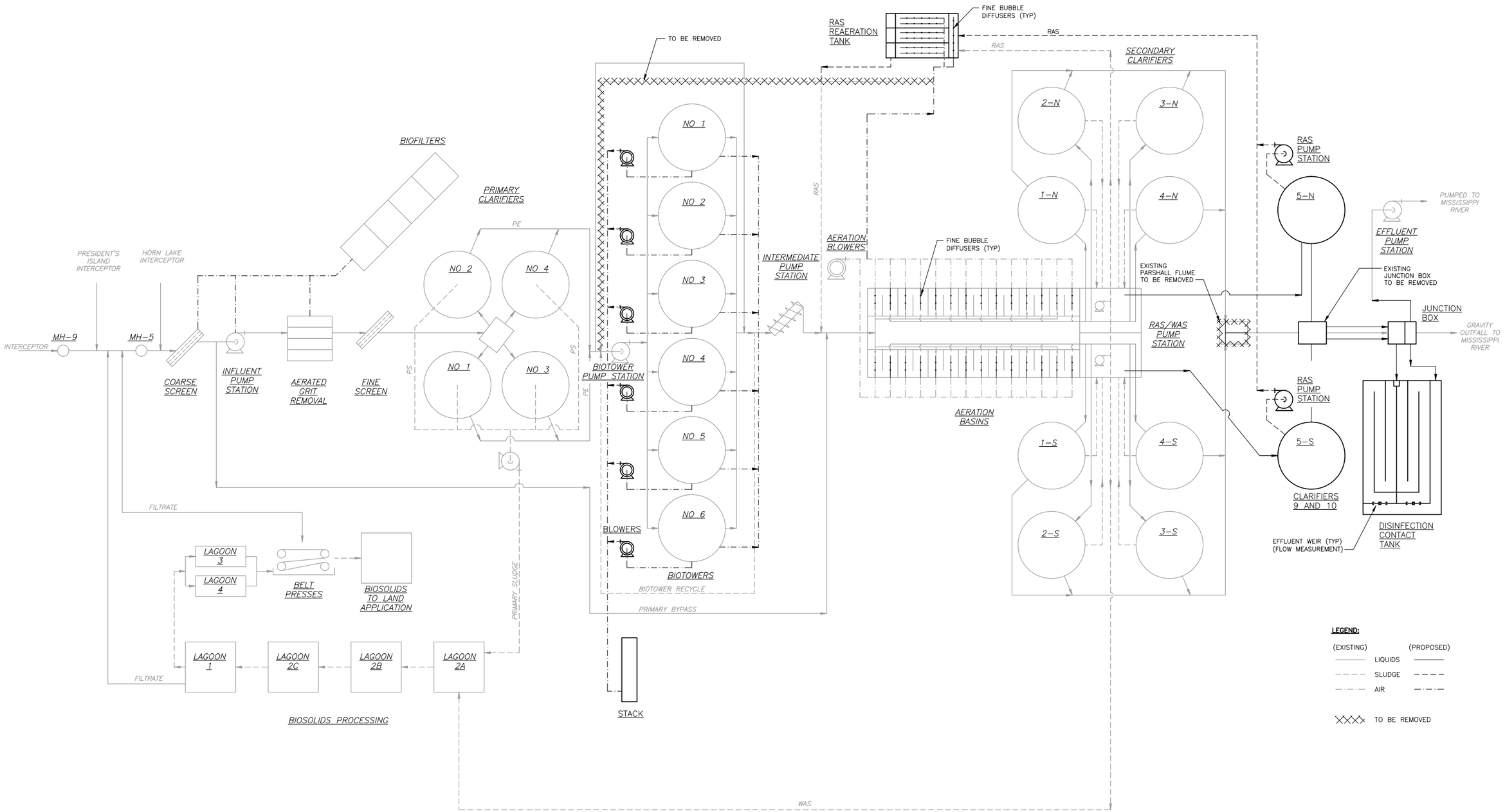

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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DRAWING: **GP-G-15B** SHEET OF

CITY OF MEMPHIS

ALTERNATIVE 3 PROCESS FLOW DIAGRAM - BASE BID

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	–
DRAWN BY	BJL	DATE	X	SCALE	NOT TO SCALE
DESIGN BY	BMK	DATE	X	PROJECT	36694-111641

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

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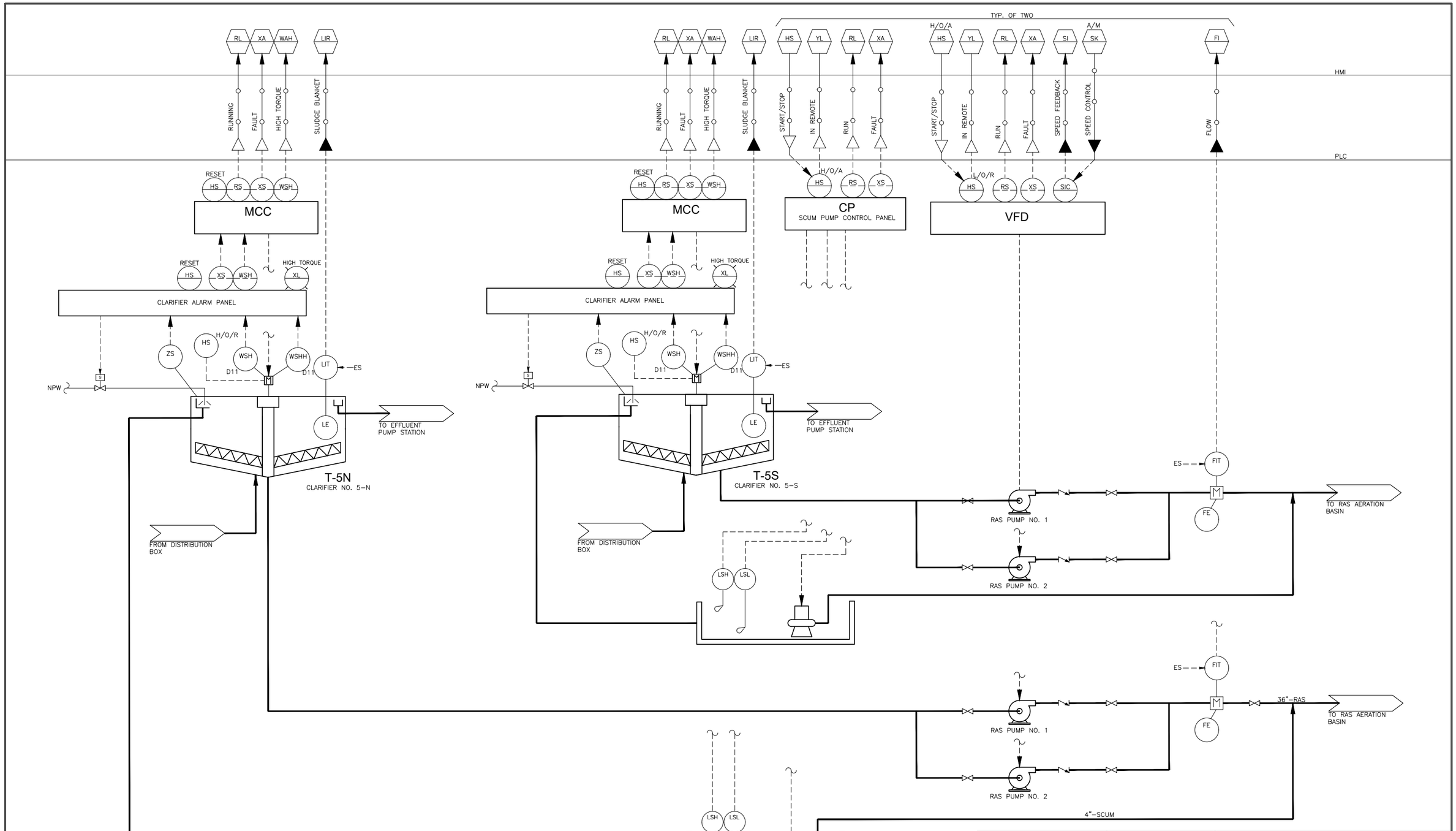

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DRAWING: I-7 SHEET OF

CITY OF MEMPHIS

ALTERNATIVE NO. 3

CLARIFIERS AND RAS PUMP STATIONS

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____
DRAWN BY ____ DATE ____ SCALE ____
DESIGN BY ____ DATE ____ PROJECT 36694-111641

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EPA-HQ-2019-004783 002109

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

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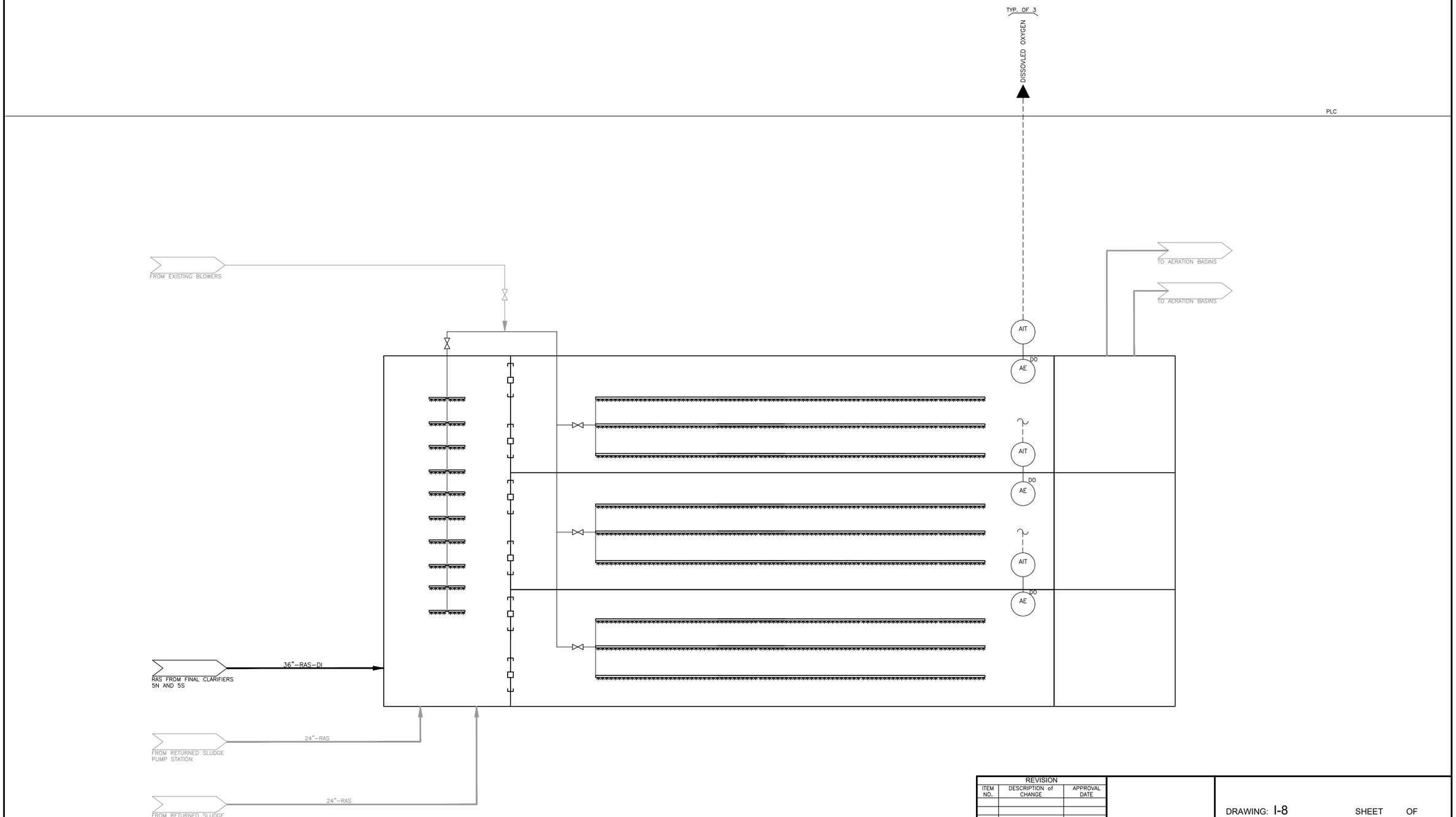

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

DRAWING: I-8 SHEET OF

CITY OF MEMPHIS

ALTERNATIVE NO. 3

RAS AERATION TANK

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK ____

DRAWN BY S. DAY DATE ____ SCALE ____

DESIGN BY ____ DATE ____ PROJECT 36694-111641

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EPA-HQ-2019-004783 002110

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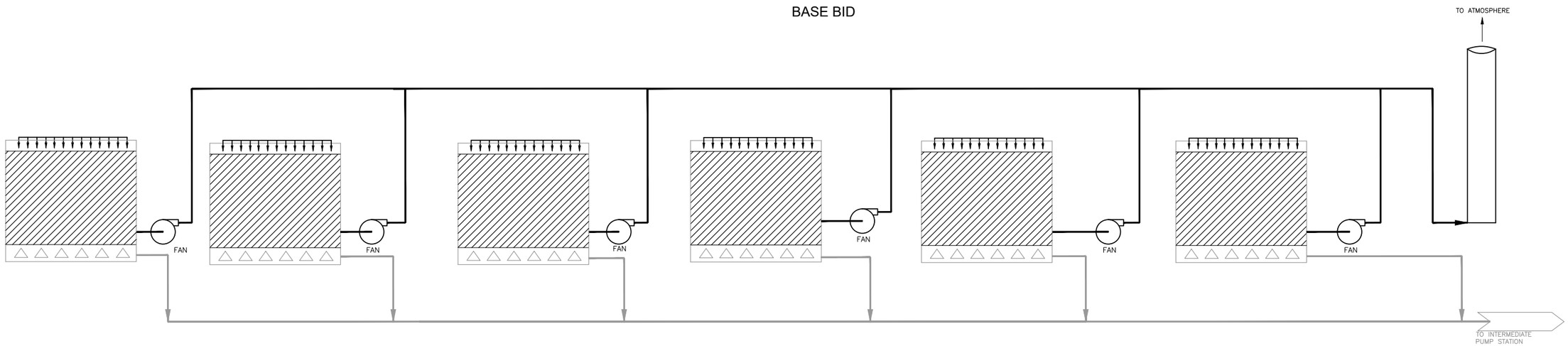
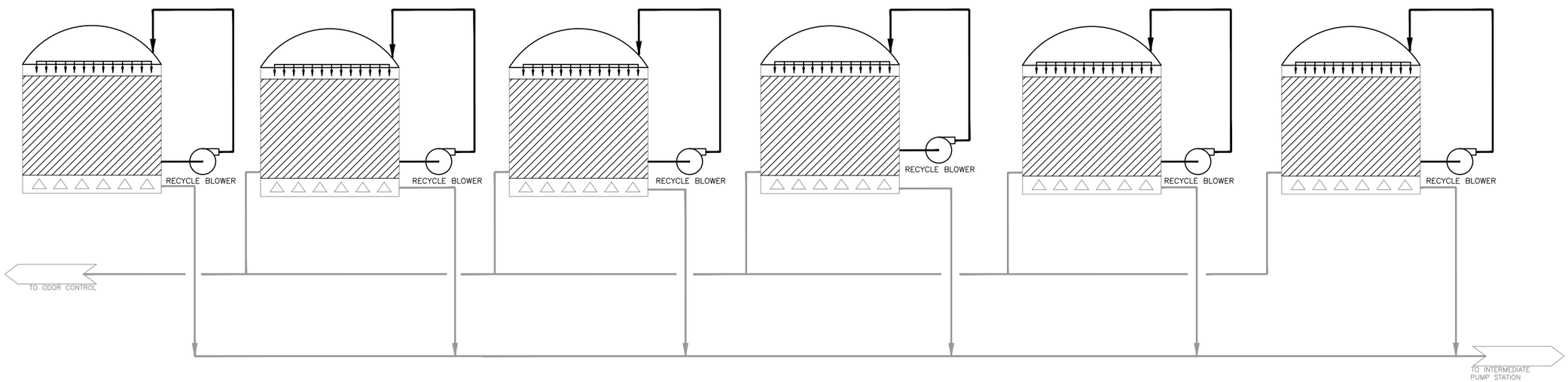
BASE BID



ADDITIVE ALTERNATE



REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

DRAWING: I-9 SHEET OF

CITY OF MEMPHIS

ALTERNATE NO. 3

EXISTING BIOFILTER MODIFICATIONS

MEMPHIS, TN

SURVEY ____ DATE ____ BOOK BOOK

DRAWN BY ____ DATE ____ SCALE SCALE

DESIGN BY ____ DATE ____ PROJECT 36694-111641

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EPA-HQ-2019-004783 002111

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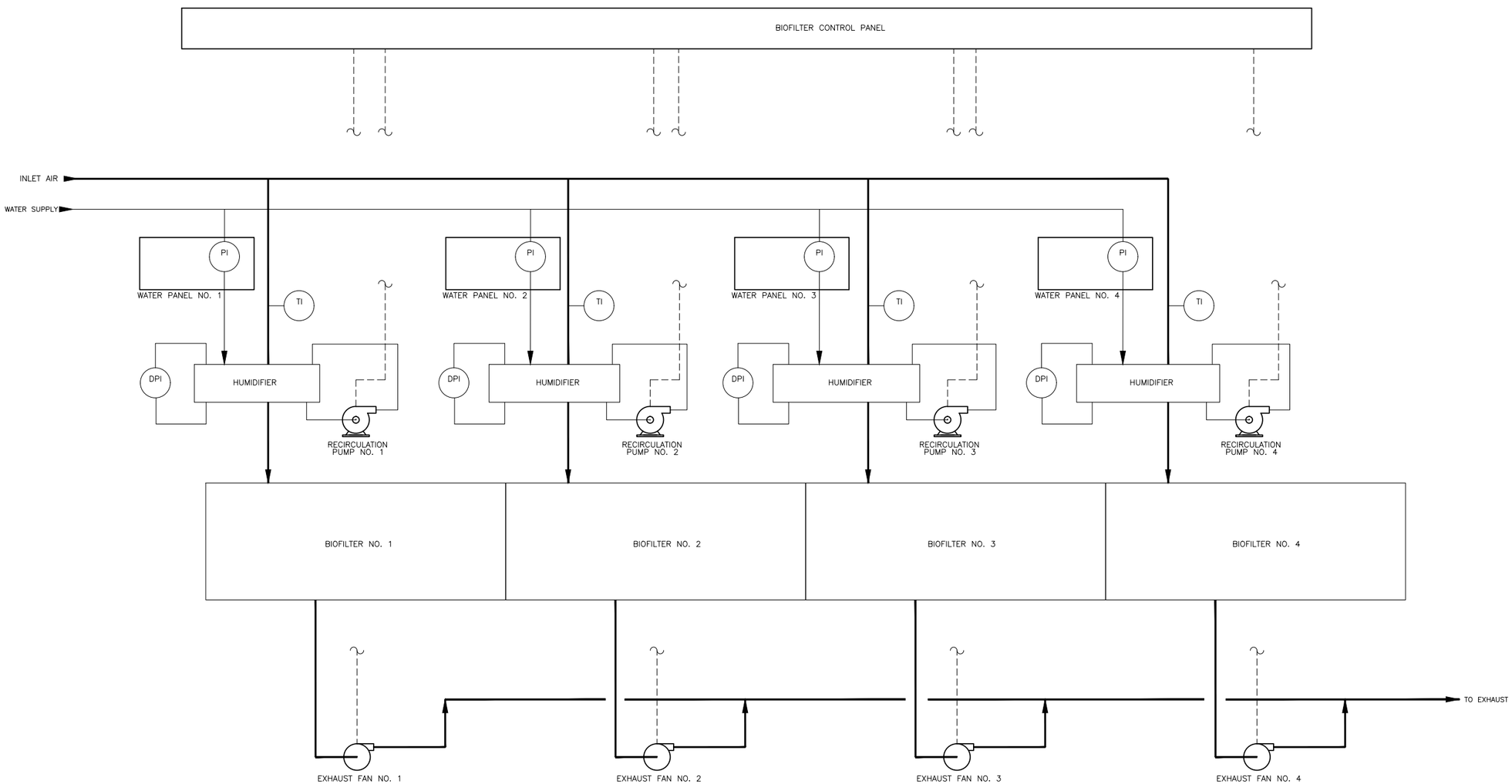

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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Tel: (901) 322-8710

T.E. MAXSON WWTP

DRAWING: I-10 SHEET OF

CITY OF MEMPHIS
ALTERNATE NO. 3
BIOFILTER ODOR CONTROL
MEMPHIS, TN

SURVEY ____ DATE ____ BOOK BOOK
DRAWN BY ____ DATE ____ SCALE SCALE
DESIGN BY ____ DATE ____ PROJECT 36694-111641

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DEP. CITY ENGINEER DATE CITY ENGINEER DATE

