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Appendix B

Remedial Action Plan

PETRO
environmental
technologies

March 15, 2002

Mr. David Kline
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KNAPPS Office Center
P.O. Box 30426
Lansing, Michigan 48909-7926

Letter #033

RE: Remedial Action Plan (RAP)
For the Macomb County Landfill Sites 9 and 9A
Final Version

Dear Mr. Kline,

In response to comments received from your office dated February 21, 2002, the RAP has been further revised. These revisions result in the final version of the RAP submittal. All other attachments and appendices have been produced in final format and included with this submittal.

Please call us at (513) 489-6789 if you have any questions or comments. We are at your convenience and look forward to your response.

Respectfully yours,
Petro Environmental Technologies, Inc.

Daniel P. Duffy, PE

Cc: Mark Mather
File
Ted Wahby (SMDA)
Roger Timm (Dykema-Gosset)
John Brennan (Macomb Township)
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Attachments

Remedial Action Plan Narrative (Revision #10), 5 copies

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Remedial Action Plan Narrative
(Revision #10)

for the

South Macomb Disposal Authority
Landfills 9 and 9A

by

Petro Environmental Technologies, Inc.

February 2002

SMDA Landfills 9 and 9A
Remedial Action Plan
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A. Site Specific Health and Safety Plan
B. Quality Assurance Program Plan (with Chain of Custody)
C. Technical Specifications
D. Performance Monitoring Plan
E. Contingency Plan
F. Sanitary Sewer Discharge Permit Application
G. NPDES Permit Application
H. Operations and Maintenance Plan
I. Drawing Set
J. Leachate and Groundwater Management Plan
K. Restrictive Covenant for Landfill Properties
L. Landfill Gas Vent and Probe Plan

Executive Summary

The South Macomb Disposal Authority (SMDA) Macomb County Landfill Properties 9 and 9A has contamination that has exited the landfill. "Property" means the property of Landfills 9 an 9A located south of 24 Mile Road, west of Card Road, and north of the McBride Drain and legally described in Appendix A of the Consent Decree except as modified by written agreement between SDMA and MDEQ. This Remedial Action Plan (RAP) is focused on:

1. Eliminating