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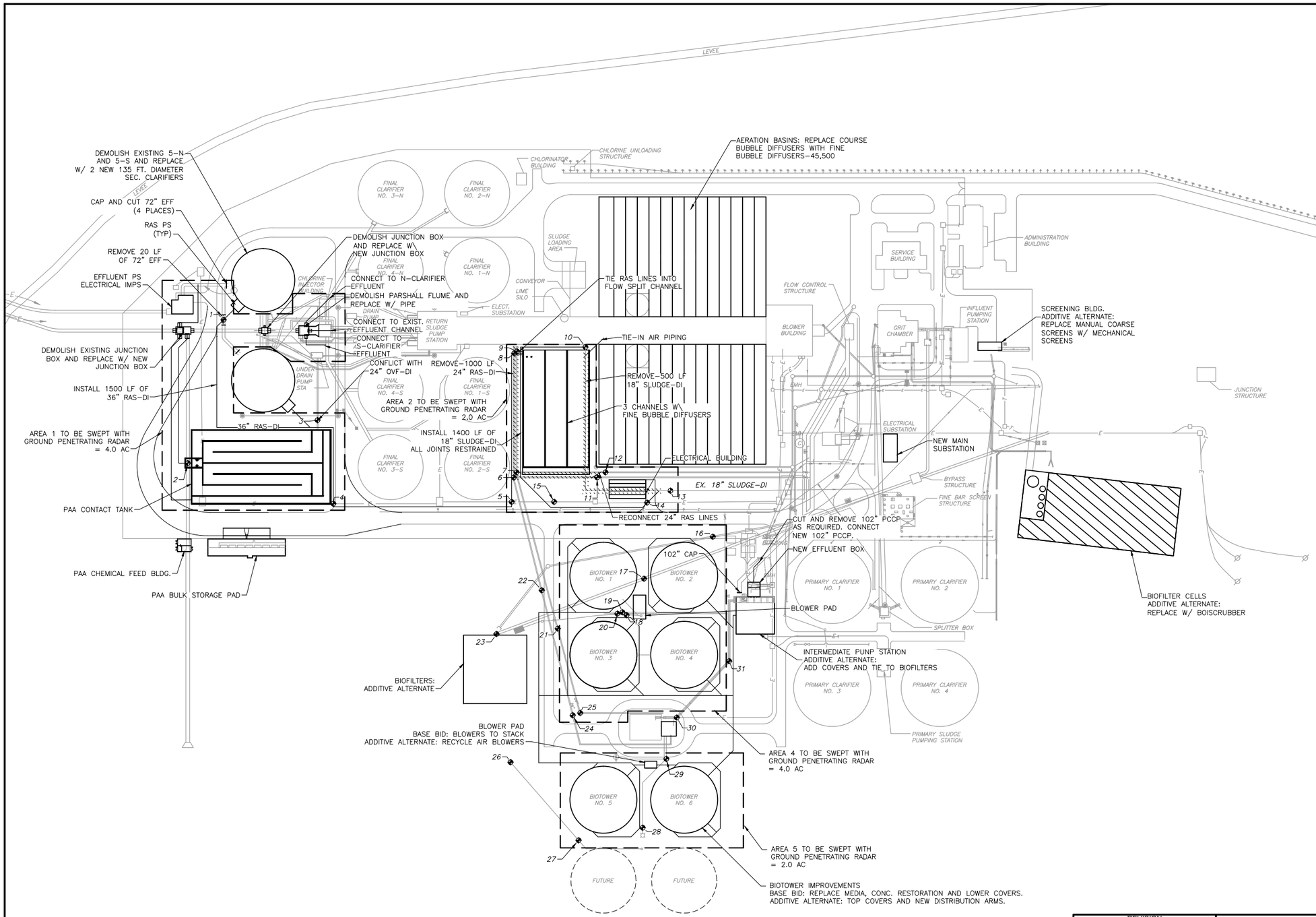

LEGEND

- AREA FOR GROUND PENETRATING RADAR
- SUE LOCATION
- TO BE REMOVED

SUBSURFACE UTILITY EXPLORATION POINT TABLE

POINT NO.	ELEVATION	NORTHING	EASTING	DESCRIPTION
1	0.00	207.21	-207.04	72" EFF
2	0.00	181.69	-213.42	8'x6' EFF
3	0.00	189.35	-190.31	24" OVF-DI
4	0.00	174.46	-187.49	ELECTRIC
5	0.00	174.79	-155.73	ELECTRIC
6	0.00	179.14	-155.34	24" RETURN SLUDGE
7	0.00	180.05	-154.85	24" RETURN SLUDGE
8	0.00	201.27	-155.27	24" RETURN SLUDGE
9	0.00	201.60	-154.77	24" RETURN SLUDGE
10	0.00	202.36	-142.58	18" SLUDGE DI
11	0.00	179.15	-140.49	24" RETURN SLUDGE
12	0.00	180.06	-139.00	24" RETURN SLUDGE
13	0.00	176.78	-127.44	18" SLUDGE
14	0.00	174.66	-131.58	ELECTRICAL
15	0.00	174.79	-148.16	ELECTRIC
16	0.00	168.59	-119.88	36" SD-RCP
17	0.00	161.11	-132.14	60" SAN-PCCP
18	0.00	154.63	-135.25	12" ST
19	0.00	155.15	-135.99	(UNK) WATER
20	0.00	154.90	-136.90	6" EW
21	0.00	152.23	-147.51	24" RETURN SLUDGE
22	0.00	159.04	-150.35	24" RETURN SLUDGE
23	0.00	151.27	-158.42	60" SAN
24	0.00	136.81	-144.84	24" RETURN SLUDGE
25	0.00	137.21	-143.51	24" RETURN SLUDGE
26	0.00	128.44	-155.92	12" ST-CMP
27	0.00	114.54	-143.80	12" ST-CMP
28	0.00	116.77	-132.38	ELECTRIC
29	0.00	129.03	-128.17	ELECTRIC
30	0.00	136.40	-126.31	48" (UNK)
31	0.00	146.44	-116.98	48" (UNK)

REVISION

ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

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Memphis, TN 38103
Tel: (901) 322-8710

T.E. MAXSON WWTP

DRAWING: GS-C-10 SHEET OF

CITY OF MEMPHIS

YARD PIPING PLAN ALT-3

MEMPHIS, TN

SURVEY SURVEYBY DATE BY_DATE BOOK BOOK
DRAWN BY DRAWNBY DATE BY_DATE SCALE 1"=100'
DESIGN BY DESIGNBY DATE BY_DATE PROJECT 36694-111641

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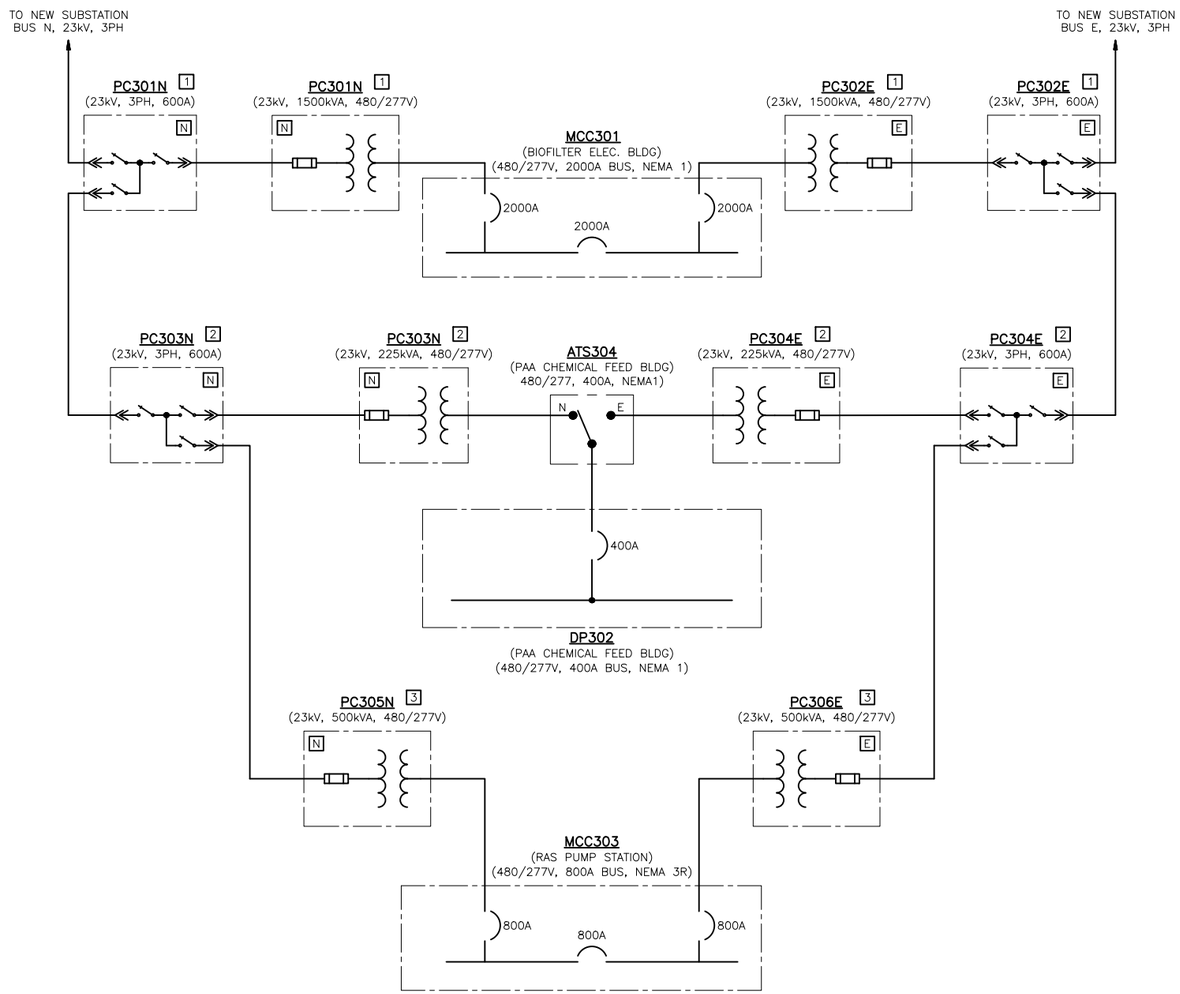
1 NEAR NEW BIOFILTER ELEC. BLDG.
2 NEAR PAA CHEMICAL FEED BLDG.
3 NEAR NEW RAS PUMP STATION.



ALTERNATE NO. 3

ONE LINE POWER DIAGRAM

CDM Smith

Figure 6-3
EPA-HQ-2019-004783 0021.14 MAXSON WWTP
ALTERNATE NO. 3 ONE LINE POWER DIAGRAM
JANUARY 2016

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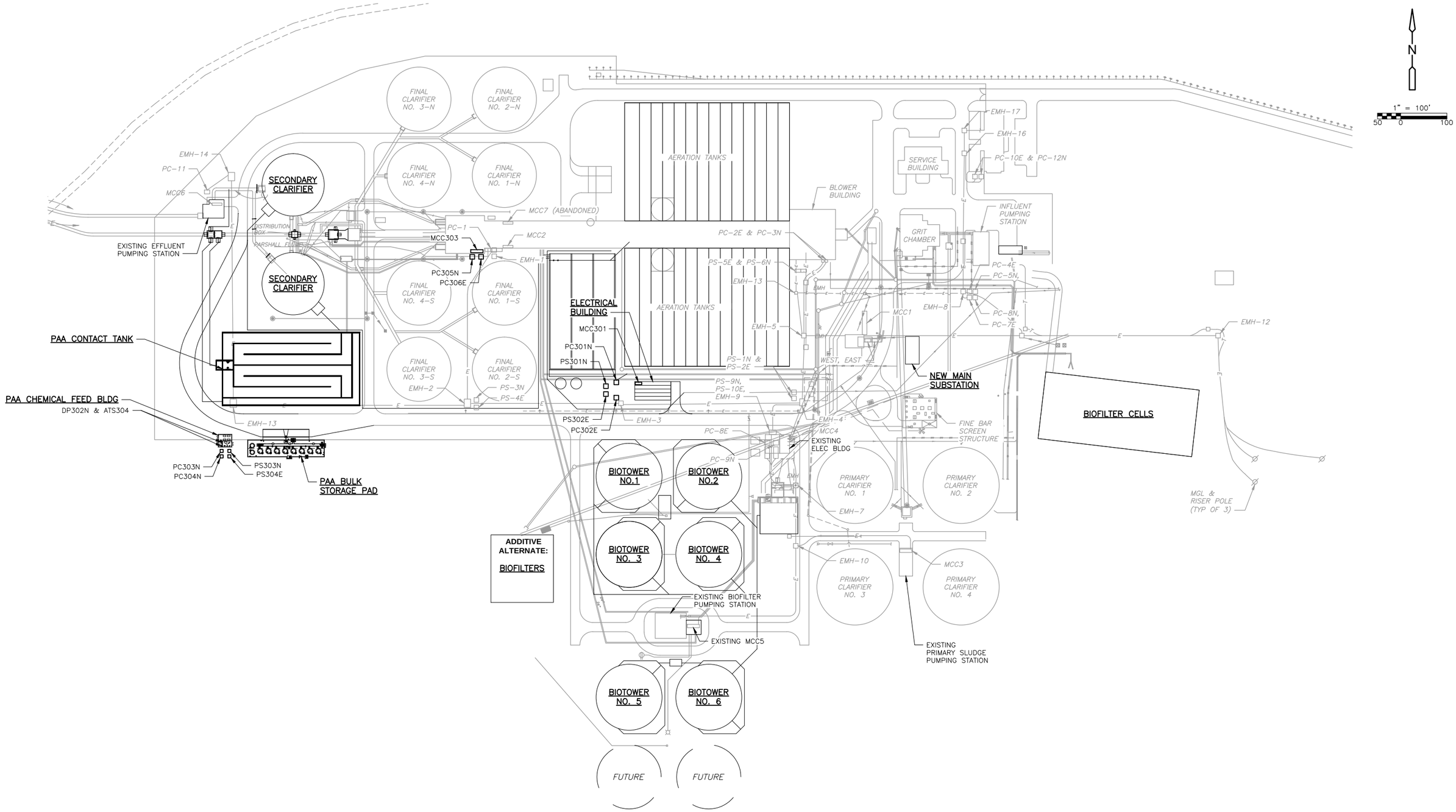
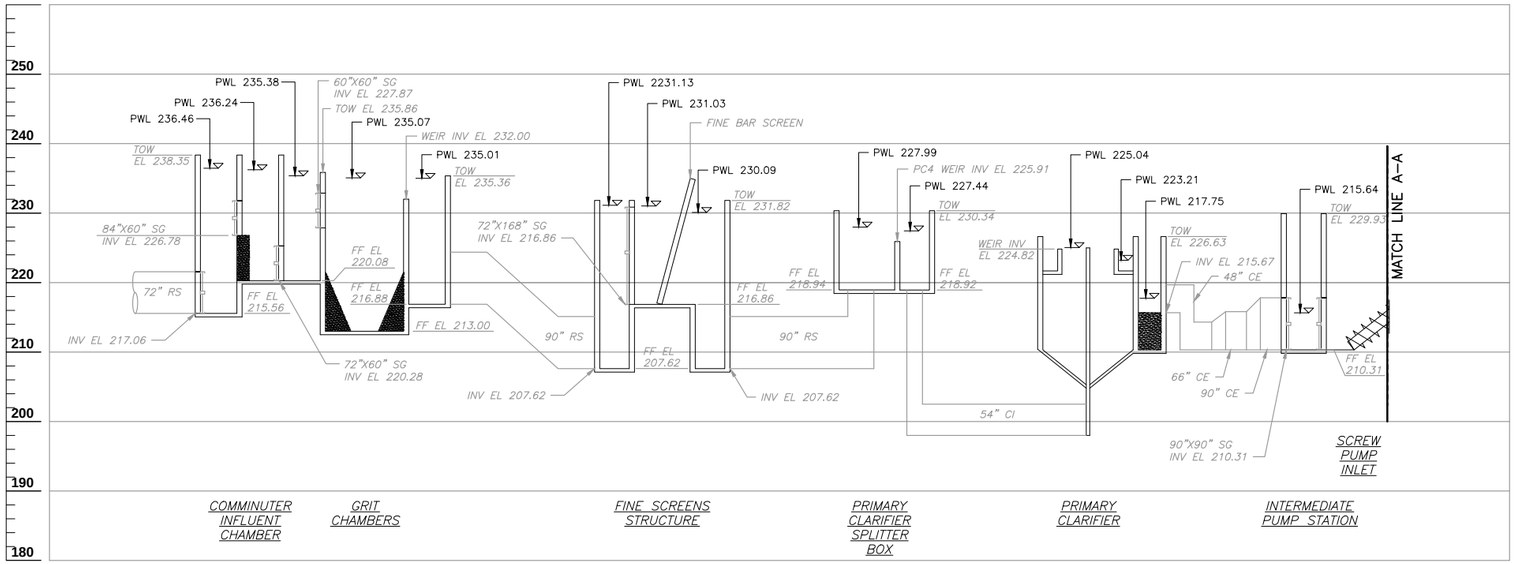
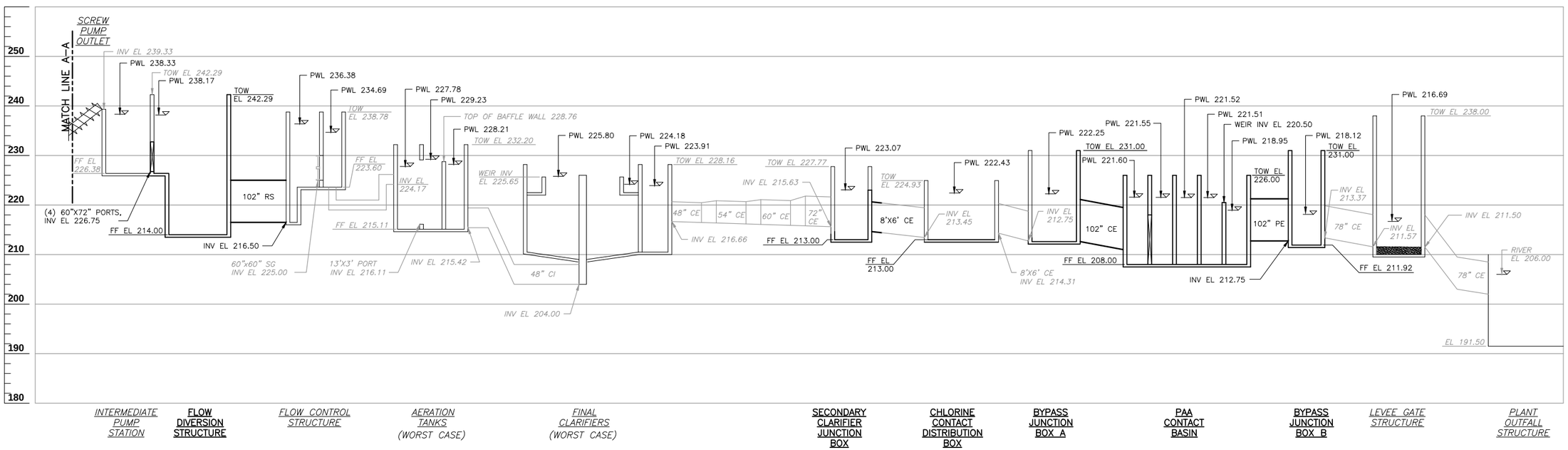


PLAN



NOTES:

1. PEAK WATER LEVELS (PWL) COMPUTED FOR AN ASSUMED 156 MGD TOTAL FLOW WITH AN ASSUMED 47 MGD RAS FLOW.
2. STARTING WATER SURFACE ELEVATION IN INTERMEDIATE PUMP STATION WET WELL ASSUMED TO BE 215.64 FT.
3. ALL ELEVATIONS REFERENCED TO NAVD88 DATUM.
4. PROFILE ASSUMES ALL PRIMARY CLARIFIERS ARE IN SERVICE.
5. HEADLOSS THROUGH FINE SCREENS CALCULATED WITH A 30% BLINDING FACTOR.



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T.E. MAXSON WWTP

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CITY OF MEMPHIS

ALTERNATE 3

HYDRAULIC PROFILE

MEMPHIS, TN

SURVEY X DATE X BOOK –
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DESIGN BY BAH DATE X PROJECT 36694–111641

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Section 7

Miscellaneous Plant Improvements

7.1 Effluent Pump Station Improvements

Improvements to the Effluent Pump Station include electrical improvements for new service and transformers. The hydraulic design considerations for the Effluent Pump Station pumps

7.1.1 Electrical Improvements

The Effluent Pump Station (EPS) electrical distribution system consists of power switch station PS4E rated at 23 kV, 600 A, power center PC11 transformer rated 3ϕ, 23 kV-4160 V, 1,000 kVA and motor control center MCC6 rated 3ϕ, 4160 V, 1,200 A. Four effluent pumps and one 30kVA dry-type transformer for accessory loads are connected to MCC6. Pumps 1 and 2 are rated at 350 horsepower (hp), while pumps 3 and 4 are rated at 300 hp. The existing 1,000 kVA transformer PC11 was not adequately sized to run all pumps simultaneously, which is required by the City. The transformer should be upgraded to 1,500 kVA to meet this requirement, per the load calculation shown in **Figure 7-1**. The existing concrete transformer pad will be reused along with the existing primary and secondary ductbanks. The primary and secondary feeders, although adequately sized for the upgraded transformer size, are over thirty years old and should be replaced.

	CONNECTED LOAD					
DESCRIPTION	QTY	HP	FLA	KVA	KW	TOTAL FLA
EFFLUENT PUMP NO 1	1	350	46.8			46.8
EFFLUENT PUMP NO 2	1	350	46.8			46.8
EFFLUENT PUMP NO 3	1	300	40.1			40.1
EFFLUENT PUMP NO 4	1	300	40.1			40.1
XFMR PANEL A	1		4.16	30.0		4.2
SUM OF CONNECTED						178.0
25% OF LARGEST MOTOR						11.7
Total						**189.7**

Total Connected Load (KVA)	**1,366.8**
Total Connected Load (A)	**189.7**

Figure 7-1 Effluent Pump Station Load Summary

Another issue the City has identified with the Effluent Pump Station is the lack of a redundant power source, unlike the rest of the existing plant process equipment. Without standby power, failure of the single electrical feed would result in the inability to operate the Effluent Pump Station. Therefore, a second feeder from the alternative medium-voltage circuit will be installed to provide redundant power to the Effluent Pump Station via another 1,500 kVA pad-mounted transformer. An automatic transfer switch rated at 4160 V, 1200 A in a NEMA 3R enclosure will be provided onsite to provide circuit-switching between the two power sources.

The proposed improvements for the Effluent Pump Station improvement will provide an electrical distribution system that will allow all effluent pumps to run simultaneously with the 100-percent redundant alternative circuit available immediately and automatically should the primary circuit fail.

The first Guaranteed Maximum Price Package (GMP 1) will include the installation of one of the 1,500 kVA pad-mounted transformers. The draft design package for GMP for this item is included in **Appendix D**. The proposed improvements associated with the secondary treatment and disinfection system upgrades will likely require relocation of some of the existing medium-voltage underground distribution infrastructure, including the primary feeder to the Effluent Pump Station service transformers. The replacement of the existing primary and secondary feeders, the installation of the redundant 1,500 kVA pad-mounted transformer, the automatic transfer switch and their associated new primary and secondary feeders and ductbank will be performed in a future phase when the final routing of the medium-voltage underground distribution infrastructure is determined.

7.1.2 Mechanical Improvements

The existing Effluent Pump Station has four Byron Jackson Model 52 PMR VCT 1 Stage, 400 hp vertical mixed flow pumps. CDM Smith believes this pump model is still manufactured, albeit by Flowserve, and it may be possible to refurbish these pump if it is required. Factory test results for these pumps was conducted in 1986, making the pumps approximately 29 years old. The pumps are used to lift plant effluent from the Effluent Pump Station wet well to the Effluent Pump Station discharge channel through individual discharges, which makes the system head mainly static lift with a minimal friction component. The original factory test curves indicate the existing pumps have a normal operating head of 20 to 25 feet: at 25 feet the pumps have a flow of 39,000 gallons per minute (gpm), or 56.2 million gallons per day (MGD) each. This means the Station has 168.5 MGD capacity with three pumps in operation. However, it has been reported that the Station cannot currently achieve these flow rates with three pumps in operation. It is recommended to conduct flow tests on the existing pumps and compare the results to the original factory test results. If it is determined that the current performance does not match the original factory test, it is recommended that the pumps be inspected and rebuilt to achieve original performance, if desired.

The Effluent Pump Station will operate the same in both Alternative 1 and Alternative 3. The Effluent Pump Station will be placed into operation when the river stage reaches elevation 206, at which point operations staff would close the gate to the main outfall in the Disinfection Junction Box and open the gate to the Effluent Pump Station. The Effluent Pump Station would then be required to start one, two or three pumps, depending on plant flow. The pumps would be designated as lead, lag, lag 2 and standby. The pumps will be controlled to start and stop in automatic mode by monitoring the level in the wet well, with pre-selected start and stop elevations provided for the lead, lag, and lag 2 pumps.

7.2 Coarse Screen Improvements

This section provides an evaluation of coarse screening removal technologies available for use at the Maxson WWTP and includes a recommendation for the proposed technology to be implemented.

7.2.1 Background

The existing headworks building was constructed in the mid-1970's and currently utilizes two influent channels with two manually-cleaned coarse screens, in series, in each channel. The existing coarse screens utilize embedded guiderails and an overhead wire rope winch that allows them to be removed from the channel to be manually cleaned. Screenings are placed on one of two belt conveyors, where

they are conveyed into the screenings dumpsters located outside of the building. The City staff has estimated the screens to have a spacing between 1-1/2-inches and 2-inches.

Although the coarse screens were replaced and the channels repaired around 1999, further concrete degradation in the channels, operator safety concerns and a lack of screen capture have been reported to the City since the earlier repairs. As a result, the City has asked CDM Smith to evaluate what type of coarse screening removal technologies are available for use at the existing headworks building.

7.2.2 Screen Evaluation Criteria

The coarse screens are intended to collect large debris and protect the influent pumps, while the fine screens located between the grit tanks and the primary clarifier distribution structure are intended to collect rags and small material to prevent problems with material collecting in the primary clarifiers and aeration tanks. The fine screens have a 3/8-inch bar spacing.

The coarse screen criteria are summarized in **Table 7-1**.

Table 7-1 Coarse Screen Evaluation Criteria

Parameter	Value	Notes
Total Peak Hour Flow, MGD	170	
Total Design Average Flow, MGD	90	
Total Minimum Flow, MGD	50	
No. of Channels	2	
Channel Width, feet	6.5	
Channel Height, feet	10	To underside of slab
Channel Invert Elevation	181.25	
Operating Floor Elevation	229.0	
Minimum Rake Engagement Frequency, minutes	5	
Angle of Inclination (from horizontal), degrees	80	

The key criteria considered when evaluating the screening alternatives include:

- Ease of operation and maintenance
- Review of similar installations for reliability and ease of maintenance
- Number of similar installations in service
- Headloss through the screen and potential impact to the hydraulic grade line of the Maxson WWTP
- Materials of construction
- Screen capital cost
- Screen dimensions and arrangement
- Manufacturer's ability to offer a wash press in a common screenings treatment package.

The operations and maintenance requirements for the screens and screenings wash presses evaluated herein are estimated to be approximately the same. Screen manufacturers indicate that all routine maintenance requirements are performed above and outside of the channel. The motors required to operate all of the evaluated screens and screening wash presses are small horsepower, therefore power requirements are approximately the same and considered minor when compared to the overall WWTP power requirements. Most units have similar moving parts and have similar recommended maintenance requirements.

7.2.2.1 Headloss Evaluation

During high flow conditions the existing coarse screen system floods. This is a result of blinding across the manually cleaned screens, a high wet well water surface elevation (the wet well water surface elevation is a key factor in the headloss across the screens), and simply too much wastewater entering the headworks building. While new mechanically cleaned coarse screens would improve screening removal and operator safety, it will not eliminate flooding in the coarse screen area of the headworks. As a result, the objective of installing new mechanically cleaned coarse screens is to eliminate the manually cleaning of the screens, and decrease the bar spacing so that the hydraulic impacts are no worse than the current conditions.

The headloss through a screen is impacted by the available flow area; which are driven by screen blinding rate, bar spacing, and downstream water surface; and the flow through the screen. The blinding rate is a function of the frequency with which the screen is cleaned, i.e. climber screens typically have a blinding rate of 40 to 60-percent, while multi-rake screens have a blinding rate of 10 to 20-percent. The bar spacing is variable depending upon the desired screening capture and the available headloss, and the flow rate is set at a given facility. So the primary variable that can be manipulated is the downstream water surface elevation. The City of Memphis provided the hourly instantaneous influent pump station discharge flow, and water levels upstream and downstream of the existing coarse screens from May 2015 through November 2015. That data is summarized in **Table 7-2**.

Table 7-2 Hourly Influent Pump Station Flow and Water Depth Data

Parameter	Average	Percentiles[1]		
		50th	90th	95th
IPS Discharge Flow, MGD	66.8	62.1	84.7	102.9
Water Depth Upstream of Screens, inches	106.3	105.9	133.7	143.1
Water Depth Downstream of Screens, inches	75.2	75.7	105.4	115.6

Notes: 1. Based on hourly data from May 2015 through November 2015

The downstream water surface is the same water surface in the influent pump station wet well. Therefore, the plant staff are able to control the downstream water surface to a degree. Based on discussions with Maxson plant staff, the downstream water surface elevation data used to calculate screen headloss will be based on the 50th percentile and checked against the 90th percentile to ensure the upstream water depth doesn't exceed 120 inches at peak flow. Bar spacing of 1-inch, 1-1/4-inch and 1-1/2-inch were evaluated for these calculations. Other assumptions used for the headloss calculations included:

- Blinding rate of 50-percent for climber screens and 20-percent for multi-rake screens

- Screen frame protrudes 6-inches from each channel wall
- Bar thickness is 3/8-inch
- Maximum upstream water depth is 120 inches
- 50th percentile downstream water depth is 76 inches
- 90th percentile downstream water depth is 105 inches
- Peak Hour Flow is 170 MGD
- Design Average Flow is 90 MGD
- Two channels are in service

The results of the headloss calculations are summarized in **Table 7-3** for climber screens and **Table 7-4** for multi-rake screens.

Table 7-3 Climber Screen Headloss Calculation Results

Parameter	Downstream Depth = 50th Percentile						Downstream Depth = 90th Percentile					
	Peak Flow			Average Flow			Peak Flow			Average Flow		
Total Flow, MGD	170			90			170			90		
Number of Operational Screens	2			2			2			2		
Flow per Screen, MGD	85			45			85			45		
Bar Spacing, inches	1	1.25	1.5	1	1.25	1.5	1	1.25	1.5	1	1.25	1.5
Channel Velocity, feet per second	3.20	3.20	3.20	1.69	1.69	1.69	2.31	2.31	2.31	1.22	1.22	1.22
Velocity through Bars, feet per second	10.39	9.82	9.44	5.50	5.20	5.00	7.52	7.11	6.83	3.98	3.76	3.62
Free Space Between Bars1, feet	4.00	4.23	4.40	4.00	4.23	4.40	4.00	4.23	4.40	4.00	4.23	4.40
Assumed Downstream Water Level, feet	6.33			6.33			8.75			8.75		
Channel Freeboard, feet	1.50	1.76	1.92	3.06	3.13	3.18	0.11	0.25	0.33	0.93	0.97	0.99
Headloss, feet	2.17	1.91	1.75	0.61	0.54	0.49	1.14	1.00	0.92	0.32	0.28	0.26
Upstream Water Level, inches	102	99	97	83	82	82	119	117	116	109	108	108
Blinding Factor	50%			50%			50%			50%		

Notes: 1. Assumes frame takes up 1 foot of channel width

Table 7-4 Multi-Rake Screen Headloss Calculation Result

Parameter	Downstream Depth = 50th Percentile						Downstream Depth = 90th Percentile					
	Peak Flow			Average Flow			Peak Flow			Average Flow		
Total Flow, MGD	170			90			170			90		
Number of Operational Screens	2			2			2			2		
Flow per Screen, MGD	85			45			85			45		
Bar Spacing, inches	1	1.25	1.5	1	1.25	1.5	1	1.25	1.5	1	1.25	1.5
Channel Velocity, feet per second	3.20	3.20	3.20	1.69	1.69	1.69	2.31	2.31	2.31	1.22	1.22	1.22
Velocity through Bars, feet per second	6.5	6.1	5.9	3.4	3.2	3.1	4.7	4.4	4.3	2.5	2.4	2.3
Free Space Between Bars[1], feet	4.00	4.23	4.40	4.00	4.23	4.40	4.00	4.23	4.40	4.00	4.23	4.40
Assumed Downstream Water Level, feet	6.33			6.33			8.75			8.75		
Channel Freeboard, feet	3.0	3.1	3.1	3.5	3.5	3.5	0.9	0.9	1.0	1.1	1.2	1.2
Headloss, feet	0.7	0.6	0.5	0.2	0.2	0.2	0.4	0.3	0.3	0.1	0.1	0.1
Upstream Water Level, inches	84	83	83	78	78	78	109	109	108	106	106	106
Blinding Factor	20%			20%			20%			20%		

Notes: 1. Assumes frame takes up 1 foot of channel width

These results indicate that both the climber and multi-rake screens can maintain an upstream water depth less than 120 inches at peak flow and the 90th percentile downstream water depth at all three bar spacings. The velocity through the climber screen at peak flow conditions ranges from 10.39 feet to 6.83 feet per second, depending on the bar spacing and downstream water depth. It is worth noting that velocities this high lead to a reduced screenings capture efficiency, however this occurs at the peak hour condition which is considered an infrequent occurrence.

7.2.3 Screen Alternatives

There are numerous screening technologies available to provide coarse screening to wastewater flow. CDM Smith focused on screening technologies that are appropriate for combined sewer or combined sewer like flow - climber type mechanical bar screens and multiple rake type mechanical bar screens. These bar screens are generally considered to be more robust in design than other types of screens and are less susceptible to damage from debris.

Each screen type is described in further detail below.

7.2.3.1 Climber Screens

The climber-type screen utilizes guide tracks, mounted to the inside of the screen frame, for the rake assembly shaft rollers. This design eliminates the need for a lower sprocket and drive chain, which in turn eliminates the need for permanently submerged moving parts. However, this design is not low-profile: eliminating the need for permanently submerged parts increases the overall height of the unit above the operating floor and discharge point. Many screen manufacturers such as Vulcan Industries, Infilco Degremont Industries (IDI), Huber and JWCE, manufacture climber type screens. Vulcan

Industries Inc. was contacted to provide further detail for this evaluation. It is worth noting that the existing fine screens at the Maxson WWTP are climber screens from Vulcan Industries.

Vulcan Industries manufacturers a climber type vertical bar screen called the Mensch Crawler Bar Screen. The screen is made with thick support pieces for applications like that at the Maxson WWTP. The physical setting of the bar screen rests at an angle in the influent channel while a large single rake arm removes debris. Each pass of the large rake arm removes a similar volume of screenings as the smaller multiple flight screen equipment. The rake carries the debris from the low point of the bar screen to a discharge point above the channel. At the discharge point, a wiper blade assembly helps removes all debris from the rake arm. The rake teeth fully penetrate the bar screens to avoid clogging. The drive motor and all other mechanical parts are located above the water elevation. The bar rack, rake assembly and side frame can be made of 304 or 316 stainless steel to mitigate potential corrosion concerns. Given the corrosive nature of the conditions in the headworks building, 316 stainless steel was utilized.

The Mensch Crawler has the option of a two speed drive motor that operates the rake speed from approximately 20 feet per minute during normal flow conditions to 40 feet per minute during high flow conditions. This feature is useful in taller screen applications, (similar to Maxson) so as to limit blinding by leaves, rags or other similar materials during the first-flush of a wet weather type events. In such a condition, the excessive differential head across the screen would be sensed and the screen would automatically switch to the higher speed thereby minimizing the travel time of the rake. For the Maxson application, the rake would engage the bar rack for cleaning every 3 to 4 minutes, even though the distance between the operating floor and the channel invert is 47.75 feet.

7.2.3.2 Multi-Rake Vertical Screens

The multiple rake type vertical screen is a relatively newer technology as compared to the climber type screen. Vulcan Industries Inc. was selected for further detailed evaluation. The multiple rake type vertical screens are generally equipped with upper and lower sprockets that carry the drive chain. The individual rake bars are then attached to these two chains. Multiple rakes are attached to the chain to permit quick cleaning of the bars and to reduce the amount of screen blinding.

The bar screen rests at an angle in the influent channel while multiple rakes or flights rotate in/out of the channel to remove debris. These flights carry the debris from the low point of the bar screen to a discharge point. Each flight carries less material than either rake arm of the climber screens, but the multiple flights and varying rotation speed create a removal rate in the vicinity of 116-233 cubic feet/hour. At the discharge point, a scraper mechanism helps removes all debris from the rakes. The rake teeth fully penetrate the bar screens to avoid clogging. The drive motor, upper drive shaft and upper sprocket are located above the water elevation, while the lower drive shaft and lower sprocket are submerged in the channel. The design of the multiple rake screens allows for these units to have very low headroom requirements with only a minimal amount of equipment located above the screen discharge point. Even so, this design puts moving parts (the lower sprocket and bearing) below the water level. To address this issue, some manufacturers indicate that the lower sprocket and bearing is a self-lubricating design and grease lines are not required.

The screen drive motor is typically controlled by a VFD (variable frequency drive) to moderate the rate at which the rakes revolve.

Based on discussions with the manufacturer, multiple rake screens are not recommended for application at the Maxson WWTP due to issues that would result from the required distance between chain sprockets.

7.2.4 Other Screen Technologies

Types of influent screens that were not considered as part of this detailed evaluation include Step-style, Center-flow and Belt/Band screens. The Step-style screen was not considered because this equipment does not handle grit very well and for this application grit removal will occur after screening. Grit could collect on the channel floor before the first step and grit could get jammed between the lamella bars, causing them to flex if the plastic lamella spacers have worn down. Excessive flex can cause the lamellas to rub against each other or possibly jam together. The Center-Flow screen was also not considered because this equipment requires a much larger channel size and backwash system. It is also newer technology in the United States. The Belt/Band screen was also not considered because of the higher headlosses through the screen relative to the other options. In addition, screened material remaining on the belt of a Belt/Band screen could reenter the downstream flow if not removed by the brush or spray of the mechanism - this is more likely to happen with combined sewer flow.

7.2.5 Cost Evaluation

CDM Smith contacted Vulcan Industries Inc. and obtained quotes for climber and multi-rake screens with dedicated washers and compactors. Quotes from Vulcan Industries Inc. are based on the below criteria and provided in Section 8 of the report.

- Material: 304 Stainless Steel
- Bar spacing: 1”
- Bar width: 3/8”
- Channel width: 6 ½’
- Bar rack height: 10’
- Control requirements:
  - One NEMA 4X control panel for each screen and W/C combination
  - Control shall be PLC based
  - Include Vulcan’s standard control system (alarms, etc.)
  - Panel shall include touch screen for operator interface
  - Provide Ethernet connection for monitoring of screen & W/C remotely via SCADA
  - Two NEMA 7 radar transducers and transmitters (the two LE units will be utilized by both screens)
  - One NEMA 7 float switch with transmitter (one for each screen)
  - Provide one NEMA 7 disconnect for the Screen

- Provide one NEMA 7 local control station for the screen with:
  - Push-to-Stop/Pull-to Run emergency stop maintained push button with lockout
  - HAND/OFF/AUTO selector switch
  - FORWARD/OFF/REVERSE selector switch. Switch shall spring return from REVERSE to OFF.
- Provide one NEMA 7 disconnect for the W/C
- Provide one NEMA 7 local control station for the W/C with:
  - Push-to-Stop/Pull-to Run mushroom type emergency stop maintained push button with lockout.
  - HAND/OFF/AUTO selector switch.
  - FORWARD/OFF/REVERSE selector switch. Switch shall spring return from REVERSE to OFF.
  - Hopper Wash HAND/OFF/AUTO selector switch.
  - Press Zone Wash HAND/OFF/AUTO selector switch.
  - Pan Wash HAND/OFF/AUTO selector switch
- Freight to Memphis, TN
- Vulcan Industries Inc. to provide three trips to the site
  - One for installation assistance
  - Two for equipment start up and testing

7.2.6 Recommendation

Climber screens with 1-inch bar spacing as manufactured by Vulcan Industries are recommended for installation in the headworks building in each channel. The selection of this type of screen was based on the fact that multi-rake screens aren't recommended by the manufacturer due to the depth of the installation and on City staff preference as they have had successful operation at other locations.

Each screen will be supplied with a dedicated screenings wash press/compactor unit. The discharge pipes from the units will be designed and oriented such that the units can discharge screenings directly to a conveyor system or outside into a screenings dumpster.

7.3 Headworks Odor Control Improvements

7.4.1 Background

The *Recommendations for Odor and Corrosion Control for the Memphis Wastewater Collection and Treatment System* report completed in 1997 (the "1997 Report") recommended that a 30,000 cubic feet per minute (cfm) biofilter be installed to provide odor control for the existing influent structure

biofilter, and a 10,000 cfm odor control biofilter be installed to ventilate and treat the grit chambers, Clarifier Splitter Box and clarifier launders. These biofilters were installed several years after the report and now require replacement. It is assumed that the cost for complete renovation of the existing biofilters is comparable to the cost for a new biofilter, and therefore complete replacement cost should be used for comparison.

The 1997 Report identified hydrogen sulfide (H_2S) levels of 150 parts per million (ppm) for the influent structure. This report did not include H_2S levels for the grit or primary tanks; however, the *T.E Maxson Wastewater Treatment Plant Odor Control Investigation Technical Memorandum* report completed in 2013 (the "2013 Report") identified average H_2S levels greater than 200 ppm, with levels exceeding 1000 ppm on occasion for these structures. Biofiltration is not an appropriate odor control process to treat this level of H_2S: as a rule, 50 ppm is the maximum H_2S level that should be treated in an organic media biofilter. Levels higher than 50 ppm result in excess acidification that exacerbates the mineralization of the media and decreases the media life. In addition, the biofilters have breakthrough of both H_2S and organic odorous compounds, which will actually create additional odorous compounds. Of these compounds, dimethyl disulfide $(CH_3)_2S_2$ is of particular concern as it has a nasty odor with a very low perception level.

Further, the construction of the biofilters without covers enhances the degradation of the media creating wet zones that transmits air and as a result channeling or short-circuiting occurs releasing untreated foul air to the atmosphere.

7.4.2 Biofilter Costs

The cost to completely renovate the existing biofilters, based on the costs included in the 1997 Report with escalation, is presented in **Table 7-5.** These existing biofilters use organic media.

Table 7-5 Biofilter Renovation Costs

Item	Airflow (cfm)	Number	Area, each (sf)	Cost/sf	H_2S Level (ppm)	Media Warranty	Installed Cost
Organic Media Biofilter	40,000	4	3,333	$60[1]	50	None	$800,000

Notes: 1. 1997 Report used $40/sf; current price includes escalation

The cost for a new biofilter system, comprised of a complete enclosed, concrete design with ten-year media life is presented in **Table 7-6**. This new biofilter system will use synthetic media. Note that it is not possible to compare the organic media system and the synthetic media system costs based on square footage, although the synthetic media design will not require additional space.

Table 7-6 New Biofilter Costs

Item	Airflow (cfm)	Cost/cfm	H_2S Level (ppm)	Media Warranty	Direct Cost for Comparison
Synthetic Media Biofilter	40,000	$90	50	Ten years	$3.6M

Section 8 presents the complete cost estimates for the recommended option. The costs in Table 7-6 **and 7-7** are presented for comparison purposes only and are not the complete installed cost.

7.4.3 Odor Control Biotrickling Filter Assessment

CDM Smith recommends an advanced biological treatment design that utilizes the same principles of a biofilter, with the reactions completely enclosed in a fiberglass reinforced plastic (FRP) vessel with plastic structured media. These "Biotrickling Filters" are counter current reactors with water sprayed over the top of the media and air traveling upward across the media. Mass transfer of H_2S occurs on the plastic media surface where it is converted biologically to sulfuric acid (H_2SO_4). This process is different from an organic biofilter: the acid does not attack the plastic media and is washed away with the reactor blow-down. Operations and maintenance (O&M) considerations for these systems include:

- Fan Maintenance
  - Belts
  - Lubrication
- Irrigation Control Oversight
  - Water Pressure
  - Drainage pH
  - Irrigation pressure and Flow
- Nutrients
  - Replenishment of Nutrient every 30 days

The design for 40,000 cfm and an average H_2S level of 250 ppm with peaks to 500 ppm would include four separate 12 ft. diameter vessels operating in parallel. **Figure 7-2** shows a possible layout for this application, and **Figure 7-3** shows a photo of an existing system of similar size.

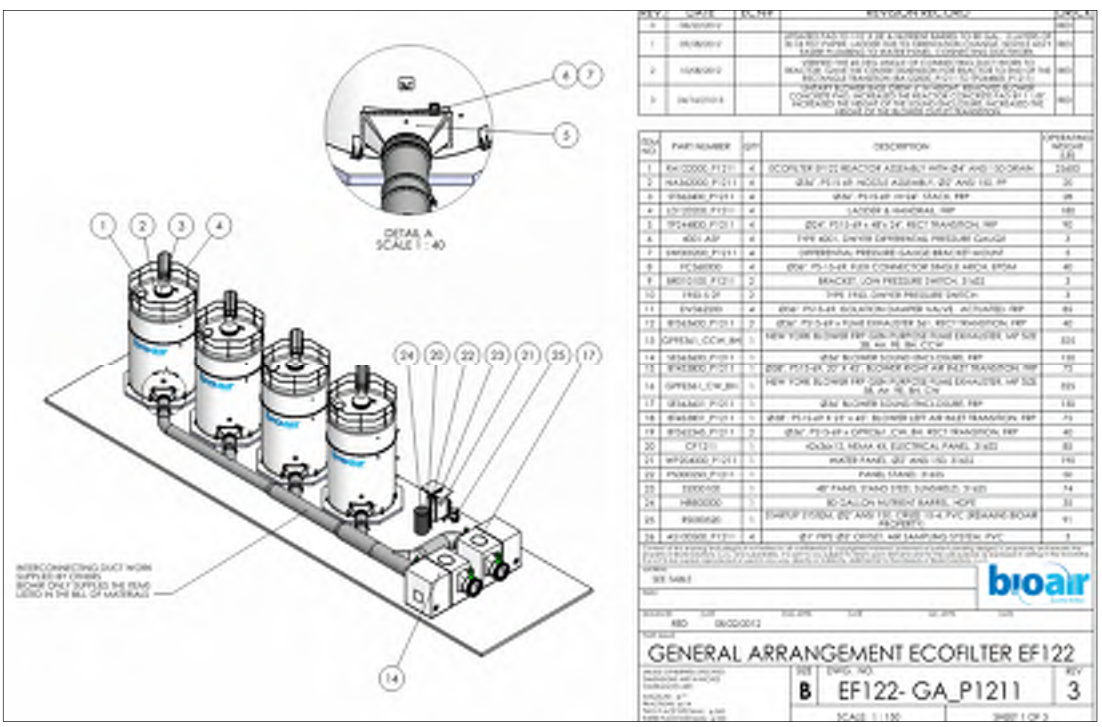


Figure 7-2 Biotrickling Filter Layout

Figure 7-3 Biotrickling Filter Installation

Capital costs for this equipment are presented in **Table 7-7**.

Table 7-7 Biotrickling Filter Costs

Item[1]	Airflow (cfm)	Number	Diameter each (ft)	Cost/cfm	H_2S Level (ppm)	Media Warranty	Direct Cost for Comparison
Biotrickling Filters	40,000	4	12	$60[1]	50	None	$3.8M

Notes: [1] Includes interconnecting ductwork between the fans and vessels.

7.4.4 Assumptions

The 2013 Report indicated that the airflow from the various odor sources at the headworks was insufficient due to water in the ductwork and flooding conditions at the plant. This assessment assumes that there will be additional work done to correct the air conveyance system to maximize the flow from each source and minimize the concentrations to be treated, and that the design criteria of airflow and H_2S levels will be confirmed afterward

Note that H_2S is a dangerous gas and exposure should not be taken lightly. The United States Department of Occupational Health and Safety (OSHA) stipulates that H_2S is "Immediately Dangerous to Health and Life" at 100 ppm: at this level H_2S begins to paralyze the olfactory senses and the sense of smell is lost. Levels below 100 ppm can still cause serious health problems. At one part per billion H_2S can be a nuisance odor and create corrosion problems to exposed metal and electronics. OSHA exposure recommendations can be found at https://www.osha.gov/SLTC/hydrogensulfide/exposure.html. Health hazards associated with H_2S are summarized in **Table 7-8**.

Table 7-8 H_2S Health Hazards

Concentration (ppm)	Symptoms
0.00011 – 0.00033	Typical background concentrations
0.01 – 1.5	Odor threshold (when rotten egg smell is first noticeable to some). Odor becomes more offensive at 3-5 ppm. Above 30 ppm, odor described as sweet or sickeningly sweet.
2 – 5	Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep. Airway problems (bronchial constriction) in some asthma patients.
20	Possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness
50 – 100	Slight conjunctivitis ("gas eye") and respiratory tract irritation after 1 hour. May cause digestive upset and loss of appetite.
100	Coughing, eye irritation, loss of smell after 2-15 minutes (olfactory fatigue). Altered breathing, drowsiness after 15-30 minutes. Throat irritation after 1 hour. Gradual increase in severity of symptoms over several hours. Death may occur after 48 hours.
100 – 150	Loss of smell (olfactory fatigue or paralysis).
200 – 300	Marked conjunctivitis and respiratory tract irritation after 1 hour. Pulmonary edema may occur from prolonged exposure.
500 – 700	Staggering, collapse in 5 minutes. Serious damage to the eyes in 30 minutes. Death after 30-60 minutes.
700 – 1000	Rapid unconsciousness, "knockdown" or immediate collapse within 1 to 2 breaths, breathing stops, death within minutes.
1000 – 2000	Nearly instant death.

7.5 Instrumentation and Controls Improvements

This section summarizes the proposed modifications and improvements of the existing SCADA system at the Maxson WWTP.

7.5.1 Instrumentation

Instrumentation furnished under this project will use the latest industry standards for monitoring the process parameters. For flow measurement the City requested the use of ABB magnetic flow meters. ABB magnetic flow meters are currently used at the site and have the Calmaster Calibration. At the time of construction the newest version of the calibration software will be furnished. The effluent flow leaving the plant is currently measured using a Parshall Flume. Due to how it was constructed, the Parshall Flume does not accurately measure flow. It is important to improve effluent flow monitoring for historical data collection and to help the operations staff.

High pressure switches and check valve limit switches on the discharge of all new pumps will serve as pump protection. These protection devices will be hardwired to the Variable Frequency Drive (VFD) or motor starters. In addition, a liquid-filled pressure gauge will be installed on the discharge of each new pump.

Dissolved oxygen (DO) measurement in the new aeration basins will be achieved using Hach analytical instruments. The DO probes will be pole mounted and extended into each new basin. This type of instrument needs frequent cleaning in order to keep the sensing head of the probe clear of debris. A probe air-blast cleaning system, manufactured by Hach, will be furnished with each new probe. This will reduce the down time of the probe required for manual cleaning.

Due to the harsh nature within the proposed peracetic acid (PAA) tanks, chemical-resistant level instruments will be used for this application. Continuous level monitoring will be measured using Pulsar Ultrasonic level instruments. The transducer within the tanks will be coated with a chemical resistant material. Point-level indication for high level/overflow conditions within the tanks will be achieved using a capacitance probe or float-type instrument. Leak detectors will be installed in each new double walled tank.

Sludge blanket monitoring will be installed in all new and existing clarifiers. Monitoring of the sludge blanket in the clarifiers will help operations staff in determining the amount of sludge to waste and the amount to return. Manufacturers such as Entech and Cerlic will be further investigated to determine what option will give the most reliable reading.

7.5.2 Controls Network

All new controllers furnished under this project will be an Ovation Controller to match the existing controllers installed at the plant. New controllers will be connected to the existing plant fiber network. The use of fiber is preferred for this project due to inherent surge protection and high data transfer speeds. All new control equipment will reside in air-conditioned spaces due to the ambient levels of hydrogen sulfide (H_2S) at the plant.

It is anticipated that a new Ovation controller will be installed in the electrical building, along with new remote I/O cabinets installed near the clarifiers and chemical building. The new Ovation controller will be connected to the existing DCS system using a fiber connection back to the blower building.

A project was conducted in 2014 to monitor temperature and vibration concerns on the existing blowers at the plant, in order to help better predict equipment failure. The project included the installation of the Ovation Machine Health System (MHM) system, which provides real-time performance monitoring and alarming using the CSI 6500 Machinery Health Monitor. All new blowers included under this project will be monitored and protected using similar equipment. An industrial computer with touch screen will be installed in a new control panel in the new blower building for monitoring and control of the equipment.

7.5.3 Process Controls

There are a number of options under consideration for control of the new aeration equipment. The most common approach for this control is to use feedback from the DO instruments in each aeration tank to adjust the position of the inlet air valve. Operations staff will have the ability to enter a desired DO set point into the controller, and the controller will then set the position of the control valve based off the PID tuning parameters. Operations staff will also have the ability to manual set the position of the valve from SCADA.

Multiple options for controlling of the Returned Activated Sludge (RAS) pumps will be provided. One option is to base the flow set point of the RAS pumps on a percentage of the influent flow into the plant. Another option is to control the RAS pumps with a user-selected flow set point with feedback coming from the flow meter on the discharge of the pumps.

The control of the Waste Activated Sludge (WAS) pumps will be achieved using a user-selected set point indicating the volume of sludge (in gallons) to be wasted. The WAS pumps will turn on based on a timer interval and will run until the selected volume of sludge is wasted. Monitoring of the sludge blankets in the clarifiers will also help operations staff determine how much sludge to waste per day.

The PAA metering pumps will have two application points for dosing of PAA, one at each end of the contact basin. The dosing to the primary application point will be based off a user-selected dosage set point (mg/L), with metering pump speed and subsequent dosing adjusted according to feedback from the effluent flow metering instrument. Another option for controlling dosing at the primary application points will be based on water quality: if excess color is detected in the water, additional PAA would be fed to the contact tank. Dosing at the secondary application points will be used to ensure there is a sufficient PAA residual in the effluent prior to discharge to the distribution system. If the desired PAA residual falls below a user-selected set point, additional PAA will be feed to the secondary application point.

7.6 Gravity System Hydraulic Modifications

7.6.1 Conveyance Between Intermediate Pump Station and Aeration Basins

7.6.1.1 Alternative 1

A new flow diversion structure is recommended downstream of the existing Intermediate Pump Station. The new structure will include two sets of weirs: one set to the existing process train and the other set to the proposed process train. The new flow diversion structure will be designed to split the 170 MGD peak hour flow between the existing and proposed process trains. The weirs to the existing process train will need to have a combined length of 30 feet (between 3 and 6 weir gates), and the weirs to the new process train will need to have a combined length of 15 feet (2 to 3 weir gates). The head across the weirs will be approximately 1.6 feet at peak hour flow.

The existing effluent box at the Intermediate Pump Station and the connection to the existing 102-inch main is not hydraulically ideal. The 102-inch main is not submerged under most conditions and there is significant turbulence in the effluent box that may be reducing the capacity of the main. It is recommended that the new flow diversion structure be approximately 14 feet deeper than the existing effluent box to allow maximum capacity to flow out the new discharge mains and to provide a reliable flow split across the weirs.

Drawing DS-1-1 shows the new Flow Diversion Structure. The structure would be connected to the existing Intermediate Pump Station effluent box, with four openings (5-feet by 6-feet each) saw cut into the existing effluent box wall. The new discharge mains would include a 72-inch to the proposed process train and a 102-inch main to the new North Train Anaerobic Selector.

From a constructability standpoint, the existing Intermediate Pump Station and 102-inch main can be left in operation while the new Flow Diversion Structure is constructed. Bypass pumping will be required during the construction of the four openings between the structures. Bypass pumping would be used to divert flow from the Intermediate Pump Station influent channel to the existing Flow Diversion Structure before the existing process train.

A second option to repurpose the Biotower Pump Station may provide capital cost savings to the City but increased operational costs due to continuous pumping. This would include repurposing the existing Biotower Pump Station to pump the new process train. Three of the existing pumps, with 350 hp WP-II motors and a rated head of 43 feet at 23,000 gpm, could be reused, as the rated head of these pumps is in the range required for the new service. The three pumps in the best condition will be selected for repurposing and will be equipped with new inverter duty motors and variable frequency drives (VFDs). However, the existing pumps would not have sufficient turn-down for the projected minimum flows, which will require the use of a new jockey pump. This jockey pump would be a 200 hp Flowserve 24MVX-D, or equal, rated for 14,000 gpm at approximately 40 feet of head with a VFD.

The existing discharge has multiple 36-inch discharge pipes. Two of these pipes could be used to connect into a new 48-inch discharge main to the new process train. A new discharge magnetic flow meter (located above grade) would be installed on the new 48-inch discharge main. The plant control system would be modified to utilize the existing influent and the new discharge flow meters to send a set proportion of the total flow to the new process train by controlling the variable frequency drives on the pumps.

The Biotower Pump Station wet well and Intermediate Pump Station influent channel would operate together, with the gates to each structure in the open position normally, which is an operational change. If this option is selected, it is recommended to further develop the design and conduct field tests to verify that no unforeseen operational issues will arise when operating the existing influent piping and gates in this manner.

If all new equipment is desired, as opposed to repurposing the existing pumps, four pumps identical to the jockey pump described above could be installed to meet the station design flows of approximately 50 MGD.

From a constructability standpoint, half of the existing Biotower Pump Station could be kept in operation during the modifications by utilizing isolation valves on the existing discharge piping system. This approach would limit the required bypass pumping needed to make the proposed modifications.

7.6.1.2 Alternative 3

Hydraulic modifications required for Alternative 3 are similar to the modifications included in Alternative 1. A new flow diversion structure would be constructed and attached to the existing Intermediate Pump Station. This Structure would also be set 14 feet deeper than the Intermediate Pump Station to achieve maximum capacity of the 102-inch main. As shown in **Drawing DS-1-2**, the Flow Diversion Structure proposed for Alternative 3 is not as large as for Alternative 1. It would also include four openings into the existing pump station wall, but for Alternative 3 these openings would be 4 feet by 5 feet. A new section of 102-inch main would be installed to connect the Flow Diversion Structure with the existing 102-inch main.

The existing Intermediate Pump Station and 102-inch main can be left in operation while the proposed Flow Diversion Structure is construction. Bypass pumping would be necessary to construct the four openings between the two structures. The existing 102-inch main would be plugged where it leaves the existing pump station. Bypass pumping would be used to divert flow from the Intermediate Pump Station influent channel to the existing Flow Diversion Structure before the existing process train.

7.6.2 Effluent Structures

The existing Parshall Flume, Clarifier Effluent Junction Box, Chlorine Tank Distribution Junction Box and Bypass Junction Box will all require modifications or replacement due to hydraulic restrictions or changes in the plant design flow path associated with proposed improvements.

7.6.2.1 Parshall Flume and Clarifier Effluent Junction Box

The incorrect installation of the existing Parshall Flume has created hydraulic constraints and high headloss, requiring replacement of both that structure and the existing Clarifier Effluent Junction Box with a new Clarifier Effluent Junction Box. This proposed Junction Box is presented in **Drawing JB-1-1**.

The proposed Clarifier Effluent Junction Box is a cast-in-place concrete box, 20 feet wide by 20 feet long. The existing effluent box culvert, two 72-inch clarifier effluent mains and clarifier bypass main will be extended into the new Junction Box. The existing 24-inch effluent water line back to the pipe gallery may need to be connected if it is still in service. Gates will be constructed in the box to isolate the 72-inch clarifier effluent main and the clarifier bypass main.

7.6.2.2 Chlorine Tank Distribution Junction Box

The existing Chlorine Tank Distribution Junction Box currently experiences 1 to 2 feet of headloss across the control gate. The Junction Box requires replacement under both Alternative 1 and Alternative 3. The replacement Chlorine Distribution Junction Box is presented in **Drawing JB-1-1**.

Alternative 1:

The existing Junction Box will be demolished and replaced with a new 8-foot by 6-foot box culvert connected to the existing effluent 8-foot by 6-foot box culvert.

Alternative 3:

The existing Junction Box will be demolished and replaced with the new Clarifier 5 N-S Effluent Junction Box. The new Effluent Junction Box is a 12-foot by 12-foot concrete box, connected upstream and downstream to the existing box culvert and the new effluent mains from Clarifiers 5-N and 5-S.

7.6.2.3 Bypass Junction Box

The Bypass Junction Box can either be used for bypass pumping (discussed below) or can be replaced with the proposed Disinfection Junction Box. If the Bypass Junction Box is used for bypass pumping, the new Disinfection Junction Box will be constructed upstream of the existing Bypass Junction Box. This new box, presented in **Drawing JB-1-1** is required for both Alternatives.

The new Disinfection Junction Box is a 30-foot by 15-foot box divided into two equal (15-foot by 15-foot) halves. The two halves are divided by a wall with a 10-foot by 10-foot normally closed gate, which will allow the Disinfection system to be bypassed. The upstream half of the Junction Box will connect to the existing effluent box culvert and the new 102-inch main from the Disinfection system. The downstream half of the new Junction Box will have a connection to the 102-inch main from the Disinfection system, the new 84-inch main to the Effluent Pump Station, and either the existing effluent box culvert or 78-inch main. Isolation gates are required for the 102-inch mains, the 84-inch main and the effluent connection (box culvert or 78-inch main).

7.6.2.4 Bypass Operations

The proposed modifications/replacements for the existing effluent structures will require bypass operations during construction. This can be achieved by installing bypass pumping or bypass piping.

7.6.2.4.1 Bypass Pumping

A temporary bulkhead will be installed downstream of the existing baffle wall in the Parshall Flume and Clarifier Effluent Junction Box. Once the bulkhead is in place the Clarifier Effluent Junction Box could serve as a wet well for bypass pumping during the construction.

The bypass pumps could pump to either the existing Bypass Junction Box (inlet connection would need to be plugged or bulk headed), the Levee Gate Structure or the effluent channel of the Effluent Pump Station.

Additional discussion with TDEC will be required regarding use of the effluent channel of the Effluent Pump Station to determine if this discharge point could be utilized during bypass pumping. This may also require installing additional rip rap at the discharge point to protect the levee, as this discharge point is typically used during high river stages.

During bypass pumping the new Clarifier Effluent Junction Box and downstream modifications would be completed. When these modifications have been completed, the new Clarifier 5 72-inch mains would be connect to the new Clarifier Effluent Junction Box. These connections would be made individually during low flow periods, allowing either the north or south clarifiers to be in service while the others are out of service. The temporary bulk head and reminder of the existing Parshall Flume and Clarifier Effluent Junction could then be demolished and the clarifier bypass connected to the new Clarifier Effluent Junction Box.

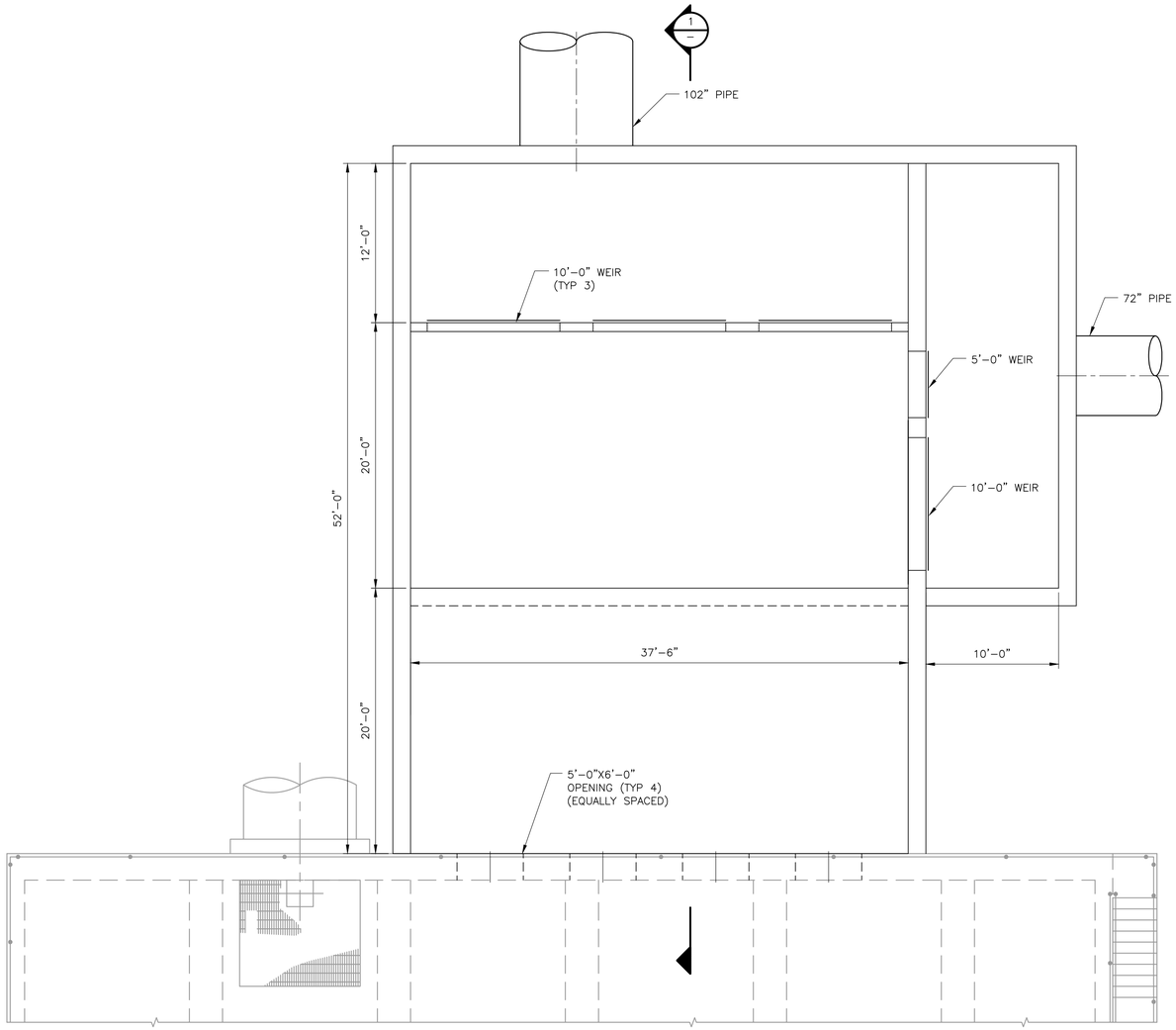
7.6.2.4.2 Bypass Piping

Utilizing a series of limited shut downs of the north or south clarifiers, temporary 60-inch mains could be connected to the existing 72-inch clarifier effluent mains which would then be routed to connect to the existing 66-inch chlorine contact influent mains. These 66-inch mains would also need to be disconnected from the Chlorine Tank Distribution Box. Once these mains were in service the existing Effluent Pump Station could be used to pump the effluent out of the plant during construction.

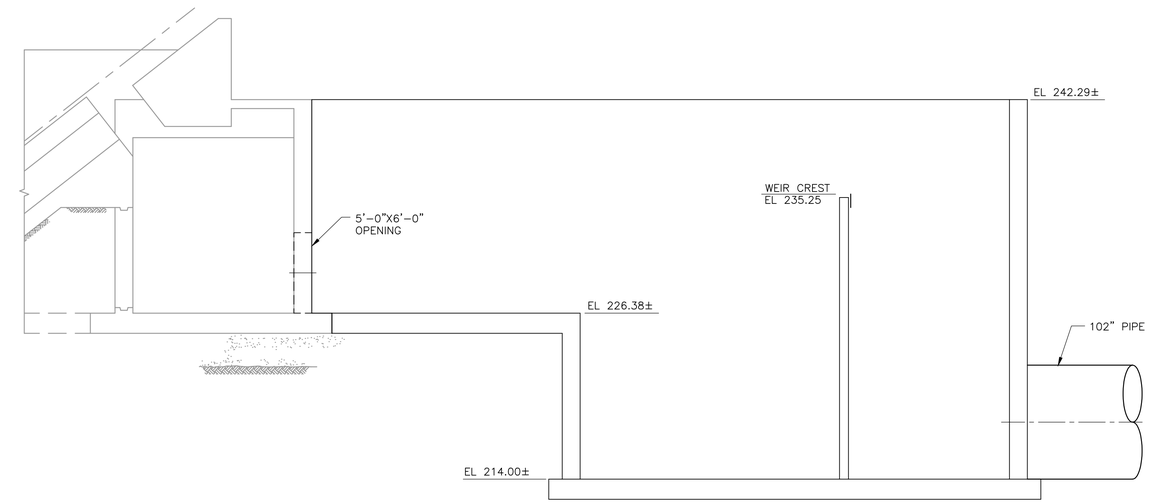
Additional discussion with TDEC will be required regarding the use of the effluent channel of the Effluent Pump Station to determine if we could use this discharge point during bypass pumping. This may also require installing additional rip rap at the discharge to protect the levee, as this discharge point is typically used during high river stages.

The Effluent Pump Station does have reported flow limitations so it would be necessary to have 20 to 40 MGD of emergency bypass pumping from the existing Chlorine Contact Tanks to the Effluent Pump Station Effluent Box in the chance the plant experiences the design peak flow during construction. If this option is the preferred option moving forward, additional we could flow testing at the Effluent Pump Station will be conducted to determine the required flow from emergency bypass pumping.

During the bypass operation, the new Clarifier Effluent Junction Box and downstream modifications would be completed. When these modifications have been completed the new Clarifier 5 72-inch mains would be connected to the new Clarifier Effluent Junction Box. These connections would be made individually during low flow periods, allowing either the north or south clarifiers to be in service while the others are out of service.



PLAN
3/16" = 1'-0"



SECTION 1 –
3/16" = 1'-0"

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

T.E. MAXSON WWTP

Drawing: DS-1-1 SHEET OF

CITY OF MEMPHIS

DIVERSION STRUCTURE ALT 1

MEMPHIS, TN

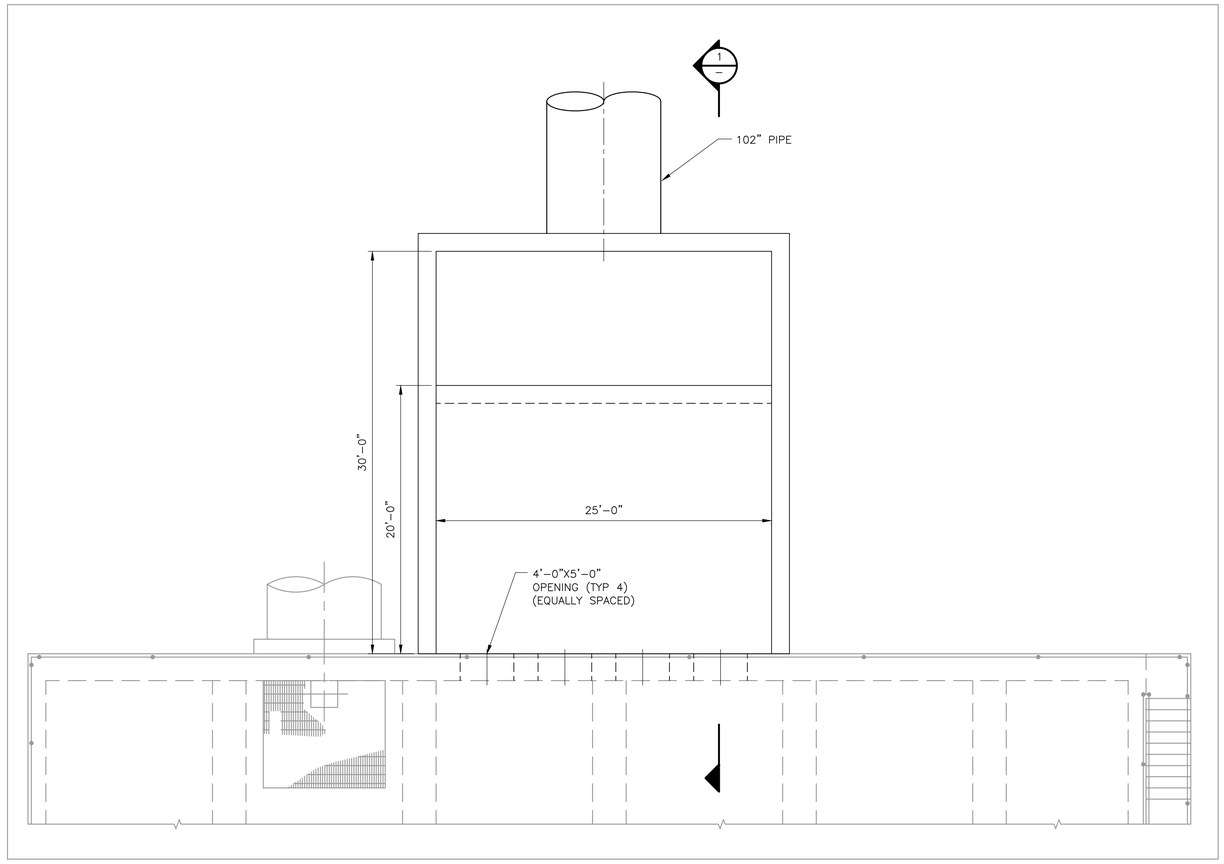
SURVEY	X	DATE	X	BOOK	X
DRAWN BY	X	DATE	X	SCALE	AS NOTED
DESIGN BY	X	DATE	X	PROJECT	36694-111641

REVIEWED

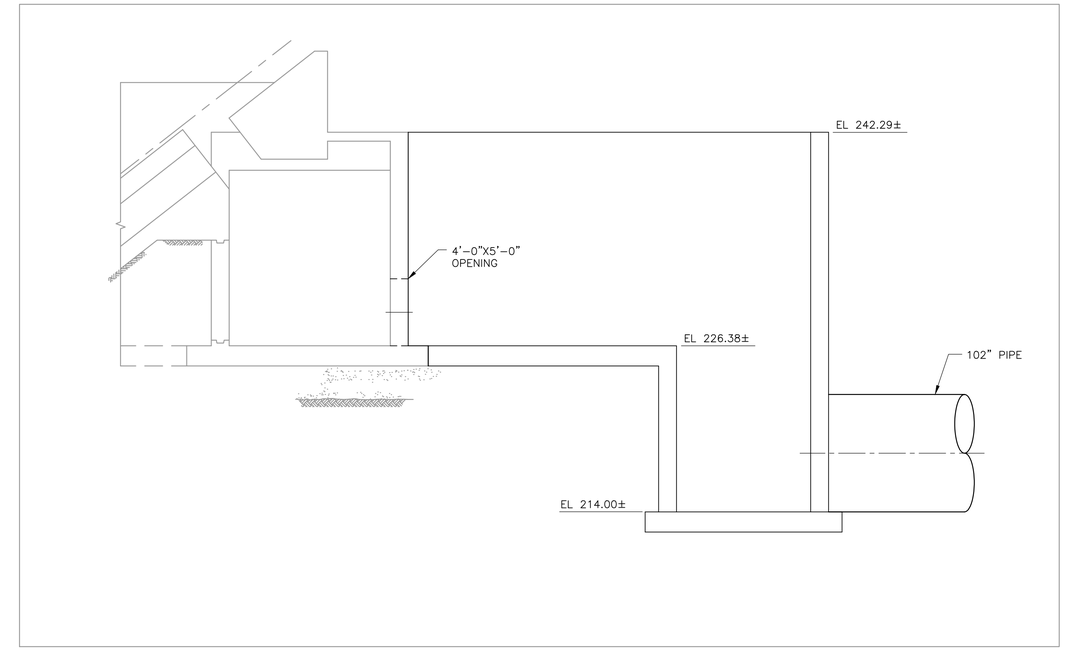
DEP. CITY ENGINEER DATE CITY ENGINEER DATE

DIRECTOR OF PUBLIC WORKS

10% SUBMITTAL - NOT FOR CONSTRUCTION



PLAN
3/16" = 1'-0"



SECTION 1
3/16" = 1'-0"

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

Drawing DS-1-2

SHEET OF

CITY OF MEMPHIS

DIVERSION STRUCTURE ALT 3

MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	X
DRAWN BY	X	DATE	X	SCALE	AS NOTED
DESIGN BY	X	DATE	X	PROJECT	36694-111641

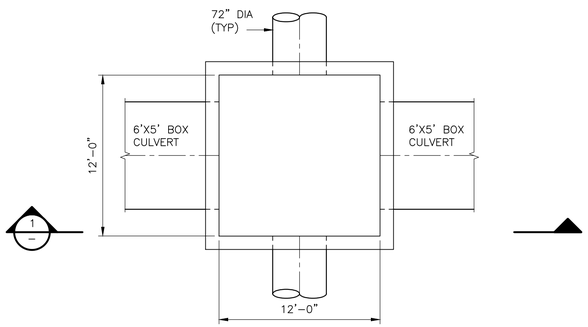
REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

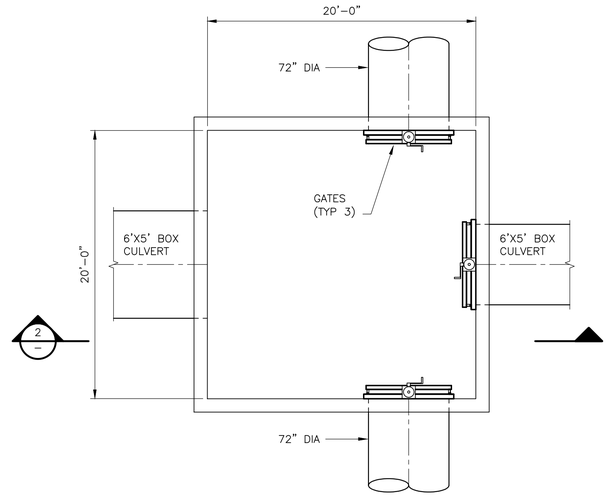
T.E. MAXSON WWTP

10% SUBMITTAL - NOT FOR CONSTRUCTION



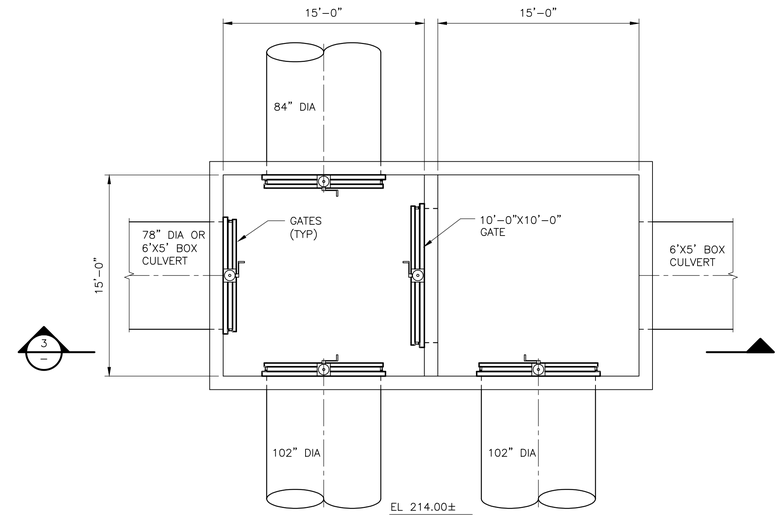
ALT 1
CLARIFIER 5N-S EFFLUENT JUNCTION BOX

PLAN
3/16" = 1'-0"



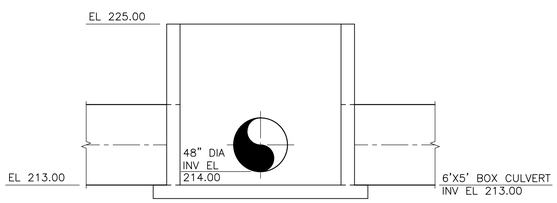
ALT 1 AND 3
CLARIFIER EFFLUENT JUNCTION BOX

PLAN
3/16" = 1'-0"

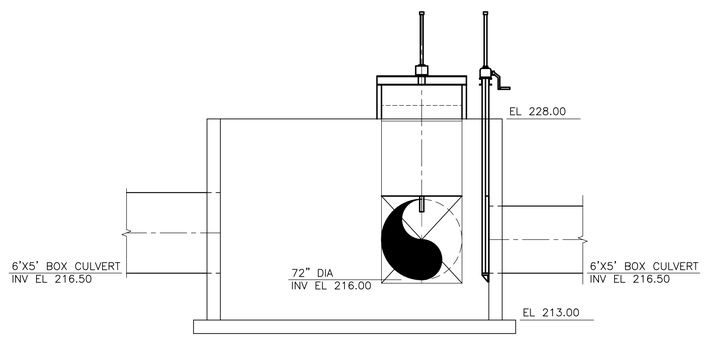


ALT 1 AND 3
DISINFECTION JUNCTION BOX

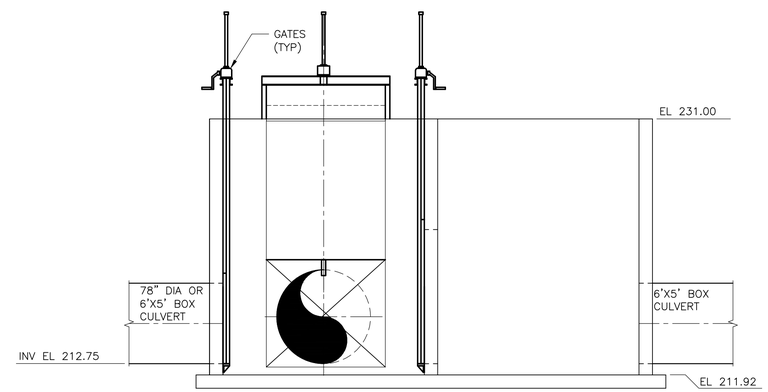
PLAN
3/16" = 1'-0"



SECTION 2
3/16" = 1'-0"



SECTION 2
3/16" = 1'-0"



SECTION 3
3/16" = 1'-0"

REVISION		
ITEM NO.	DESCRIPTION of CHANGE	APPROVAL DATE

CDM Smith
210 25TH Avenue North
Suite 1102
Nashville, TN 37203
Tel: (615) 3203161

T.E. MAXSON WWTP

Drawing JB-1-1

SHEET OF

CITY OF MEMPHIS
JUNCTION BOXES
PLANS AND SECTIONS
MEMPHIS, TN

SURVEY	X	DATE	X	BOOK	X
DRAWN BY	X	DATE	X	SCALE	AS NOTED
DESIGN BY	X	DATE	X	PROJECT	36694-111641

REVIEWED

DEP. CITY ENGINEER DATE CITY ENGINEER DATE

10% SUBMITTAL - NOT FOR CONSTRUCTION

BLACK & VEATCH

8400 Ward Parkway, P.O. Box No. 8405, Kansas City, Missouri 64114, (913) 339-2000

Memphis, Tennessee
Anaerobic Digestion Study

B&V Project 30554
B&V File B
October 20, 1996

Jerry R. Collins, Jr., PE
Administrator, Environmental Engineering
Division of Public Works
125 N. Mid-America Mall, Room 620
Memphis, Tennessee 38103-2091

Subject: Preliminary Review of Alternatives

Dear Mr. Collins:

We have completed our preliminary sizing of the sludge digestion facilities and have developed five alternatives, A through E, for the anaerobic digestion of the primary and waste activated (WAS) sludges at the T. E. Maxson Wastewater Treatment Plant. Alternatives A through E include multiple options for WAS thickening and digested sludge dewatering processes. We are currently screening these options to determine which appears to be the most economical for both thickening and dewatering. Once that is determined we will continue with our evaluation of life cycle costs based on the selected thickening and dewatering option for each alternative.

We have enclosed six sheets of schematics depicting the existing sludge treatment processes for the Maxson WWTP as well as the five alternatives we are evaluating. We have also enclosed two tables. The first table lists alternatives A through E. Under each alternative are raw and digested sludge quantities and concentrations, the size and number of the digestion facilities, and the number and sizes of equipment required for WAS thickening and dewatering. The second table also expands on the location of the facilities and the thickening and dewatering options that are being screened.

For your convenience, we have summarized Alternatives A through E below.

Alternative A: Alternative A is the digestion of combined primary and WAS sludge in 200 mg of covered lagoons. Of this volume, 122 mg are new, covered anaerobic lagoons. WAS sludge will be thickened prior to introduction into the lagoon by gravity belt thickeners, centrifuges, or dissolved air flotation tanks. After digestion, the combined sludge will be dewatered by belt filter presses or centrifuges.

Jerry R. Collins, Jr., PE

B&V Project 30554
October 20, 1996

Alternative B: Alternative B is the digestion of primary sludge in new conventional digesters and the digestion of WAS in existing and new covered anaerobic lagoons. WAS sludge will be thickened prior to introduction into the lagoon by gravity belt thickeners, centrifuges, or dissolved air flotation tanks. After digestion, each sludge will be dewatered by belt filter presses or centrifuges.

Alternative C: Alternative C is the digestion of combined primary and WAS sludge in conventional digesters. WAS sludge will be thickened prior to introduction into the digesters by gravity belt thickeners, centrifuges, or dissolved air flotation tanks. After digestion, the combined sludge will be dewatered by belt filter presses or centrifuges.

Alternative D: Alternative D is similar to Alternative B except that the digestion of primary sludge will take place in thermophilic digesters. WAS will be thickened prior to introduction into new and existing covered anaerobic lagoons. Methods for thickening include belt filter presses and centrifuges. After digestion, the combined sludge will be dewatered by belt filter presses or centrifuges.

Alternative E: Alternative E is similar to Alternative C except that the digestion of sludge will take place in thermophilic digesters. WAS will be thickened prior to introduction into the digesters by gravity belt thickeners, centrifuges, or dissolved air flotation tanks. After digestion, the combined sludge will be dewatered by belt filter presses or centrifuges.

After we finalize the screening of the dewatering and thickening options for each alternative we will again summarize each alternative and forward the summary to you for your comments.

If you have any comments on this initial information please contact us. If you have any questions, please do not hesitate to call me at 913-458-3574 or Steve Phillips.

Very truly yours,

BLACK & VEATCH

[redacted]

Jerry Burnett
Project Engineer

LAW
Enclosures

SUBJECT MEMPHIS, TN.
WORK ANAEROBIC DIGESTER STUDY
PROJECT NO. 30554.101
FILE NO.

DATE 4-22 19
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PAGE NO. 1 OF 4

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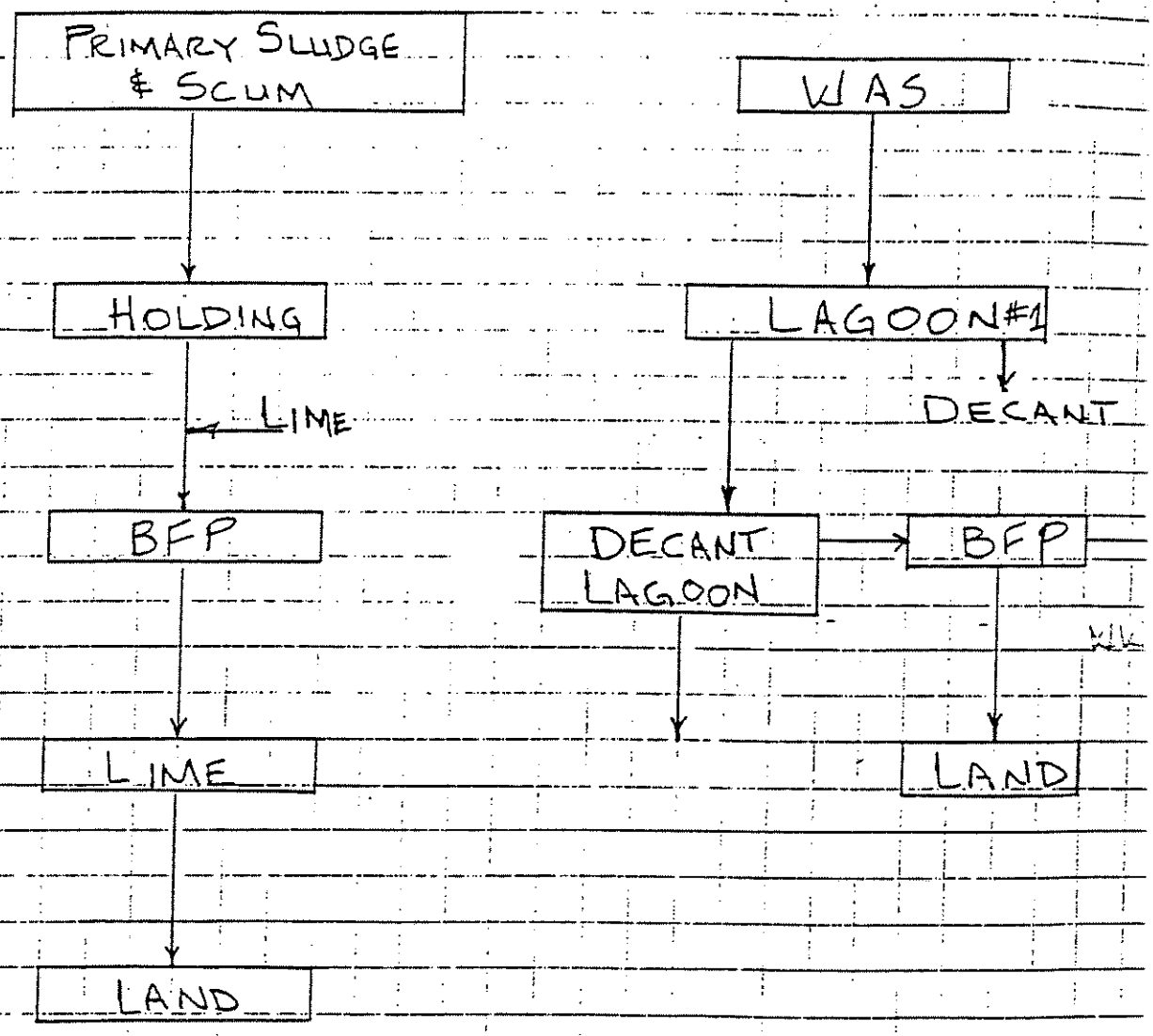
EXISTING SLUDGE HANDLING



SUBJECT MEMPHIS TN
WORK ANAEROBIC DIGESTER STUDY
PROJECT No. 30554.101 FILE No.
DATE 4-22 19
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PAGE No. 2 OF 1

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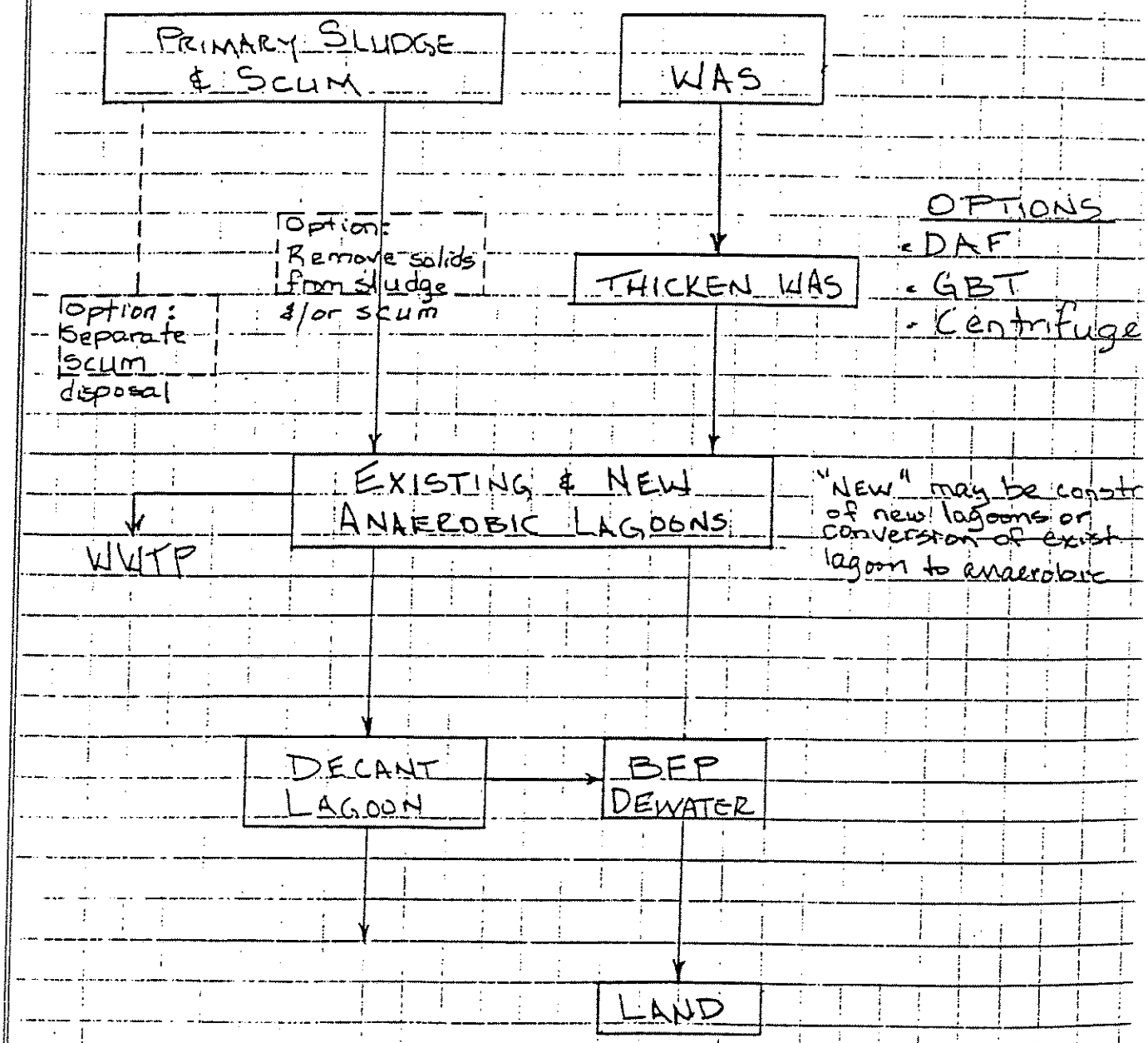
ALTERNATIVE SLUDGE HANDLING

Alternative A - Anaerobically digest all prima & WAS sludge in covered lagoons



SUBJECT MEMPHIS, TN.
WORK ANAEROBIC DIGESTER STUDY
PROJECT No. 30554.101
FILE No.
DATE 4-22 19
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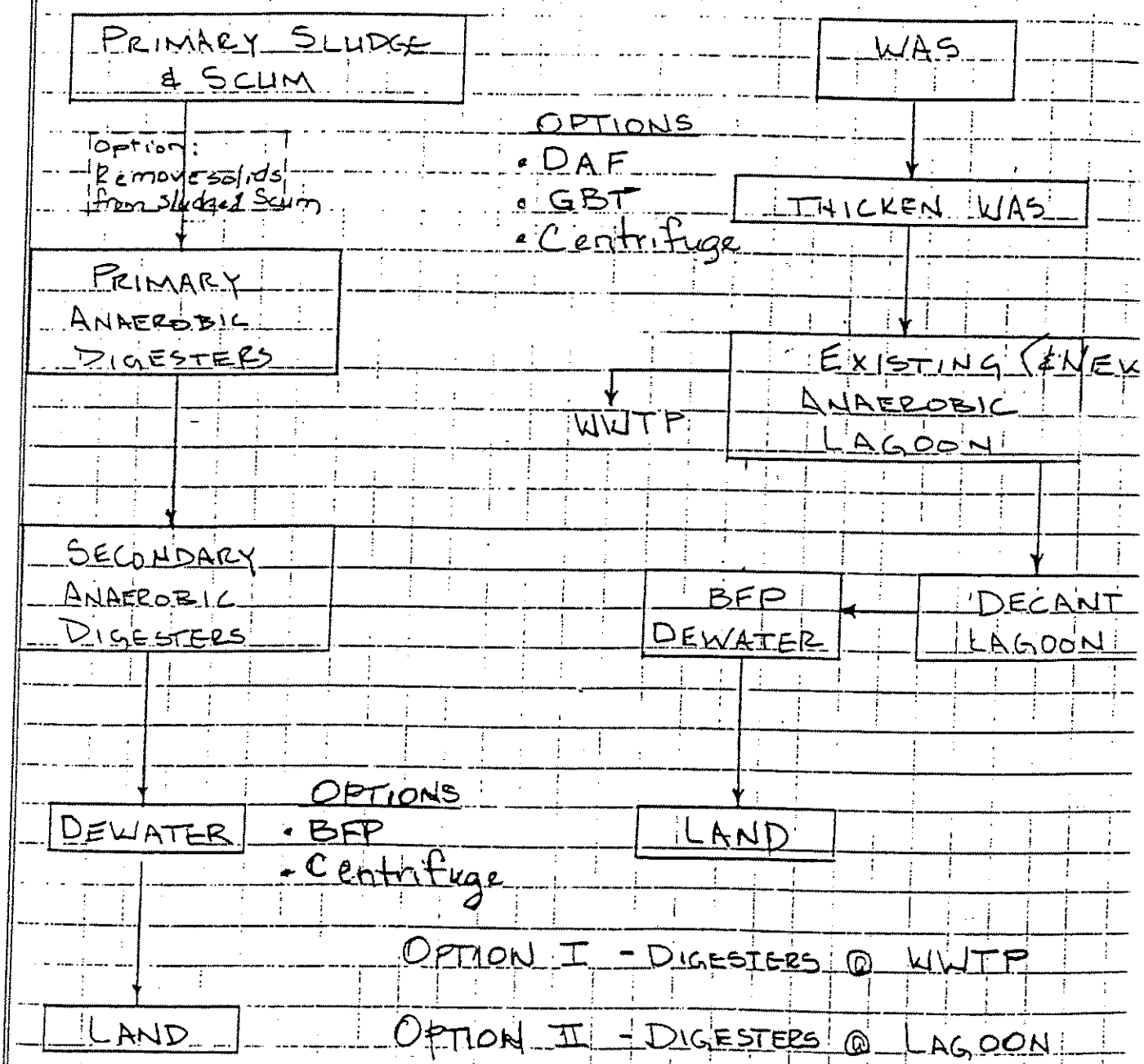
Alternative B - a. Use existing anaerobic lagoon, &
b. Construct new "conventional" anaerobic digesters.



OPTION I - DIGESTERS @ WWTP

OPTION II - DIGESTERS @ LAGOON

SUBJECT MEMPHIS, TN.

WORK ANAEROBIC DIGESTER STUDY

PROJECT NO. 30554.101

FILE NO.

DATE 4-22 19

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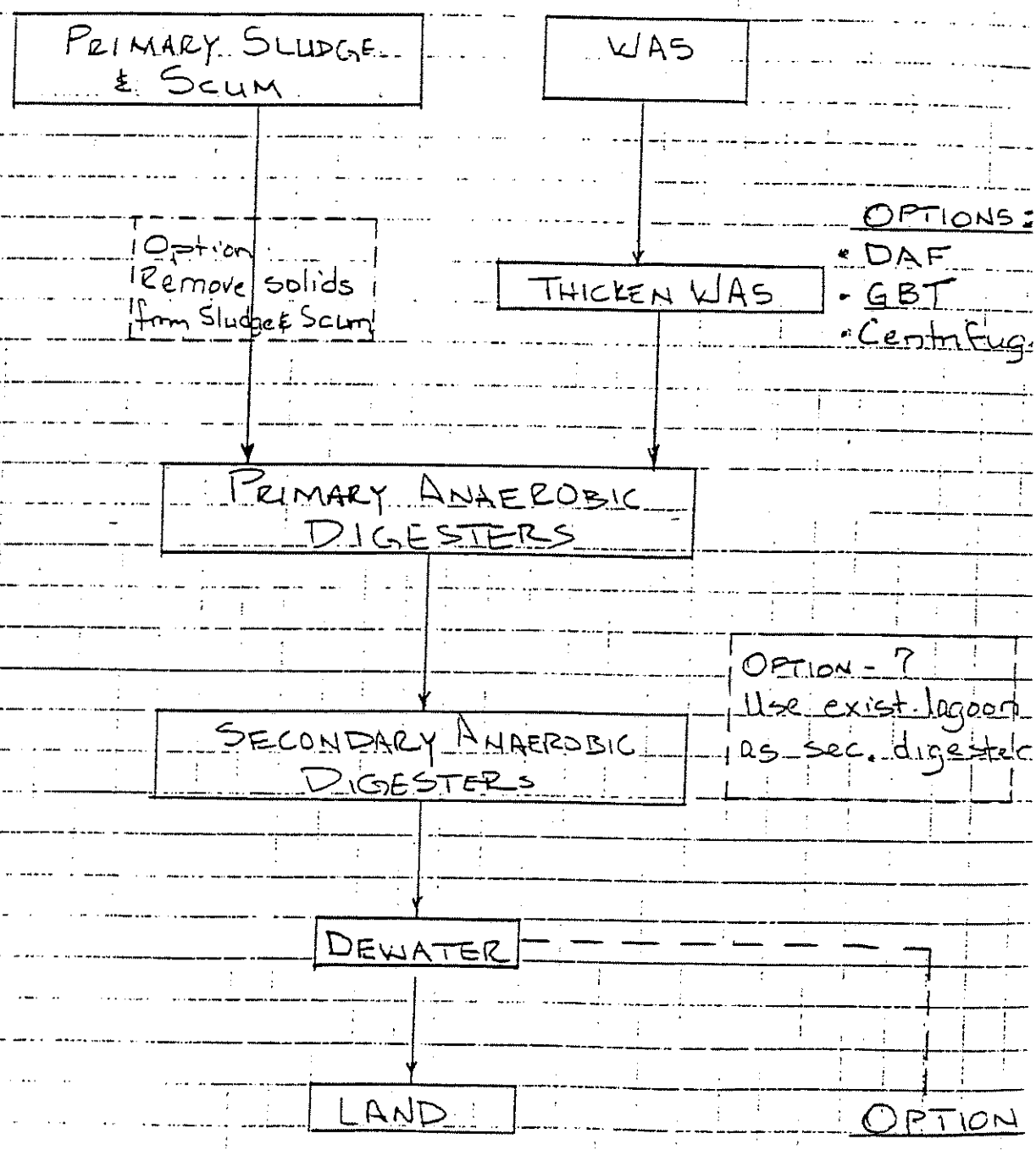
Alternative C - Anaerobically digest all sludge in conventional digestion facilit



OPTION I - DIGESTERS @ WWTP

OPTION II - DIGESTERS @ LAGOON • BFP

SUBJECT MEMPHIS, TN.
WORK ANAEROBIC DIGESTER STUDY
PROJECT NO. 30554.101
FILE NO.
DATE 4-22 19
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PAGE NO. 3 OF 4

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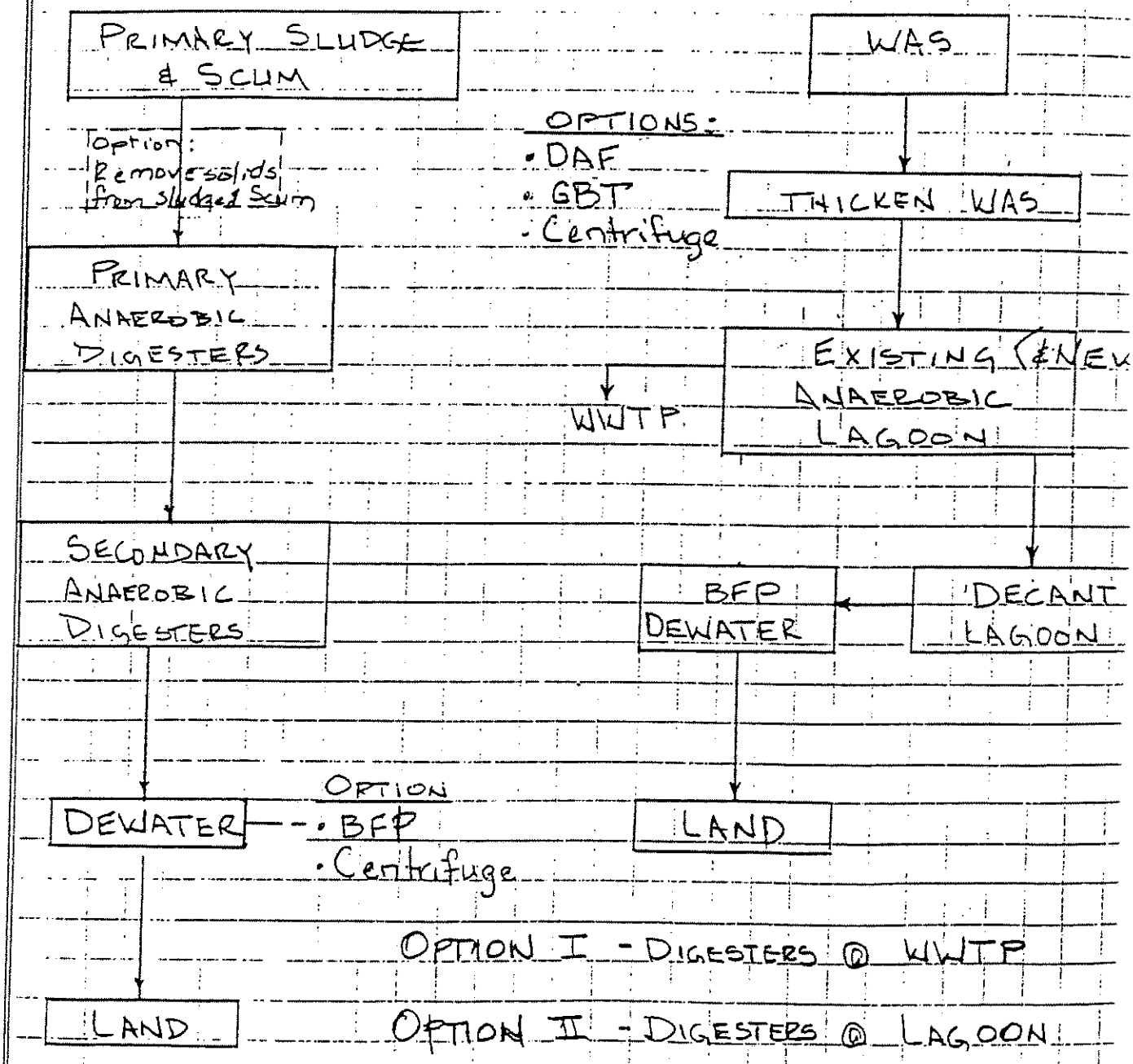
Alternative D - a. Use existing anaerobic lagoon. &
b. Construct new "thermophilic" anaerobic digesters.



OPTION I - DIGESTERS @ WWTP

OPTION II - DIGESTERS @ LAGOON

SUBJECT MEMPHIS, TN.
WORK ANAEROBIC DIGESTER STUDY
PROJECT NO. 30554.101
FILE NO.
DATE 4-22 19
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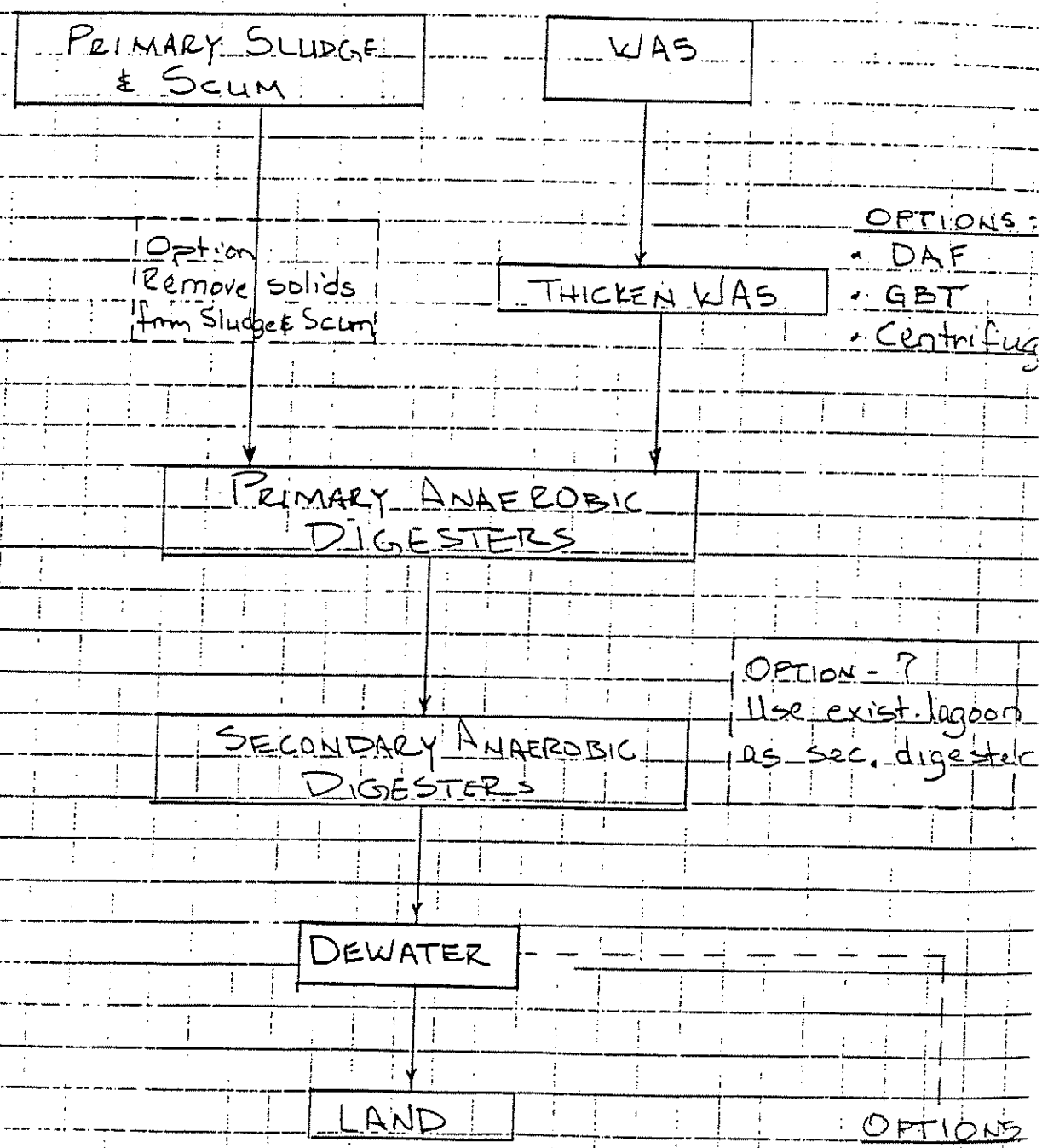
Alternative E - Anaerobically digest all sludge in thermophilic digestion facilit



OPTION I - DIGESTERS @ KKTP

OPTION II - DIGESTERS @ LAGOON • BFP

Facility	ALTERNATIVES A All Lagoon	B Conv. Primary Lagoon WAS	C All Conventional	D Thermo. Primary Lagoon WAS	E All Thermophilic
Raw Sludge					
Primary					
Quantity, ppd	250,000	250,000	250,000	250,000	250,000
Concentration, %	4	4	4	4	4
WAS					
Quantity, ppd	400,000	400,000	400,000	400,000	400,000
Concentration, Unthickened	0.9	0.9	0.9	0.9	0.9
Concentration, Thickened %	4	4	6	4	6
WAS Thickening (24 hrs/day)					
GBT (3 meter units)	12 (14)	12 (14)	12 (14)	12 (14)	12 (14)
Centrifuge	8 (9)	8 (9)	8 (9)	8 (9)	8 (9)
DAF					
Square feet	16,700 (19,240)	16,700 (19,240)	16,700 (19,240)	16,700 (19,240)	16,700 (19,240)
70' Diameter Tanks, no.	4 (5)	4 (5)	4 (5)	4 (5)	4 (5)
Anaerobic Digestion					
Lagoons (new volume mg)	122	78	-	78	-
Digesters					
Primary					
105' Diam., 30' SWD	-	6		-	-
120' Diam., 30' SWD	-	-	14	-	-
Secondary					
105' Diam., 30' SWD	-		4	-	2
95' Diam., 30' SWD		2		1	
Thermophilic					
95' Diameter, 30' SWD	-	-	-	4	-
110' Diam., 30' SWD	-	-	-	-	8
Gas Holder Sphere	N/A	1	1	1	1
Digested Sludge					
Total					
Quantity, ppd	445,400	397,400	309,200	397,400	309,200
Concentration, %	2.7	2.45	2.39	2.45	2.39
Primary					
Quantity, ppd	-	136,000	-	136,000	-
Concentration, %	-	2.18	-	2.18	-
WAS					
Quantity, ppd	-	261,400	-	261,400	-
Concentration, %	-	2.6	-	2.6	-
Dewatering (24 hrs/day)					
Polymer (10 lbs/ton dry solids)					
WAS					
BFP (2 meter units)	-	6 (7)	-	6 (7)	-
Centrifuge	-	4 (5)**	-	4 (5)**	-
Primary					
BFP (2 meter units)	-	4 (5)	-	4 (5)	-
Centrifuge	-	2 (3)	-	2 (3)	-
Combined					
BFP (2 meter units)	9 (10)	-	7 (8)	-	7 (8)
Centrifuge	7 (8)**	-	5 (6)***	-	5 (6)***

* Numbers in ( ) are the installed number of units

**Since existing dewatering building is adequate for immediate growth in Alternative A and adequate for ultimate growth in Alternative B and D, then centrifuge option is not justifiable economically.

***Since existing BFP dewatering facility is adequate, centrifuge option can not be economically justified.

CAPITAL COSTS

-lanuary 17, 1997
·mphis Digester Study Summary of Calculations
.I 30554.101

General

O&M Estimates from Jorj Long for thickening and dewatering and polymer
See Notebook under Cost tab
Cecil Stegman has updated ENR index through September
Assume odor control on GBT and BFP only.
Jerry Burnett decided to use 15% on this project for new and existing building electrical work
Jerry Burnett decided to use 10% for sitework on this project
Use 1/2% per year for material cost of routine maintenance and electricity or a maximum of $55,000.
Equipment life of 20 years except for lagoon covers which will have a life of ten years.
18% Engineering
20% Contingencies

Cover for Lagoon - 825'x825' and 1300'x1300'

Cost from Memphis Maxson WWTP project # 24988, 1994, covering 825'x825' lagoon. (Doug Lisak and Cindy Hurd contacts)
Cost is for entire job including sludge pumps, gas piping, gas control bldg., and equipment and flare.
Adjusted for September 1996. (5672/5424) x $3,152,399.75 = **$3,296,536**
For 1,300' x 1,300' lagoon: **$5,195,000**

Build New Lagoons - 175 mg and 78 mg. Max water level is 21' deep and total side depth is 25'.

From Larry Steinke computer program that determines amount of cut & fill :
Larry Steinke and Cecil Stegman recommended $2.50 for cut and $1.50 for fill.
*SDP thought price might be low. I spoke with Jeff Brooks of the transportation estimators. He said if compaction for the levees are included in the cost he recommends $3.00 for cut and $5.00 for fill.
Price increase also due to river bottom soil being more difficult to handle. Also increase liner to $1.00 in case special requirements for lining are determined during actual design.
A cost for clearing & grubbing, stripping topsoil & stockpiling, placing top soil on outside of berms, seeding, and other sitework was added. Use a percentage of 10% for all sitework.
Option A requires two parallel 10" forcemains from the primary clarifiers to the new lagoons. Use a cost from Steinke of $50/lin ft. Approximate distance is 8,000 feet.

78 mg lagoon will be approximately 825' x 825'	Cut	159,422	cu yd	x	$3.00	cu yd	=	$478,267
	Fill	159,372	cu yd	x	$5.00	cu yd	=	$796,861
	Liner	643,709	sq ft	x	$1.00	sq ft	=	$643,709
	Fence	4,000	lin ft	x	$12.50	lin ft	=	$50,000
	Gravel Road	3,240	lin ft	x	$10.00	lin ft	=	$32,400
	Decant Structure		LS	x	$30,000.00	LS	=	$30,000
	Inlet Structure		LS	x	$2,000.00	LS	=	$2,000
	Sitework	10%		x			=	$203,324
							Total	$2,236,561
125 mg lagoon will be approximately 1000' x 1000'	Cut	286,454	cu yd	x	$3.00	cu yd	=	$859,362
	Fill	286,426	cu yd	x	$5.00	cu yd	=	$1,432,130
	Liner	1,242,000	sq ft	x	$1.00	sq ft	=	$1,242,000
	Fence	6240	lin ft	x	$13	lin ft	=	$78,000
	Gravel Road	5278	lin ft	x	$10	lin ft	=	$52,780
	Decant Structure		LS	x	$30,000	LS	=	$30,000
	Inlet Structure		LS	x	$2,000	LS	=	$2,000
	Forcemain	16000	lin ft	x	$50	lin ft	=	$800,000
	Sitework	10%		x			=	$449,627
							Total	$4,945,899

Total Option A Lagoon & Cover **$10,140,899**

Total Option B & D Lagoon & Cover **$5,533,097**

O&M

Option A

$3,510 per month for elec. (from WWTP staff w/ amount increased per lagoon size) = $42,120/yr
10 hrs per week maintenance at covered lagoon x 52 wks/yr = 520 hrs/yr
520 hrs/yr x $21.69/hr (salary from WWTP staff) = $11,280/yr
Use assumed equipment repair cost per year of $20,000/yr after discussion with Jerry Burnett

Total Option A O&M **$73,400**

Option B & D

$1,100 per month for elec. (from WWTP staff) = $13,200/yr
6 hrs per week maintenance at covered lagoon x 52 wks/yr = 312 hrs/yr
312 hrs/yr x $21.69/hr (salary from WWTP staff) = $6,770/yr
Use assumed equipment repair cost per year of $20,000/yr after discussion with Jerry Burnett

Total Option B & D **$40,000**

Fixed Cover Primary Digesters - 105 ' Diam. and 120' Diam. with SWD of 30'.

Use $8.00/cu ft for digester and $150/sq ft for building based on previous jobs. No basement per Jerry Burnett.
Install one 100'x100' building w/ basement for every four digesters per Mark Bushouse & previous plans.

Digesters

	Item	Quantity	Volume	Unit	Unit Cost	Total
Option B	105' Diam.	6	259,639	cu ft	$8.00	$12,462,672
Option C	120' Daim.	14	339,120	cu ft	$8.00	$37,981,440

Digester Buildings

	Item	No. of Bldgs.	Area/bldg	Unit	Unit Cost	Total
Option B	100'x100' Building	1.5	10,000	sq ft	$150.00	$2,250,000
	15% equip. elec.					$337,500
Option C	100'x100' Building	3.5	10,000	sq ft	$150.00	$5,250,000
	15% equip. elec.					$787,500

Add on 10% for sitework to each option. Sitework includes yard piping, grading, seeding, and other misc. costs.

Total for B = $15,050,172
with 10% $16,555,189

Total for C = $44,018,940
with 10% $48,420,834

O&M

Option B — 2 people 24 hours per day — $411,000 per year
Parts for repair use 1/2% of initial cost per year for routine maintenance of equipment & power.
Use the maximum value of $55,000.

Total for B O&M $466,000

Option C — 3 people 24 hours per day — $616,500 per year
Parts for repair use 1/2% of initial cost per year for routine maintenance of equipment & power.
Use the maximum value of $55,000.

Total for C O&M $672,000

Floating Cover Secondary Digesters - 105' Diam. and 95' Diam. with SWD of 30'

Same as above

Digesters

	Item	Quantity	Volume	Unit	Unit Cost	Total
Option C	105' Diam.	4	259,639	cu ft	$8.00	$8,308,448
Option E	105' Diam.	2	259,639	cu ft	$8.00	$4,154,224
Option B	95' Diam.	2	212,539	cu ft	$8.00	$3,400,624
Option D	95' Diam.	1	212,539	cu ft	$8.00	$1,700,312

Digester Buildings

	Item	No. of Bldgs.	Area	Unit	Unit Cost	Total
Option C	100'x100' Building	1	10,000	sq ft	$150.00	$1,500,000
	15% equip. elec.					$225,000
Option E	100'x100' Building	0.5	10,000	sq ft	$150.00	$750,000
	15% equip. elec.					$112,500
Option B	100'x100' Building	0.5	10,000	sq ft	$150.00	$750,000
	15% equip. elec.					$112,500
Option D	100'x100' Building	0.5	10,000	sq ft	$150.00	$750,000
	15% equip. elec.					$112,500

Add on 10% for sitework to each option. Sitework includes yard piping, grading, seeding, and other misc. costs.

Total for C = $10,033,448
with 10% $11,036,793

Total for E = $5,016,724
with 10% $5,518,396

Total for B = $4,263,124
with 10% $4,689,436

Total for D = $2,562,812
with 10% $2,819,093

O&M

See primary digesters for O&M for both primary digesters and secondary digesters.
Parts for repair use 1/2% of initial cost per year for routine maintenance of equipment & power for each option

Thermophilic Fixed Cover Primary Digesters - 95' Diam. and 110' Diam. with SWD of 30'

Same as for conventional digesters except add 10% to total cost for additional mechanical equipment required for thermophilic digesters.

Digesters

	Item	Quantity	Volume	Unit	Unit Cost	Total
Option E	110' Diam.	8	284,955	cu ft	$8.00	$18,237,120
Option D	95' Diam.	4	212,539	cu ft	$8.00	$6,801,248

Digester Buildings

	Item	No. of Bldgs.	Quantity	Unit	Unit Cost	Total
Option E	100'x100' Building	2	10,000	sq ft	$150.00	$3,000,000
	15% equip. elec.					$450,000
Option D	100'x100' Building	1	10,000	sq ft	$150.00	$1,500,000
	15% equip. elec.					$225,000

Add on 10% for sitework to each option. Sitework includes yard piping, grading, seeding, and other misc. costs.
Add on additional 10% for extra mechanical equipment required for thermophilic digesters.

Total for E = $21,687,120
with 20% **$26,024,544**

Total for D = $8,526,248
with 20% **$10,231,498**

O&M

Option E — 2 people 24 hours per day — $411,000 per year
Use 1/2% of initial cost per year for routine maintenance of equipment & power
Use maximum cost of $55,000 per year.
Assume additional $15,000 for extra elec. required for thermo process
Total for D O&M **$481,000**

Option D — 3 people 24 hours per day — $616,500 per year
Use 1/2% of initial cost per year for routine maintenance of equipment & power
Use maximum cost of $55,000 per year.
Assume additional $15,000 for extra elec. required for thermo process
Total for E O&M **$686,500**

THICKENING

Gravity Belt Thickener - Fourteen, 3 m units

GENERAL :

Jerry Vernen of Flotation Equipment Compay (795-8511) suggested that the budget cost for gravity belt thickeners would be about $120,000 each (not installed price). Total width of the unit would be 158.25". The width of the unit without the drive unit would be 142". In order to facilitate maintenance, the units should have at least 142" between them. Assume Ashbrook 3 meter wide GBT for costs.
Additional costs are polymer system, feed pumps to get sludge to GBTs and belt wash water of at least 85 psi and 40 gpm per GBT. Installed cost for GBT (+20%) is **$144,000**

Odor control is based on a table by Gayle VanDurme. Assume ceilings are 15' high, 22'x22' are required for each piece of equipment, 12 ACH, and 5 ppm.

Gravity Belt Thickener Building

Use $200 per square foot for ground floor plus $100 per square foot for basement.
Assume basement is only under thickener room and pump room.
Building costs include HVAC & Electrical

Total GBT & Building

	Quantity	Unit		Unit Cost	Total
Building - First Floor	26,000	sq ft		$150	$3,900,000
Building - Basement	12,320	sq. ft.		$100	$1,232,000
Gravity Belt Thickeners	14	each		$144,000	$2,016,000
Pumps/Piping		Lump Sum		$1,000,000	$1,000,000
Polymer Feed	7	each		$145,000	$1,015,000
Odor Control					$305,500
3% HVAC for equip.					$274,890
15% elec. equip.					$1,374,450
				Total	$11,117,840

Add on 10% for sitework to each option. Sitework includes yard piping, grading, seeding, and other misc. costs.
Sitework is $1,111,784

Total $12,230,000

O&M

GENERAL :

Assume one polymer system per every two BFP. GBT, Centrifuge, or DAF system.
Use estimate of $145,000 per polymer feed system.
Use 5 lbs/dry ton for DAF and Centrifuge
Use 10 lbs/dry ton for GBT and BFP
$2.50 per dry pound of polymer

Number of hours from Jorj Long of B&V O&M group to man GBTs is 7,934 hrs/yr and 3,104 hrs/yr for maintenance.
GBTs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

7,934	x	23.46	=	$186,132	per year
3,104	x	23.46	=	$72,820	per year

400,000 lbs/day dry solids = 200 tons x 10 lbs/ton x $2.50 = 5,000/day x 365 days = $1,825,000/year
Use 1/2% of initial cost per year for routine maintenance of equipment & power is $52,687 per year.
Odor control based on Gayle Van Durme table for 14 GBTs is $103,800 per year.

O&M Total $2,240,000

Centrifuge - Sharples PM-7600

GENERAL :

Andy Biddle called Ron Moody (708-571-6120) of Sharples on 8/22/96 & received price of $550,000 each
Cost includes electrical, control panel, etc. but is not an installed price
Use $650,000 per centrifuge.

Centrifuge Building -

Assume pumps/piping to be $1,000,000 installed. Also assume one complete polymer system for every two centrifuges which would be 4 polymer systems. Assume each complete polymer system is $145,000.
Use same building costs as for other buildings of $150/sq ft for bottom floor and $100/sq ft for basement.

Total Centrifuges & Building

	Quantity	Unit		Unit Cost	Total
First Floor Building	8,712	sq. ft.		$150	$1,306,800
2nd floor bldg.	8,712	sq. ft.		$150	$1,306,800
Centrifuges	9	each		$660,000	$5,940,000
Pumps/Piping		Lump Sum		$1,000,000	$1,000,000
Polymer feed	4	each		$145,000	$580,000
3% HVAC for equip.					$304,008
15% equip. elec.					$1,520,040
				Total	$11,957,648

Total w/ 10% sitework **$13,153,413**

O&M

Number of hours from Jorj Long of B&V O&M group to man Centrifuges is 24,178 + 12,614 maintenance.
Salary from WWTP staff is $23.46/hr including benefits

24,178	x	23.46	=	$567,216	per year
12,614	x	23.46	=	$295,924	per year

Polymer:
400,000 lbs/day dry solids = 200 tons x 5 lbs/ton x $2.50 = 2,500/day x 365 days = $912,500/year
Use 1/2% of initial cost per year for routine maintenance of equipment & power is $65,767 per year.

Total O&M $1,841,407

***Dissolved Air Flotation - 70' Diam. Tank**

Budgetary costs from Mark Bushouse for 40' diameter DAF are $800,000 including recirc. pumps, piping, & sat. tank
70'/40' = 1.75 x 800,000 = $1,400,000 + 4 sludge pumps at $45,000 (+20% installation) = $1,616,000.
Assume a 110x110 building at $150/sq ft = $1,815,000. Building is shared by five DAFs.
Increase building cost by 15% for equipment electrical work = $2,087,250
Add 10% to total cost for sitework.
Total of $11,184,000 for five DAFs & 110'x110' building.

Total $11,184,000

O&M

Number of hours from Jorj Long of B&V O&M group to man GBTs is 4,695 hrs/yr and 4,388 hrs/yr for maintenance.
DAFs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

4,695	x	23.46	=	$110,145	per year
4,388	x	23.46	=	$102,942	per year

Matt Bond suggested using $2.50 per pound of polymer.
400,000 lbs/day dry solids = 200 tons x 5 lbs/ton x $2.50 = 2,500/day x 365 days = $912,500/year
Use 1/2% of initial cost per year for routine maintenance of equipment & power.

Use maximum of $55,000 per year.

Total O&M $1,181,000

DEWATERING

Belt Filter Press - 2 meter units

TE Maxson BFP Building, 5 presses with room for eight from Monthly Construction Estimate 4/25/96.

Total cost including BFP's is $3,300,000 with each BFP costing $205,850 each BFP

Cost includes electrical and sitework. $2,270,750 Building

Odor Control from Gayle Van Durme based on 5 ppm

Use 15' high ceiling and 22'x22' requirement per BFP or GBT, 12 ACH

O&M

BFPs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

Matt Bond suggested using $2.50 per pound of polymer.

Use 1/2% of initial cost per year for routine maintenance of equipment & power

Use 1/2% of total cost without sitework for building and BFP equipment.

Odor control O&M from Gayle Van Durme program

OPTIONS

OPTION A - 10 BFPs or 8 Centrifuges

BFP

Use existing BFP building by lagoons. Enlarge to house two more BFPs. Add another 30'x75' of building at $150/sq ft.

$337,500 for building plus 15% for equipment electrical = $388,125.

There is room for eight BFPs in the existing building even though there are only five at this time. Install five new BFPs. For TE Maxson BFP building 4/25/96 the cost per BFP installed is $205,850. For five BFPs this would cost $1,029,250

According to Matt Bond, no additional polymer feed systems are required.

Odor Control is $258,700

Additional 10% added to total for sitework for a total of = $1,843,683

Total $1,844,000

BFP O&M

O&M cost for polymer feed system is 445,400 lbs/day = 223 tons x 10 lbs/ton x $2.50 / lb = $5,568/day x 365 days = $2,032,000/yr.

O&M for labor for seven BFPs is 7,933 hours for operations and 2,622 hours for maintenance.

BFPs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

7,933	x	23.46	=	$186,108	per year
2,622	x	23.46	=	$61,512	per year

Use 1/2% of total cost for building and BFP equipment for new and exist..

Exist. building was ($3,300,000 + 9 x 205,850) x .005 = $26,000

Odor Control O&M is $101,200 per year

Centrifuges were not considered for Option A Total O&M $2,407,000

OPTIONS B & D

BFP WAS Dewatering - 7 BFPs & 5 Centrifuges

WAS Dewatering - Use existing BFP building. Add two more BFPs at $205,850 each = $412,000.

Odor Control is $215,800

No new polymer feed systems are required. Total $628,000

WAS BFP O&M

O&M for labor is 10,200 hours for operations and 3,371 hours for maintenance.

BFPs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

10,200	x	23.46	=	$239,292	per year
3,371	x	23.46	=	$79,084	per year

Use 1/2% of initial cost per year for routine maintenance of equipment & power

Use 1/2% of total cost for building and BFP equipment for new and exist..

Exist. building was ($3,300,000 + 7 x 205,850) x .005 = $24,000

O&M cost for polymer feed system is 261,400 lbs/day = 131 tons x 10 lbs/ton x $2.50 / lb x 365 days = $1,193,000

Odor Control is $73,100 per year

Total O&M $1,608,000

BFP Primary Dewatering - 5 BFPs

*Primary Dewatering - Build a new BFP building at the main WWTP to house five new BFPs and two polymer feed systems.

Existing BFP building cost was approximately $3,300,000 and was designed to hold 8 BFP's (only five installed).

$3,300,000 - (5 x $205,850/BFP) - (5 x $145,000) = $1,545,750 for entire building, piping, elec., HVAC, sitework, etc. except for BFPs and polymer feed systems.

New building will be sized to house ony 5 BFPs therefore the exist. Maxson BFP building must be downsized.

$1,545,750 x (5/8) = $966,094

Add on the cost for five BFPs and for 2 polymer feed systems (see previous calcs.) for a total of $1,981,094 for the entire Building.

Odor Control is $183,300

Total $2,164,000

BFP Primary O&M

O&M cost for polymer feed systems for both primary and WAS dewatering is 136000 lbs/day =
68 tons x 10 lbs/ton x $2.50 = $1,700/day.
$1,700/day x 365 days = $620,500/year.

Use 1/2% of initial cost per year for routine maintenance of equipment & power
Use 1/2% of total cost for building and BFP equipment for new and exist..
$2,164,500 x .005 = $10,820 per year

O&M for labor is 4,533 hours for operations and 1,998 hours for maintenance.
BFPs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

4,533	x	23.46	=	$106,344	per year
1,998	x	23.46	=	$46,873	per year

Odor Control is $54,400 per year

Total O&M $838,937

Centrifuges - 3 Centrifuges

Primary Dewatering - Build a new centrifuge bldg. near main WWTP site to house 3 centrifuges and two polymer systems.
Johnson County Centrifuge project built a building to house three centrifuges. Their total cost was $3,861,000
not including centrifuges. Cost includes elec., sitework, and HVAC.
Use $3,861,000 for the new centrifuge building. Add an additional $650,000 for each of three centrifuges.
10% for sitework = $581,000
No odor control.

Total $6,392,000

Centrifuge O&M

O&M cost for polymer feed systems for both primary and WAS dewatering is 397,400 lbs/day =
199 tons x 5 lbs/ton x $2.50/ton = $2,488/day.
$2,488/day x 365 days = $907,950/year.

Use 1/2% of initial cost per year for routine maintenance of equipment & power
Use 1/2% of total cost for building and equipment.
$2,738,500 x .005 = $13,693 per year

O&M for labor is 3,022 hours for operations and 1,577 hours for maintenance.
Centrifuges will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

3,022	x	23.46	=	$70,896	per year
1,577	x	23.46	=	$36,996	per year

Total O&M $1,030,000

Centrifuges are not cost effective when comparing capital cost. Centrifuges were considered due to lower disposal costs because of higher percent solids. The difference in percent solids was not remarkable on primary sludge and therefore centrifuges were not selected. Savings are possible for WAS sludge disposal, however the savings do not balance the higher initial cost and centrifuges were not selected.

OPTIONS C & E - 8 BFPs & 6 Centrifuges

BFP

Use existing BFP building by lagoons.
There is room for eight BFPs in the existing bldg. even though there are only five at this time. Install three new BFPs.
For TE Maxson BFP building 4/25/96 the cost per BFP installed is $205,850. For three BFPs this would cost
$617,600 + 15% for additional electrical = $710,240
Odor Control is $231,400.
According to Matt Bond, no additional polymer feed systems are required.

Total $942,000

BFP O&M

O&M cost for polymer feed system is 445,400 lbs/day = 223 tons x 10 lbs/ton x $2.50 / lb =
$5,568/day x 365 days = $2,032,000/yr.

Use 1/2% of initial cost per year for routine maintenance of equipment & power. Use exist. bldg. cost.
($1,545,750 + $205,850 x 8) x .005 = $15,963 per year.

O&M for labor is 7,933 hours for operations and 2,622 hours for maintenance.
BFPs will be operating 24 hours per day. Salary from WWTP staff is $23.46/hr including benefits

7,933	x	23.46	=	$186,108	per year
2,622	x	23.46	=	$61,512	per year

Odor Control is $82,500 per year.

Centrifuge was not considered for this option since there are already BFP facilities available.

Total O&M $2,378,000

PRESENT WORTH COSTS

PRESENT WORTH OF CAPITAL AND O & M COSTS
ALTERNATIVE A - DIGESTER EXPANSION
All Lagoon

Present Worth of Capital and Present Worth Costs

ITEM	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	P.W. FACTOR	1.00000	0.94451	0.89210	0.84260	0.79584	0.75168	0.70997	0.67057	0.63336	0.59822
ALTERNATIVE A											
CAPITAL COSTS	TOTAL COST										
WAS THICKENING FACILITY	11,184,000	11,184,000									
175 MG LAGOON FACILITY	15,336,000	10,141,000									
DEWATERING FACILITY FOR COMBINED SLUDGE	1,844,000	1,844,000									
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%	10,859,000	9,638,000									
CAPITAL COST TOTAL WITHOUT CONTINGENCIES	28,364,000	23,169,000	0	0	0	0	0	0	0	0	0
PRESENT WORTH COST WITHOUT CONTINGENCIES	26,104,279	23,169,000	0	0	0	0	0	0	0	0	0
O & M COSTS											
WAS THICKENING	24,801,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000
175 MG LAGOON FACILITY	1,533,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000
DEWATERING FACILITY FOR COMBINED SLUDGE	50,547,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000
SLUDGE DISPOSAL	42,084,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000
O & M COST TOTAL	118,965,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000
PRESENT WORTH COST	71,306,000	5,665,000	5,351,000	5,054,000	4,773,000	4,508,000	4,258,000	4,022,000	3,799,000	3,588,000	3,389,000

Notes:

1. Interest Rate = 5.875 %
   - Structures = 40 years
   - Process Equip. = 20 years
   - Lagoon Cover = 10 years

60% structure, 40% equipment

ITEM	YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL PRESENT WORTH	REMAIN. VALUE	NET PRESENT WORTH
	P.W. FACTOR	0.56502	0.53367	0.50406	0.47609	0.44967	0.42472	0.40115	0.37889	0.35786	0.33801	0.31925		0.31925	
ALTERNATIVE A															
CAPITAL COSTS															
WAS THICKENING FACILITY														3,355,000	
175 MG LAGOON FACILITY		5,195,000												0	
DEWATERING FACILITY FOR COMBINED SLUDGE														553,000	
														0	
														0	
														0	
														0	
														0	
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%		1,221,008													
CAPITAL COST TOTAL WITHOUT CONTINGENCIES		5,195,000	0	0	0	0	0	0	0	0	0	0		3,908,000	
PRESENT WORTH COST WITHOUT CONTINGENCIES		2,935,279	0	0	0	0	0	0	0	0	0	0	36,963,279	1,248,000	$35,715,000
O & M COSTS															
WAS THICKENING		1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000			
175 MG LAGOON FACILITY		73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000	73,000			
DEWATERING FACILITY FOR COMBINED SLUDGE		2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000	2,407,000			
SLUDGE DISPOSAL		2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000	2,004,000			
O & M COST TOTAL		5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000	5,665,000			
PRESENT WORTH COST		3,201,000	3,023,000	2,855,000	2,697,000	2,547,000	2,406,000	2,273,000	2,146,000	2,027,000	1,915,000	1,809,000	71,306,000	0	$71,306,000

TOTAL NET PRESENT WORTH = $107,021,000

PRESENT WORTH OF CAPITAL AND O & M COSTS
ALTERNATIVE B - DIGESTER EXPANSION
Conventional Primary and Lagoon WAS

Present Worth of Capital and Present Worth Costs

ITEM	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	P.W. FACTOR	1.00000	0.94451	0.89210	0.84260	0.79584	0.75168	0.70997	0.67057	0.63336	0.59822
ALTERNATIVE B											
CAPITAL COSTS	TOTAL COST										
DIGESTION FACILITY FOR PRIMARY SLUDGE	21,245,000	21,245,000									
78 MG LAGOON FACILITY	8,849,536	5,553,000									
WAS THICKENING	11,184,000	11,184,000									
DEWATERING FACILITY FOR PRIMARY SLUDGE	2,164,000	2,164,000									
DEWATERING FACILITY FOR WAS	628,000	628,000									
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%	17,737,000	16,962,000									
CAPITAL COST TOTAL WITHOUT CONTINGENCIES	44,070,536	40,774,000	0	0	0	0	0	0	0	0	0
PRESENT WORTH COST WITHOUT CONTINGENCIES	42,636,609	40,774,000	0	0	0	0	0	0	0	0	0
O & M COSTS											
DIGESTION FACILITY FOR PRIMARY SLUDGE	9,786,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000
78 MG LAGOON FACILITY	840,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
WAS THICKENING FACILITY	24,801,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000
DEWATERING FACILITY FOR PRIMARY SLUDGE & WAS SLU	51,387,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000
SLUDGE DISPOSAL	19,330,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000
O & M COST TOTAL	127,407,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000
PRESENT WORTH COST	76,365,000	6,067,000	5,730,000	5,412,000	5,112,000	4,828,000	4,560,000	4,307,000	4,068,000	3,843,000	3,629,000

Notes:

1. Interest Rate = 5.875 %
   - Structures = 40 years
   - Process Equip. = 20 years
   - Lagoon Cover = 10 years

50% structure, 40% equipment

ITEM	YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL PRESENT WORTH	REMAINING VALUE AT 20 YEARS 0.31925	NET PRESENT WORTH
	P.W. FACTOR	0.56502	0.53367	0.50406	0.47609	0.44967	0.42472	0.40115	0.37889	0.35786	0.33801	0.31925			
ALTERNATIVE B															
CAPITAL COSTS															
DIGESTION FACILITY FOR PRIMARY SLUDGE														6,374,000	
78 MG LAGOON FACILITY		3,296,536												0	
WAS THICKENING FACILITY														3,355,000	
DEWATERING FACILITY FOR PRIMARY SLUDGE														649,000	
DEWATERING FACILITY FOR WAS														188,000	
														0	
														0	
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%		774,642												0	
CAPITAL COST TOTAL WITHOUT CONTINGENCIES		3,296,536	0	0	0	0	0	0	0	0	0			10,566,000	
PRESENT WORTH COST WITHOUT CONTINGENCIES		1,862,509	0	0	0	0	0	0	0	0	0		50,373,609	3,373,000	$57,001,000
O & M COSTS															
DIGESTION FACILITY FOR PRIMARY SLUDGE		466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000	466,000			
78 MG LAGOON FACILITY		40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000			
WAS THICKENING FACILITY		1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000			
DEWATERING FACILITY FOR PRIMARY SLUDGE & WAS SLUDGE		2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000			
SLUDGE DISPOSAL		1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000			
O & M COST TOTAL		6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000	6,067,000			
PRESENT WORTH COST		3,428,000	3,238,000	3,058,000	2,888,000	2,728,000	2,577,000	2,434,000	2,299,000	2,171,000	2,051,000	1,937,000	76,365,000	0	$76,365,000

TOTAL NET PRESENT WORTH = $133,366,000

PRESENT WORTH OF CAPITAL AND O & M COSTS
ALTERNATIVE C - DIGESTER EXPANSION
All Conventional

Present Worth of Capital and Present Worth Costs

ITEM	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	P.W. FACTOR	1.00000	0.94451	0.89210	0.84260	0.79584	0.75168	0.70997	0.67057	0.63336	0.59822
ALTERNATIVE C											
CAPITIAL COSTS	TOTAL COST										
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE	59,458,000	59,458,000									
WAS THICKENING FACILITY	11,184,000	11,184,000									
DEWATERING FACILITY FOR COMBINED SLUDGE	942,000	942,000									
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%	29,779,000	29,779,000									
CAPITAL COST TOTAL WITHOUT CONTINGENCIES	71,584,000	71,584,000	0	0	0	0	0	0	0	0	0
PRESENT WORTH COST WITHOUT CONTINGENCIES	71,584,000	71,584,000	0	0	0	0	0	0	0	0	0
O & M COSTS											
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE	19,711,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000
WAS THICKENING FACILITY	37,968,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000
DEWATERING FACILITY FOR COMBINED SLUDGE	49,938,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000
SLUDGE DISPOSAL	29,211,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000
O & M COST TOTAL	118,062,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000
PRESENT WORTH COST	70,765,000	5,622,000	5,310,000	5,015,000	4,737,000	4,474,000	4,226,000	3,991,000	3,770,000	3,561,000	3,363,000

Notes:

1. Interest Rate = 5.875 %
   - Structures = 40 years
   - Process Equip. = 20 years
   - Lagoon Cover = 10 years

60% structure, 40% equipment

ITEM	YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL PRESENT WORTH	REMAIN. VALUE	NET PRESENT WORTH
	P.W. FACTOR	0.56502	0.53367	0.50406	0.47609	0.44967	0.42472	0.40115	0.37889	0.35786	0.33801	0.31925		0.31925	
ALTERNATIVE C															
CAPITIAL COSTS															
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE														17,837,000	
WAS THICKENING FACILITY														3,355,000	
DEWATERING FACILITY FOR COMBINED SLUDGE														283,000	
														0	
														0	
														0	
														0	
														0	
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%															
CAPITAL COST TOTAL WITHOUT CONTINGENCIES		0	0	0	0	0	0	0	0	0	0			21,475,000	
PRESENT WORTH COST WITHOUT CONTINGENCIES		0	0	0	0	0	0	0	0	0	0		101,363,000	6,856,000	$94,507,000
O & M COSTS															
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE		672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000	672,000			
WAS THICKENING FACILITY		1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000			
DEWATERING FACILITY FOR COMBINED SLUDGE		2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000			
SLUDGE DISPOSAL		1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000			
O & M COST TOTAL		5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000	5,622,000			
PRESENT WORTH COST		3,177,000	3,000,000	2,834,000	2,677,000	2,528,000	2,388,000	2,255,000	2,130,000	2,012,000	1,900,000	1,795,000	70,765,000	0	$70,765,000

TOTAL NET PRESENT WORTH = $165,272,000

PRESENT WORTH OF CAPITAL AND O & M COSTS
ALTERNATIVE D - DIGESTER EXPANSION
Thermophilic Primary & Lagoon WAS

Present Worth of Capital and Present Worth Costs

ITEM	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	P.W. FACTOR	1.00000	0.94451	0.89210	0.84260	0.79584	0.75168	0.70997	0.67057	0.63336	0.59822
ALTERNATIVE D											
CAPITIAL COSTS	TOTAL COST										
DIGESTION FACILITY FOR PRIMARY SLUDGE	13,051,000	13,051,000									
78 MG LAGOON FACILITY	8,849,536	5,553,000									
WAS THICKENING	11,184,000	11,184,000									
DEWATERING FACILITY FOR PRIMARY SLUDGE	2,164,000	2,164,000									
DEWATERING FACILITY FOR WAS	628,000	628,000									
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%	14,328,000	13,553,000									
CAPITAL COST TOTAL WITHOUT CONTINGENCIES	35,876,536	32,580,000	0	0	0	0	0	0	0	0	0
PRESENT WORTH COST WITHOUT CONTINGENCIES	34,442,609	32,580,000	0	0	0	0	0	0	0	0	0
O & M COSTS											
DIGESTION FACILITY FOR PRIMARY SLUDGE	5,250,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000
78 MG LAGOON FACILITY	13,391,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
WAS THICKENING FACILITY	24,801,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000
DEWATERING FACILITY FOR PRIMARY SLUDGE & WAS SLU	51,387,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000
SLUDGE DISPOSAL	46,247,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000
O & M COST TOTAL	127,722,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000
PRESENT WORTH COST	76,557,000	6,082,000	5,745,000	5,426,000	5,125,000	4,840,000	4,572,000	4,318,000	4,078,000	3,852,000	3,638,000

Notes:

1. Interest Rate = 5.875 %
   - Structures = 40 years
   - Process Equip. = 20 years
   - Lagoon Cover = 10 years

60% structure, 40% equipment

ITEM	YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL PRESENT WORTH	REMAINING VALUE AT 20 YEARS	NET PRESENT WORTH
	P.W. FACTOR	0.56502	0.53367	0.50406	0.47609	0.44967	0.42472	0.40115	0.37889	0.35786	0.33801	0.31925		0.31925	
ALTERNATIVE D															
CAPITIAL COSTS															
DIGESTION FACILITY FOR PRIMARY SLUDGE														3,915,000	
78 MG LAGOON FACILITY		3,296,536												0	
WAS THICKENING														3,355,000	
DEWATERING FACILITY FOR PRIMARY SLUDGE														649,000	
DEWATERING FACILITY FOR WAS														188,000	
														0	
														0	
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%		774,642												0	
CAPITAL COST TOTAL WITHOUT CONTINGENCIES		3,296,536	0	0	0	0	0	0	0	0	0			8,107,000	
PRESENT WORTH COST WITHOUT CONTINGENCIES		1,862,609	0	0	0	0	0	0	0	0	0		48,770,609	2,586,000	$46,183,000
O & M COSTS															
DIGESTION FACILITY FOR PRIMARY SLUDGE		481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000	481,000			
78 MG LAGOON FACILITY		40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000			
WAS THICKENING FACILITY		1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000			
DEWATERING FACILITY FOR PRIMARY SLUDGE & WAS SLUDGE		2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000	2,447,000			
SLUDGE DISPOSAL		1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000	1,933,000			
O & M COST TOTAL		6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000	6,082,000			
PRESENT WORTH COST		3,436,000	3,246,000	3,066,000	2,896,000	2,735,000	2,583,000	2,440,000	2,304,000	2,177,000	2,056,000	1,942,000	76,557,000	0	$78,557,000

TOTAL NET PRESENT WORTH = $122,740,000

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PRESENT WORTH OF CAPITAL AND O & M COSTS
ALTERNATIVE E - DIGESTER EXPANSION
All Thermophilic

Present Worth of Capital and Present Worth Costs

ITEM	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
	P.W. FACTOR	1.00000	0.94451	0.89210	0.84260	0.79584	0.75168	0.70997	0.67057	0.63336	0.59822
ALTERNATIVE E											
CAPITIAL COSTS	TOTAL COST										
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE	31,543,000	31,543,000									
WAS THICKENING FACILITY	11,184,000	11,184,000									
DEWATERING FACILITY FOR COMBINED SLUDGE	942,000	942,000									
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%	18,166,000	18,166,000									
CAPITAL COST TOTAL WITHOUT CONTINGENCIES	43,669,000	43,669,000	0	0	0	0	0	0	0	0	0
PRESENT WORTH COST WITHOUT CONTINGENCIES	43,669,000	43,669,000	0	0	0	0	0	0	0	0	0
O & M COSTS											
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE	19,856,000	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500
WAS THICKENING FACILITY	37,968,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000
DEWATERING FACILITY FOR COMBINED SLUDGE	49,938,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000
SLUDGE DISPOSAL	29,211,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000
O & M COST TOTAL	118,366,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500
PRESENT WORTH COST	70,949,000	5,637,000	5,324,000	5,028,000	4,749,000	4,486,000	4,237,000	4,002,000	3,780,000	3,570,000	3,372,000

Notes:

1. Interest Rate = 5.875 %
   - Structures = 40 years
   - Process Equip. = 20 years
   - Lagoon Cover = 10 years

60% structure, 40% equipment

ITEM	YEAR	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTAL PRESENT WORTH	REMAIN. VALUE 0.31925	NET PRESENT WORTH
	P.W. FACTOR	0.56502	0.53367	0.50406	0.47609	0.44967	0.42472	0.40115	0.37889	0.35786	0.33801	0.31925			
ALTERNATIVE E															
CAPITIAL COSTS															
WAS THICKENING FACILITY														9,463,000	
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE														3,355,000	
DEWATERING FACILITY FOR COMBINED SLUDGE														283,000	
PRESENT WORTH CONT 20%, ENGR., LEGAL, & ADMIN 18%														0	
CAPITAL COST TOTAL WITHOUT CONTINGENCIES		0	0	0	0	0	0	0	0	0	0			13,101,000	
PRESENT WORTH COST WITHOUT CONTINGENCIES		0	0	0	0	0	0	0	0	0	0		61,835,000	4,182,000	$57,653,000
O & M COSTS															
DIGESTION FACILITY FOR PRIMARY & WAS SLUDGE		686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500	686,500			
WAS THICKENING FACILITY		1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000	1,181,000			
DEWATERING FACILITY FOR COMBINED SLUDGE		2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000	2,378,000			
SLUDGE DISPOSAL		1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000	1,391,000			
O & M COST TOTAL		5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500	5,636,500			
PRESENT WORTH COST		3,185,000	3,008,000	2,841,000	2,683,000	2,535,000	2,394,000	2,261,000	2,136,000	2,017,000	1,905,000	1,799,000	70,949,000	0	$70,949,000

TOTAL NET PRESENT WORTH = $128,602,000

EPA-HQ-2019-004783 002159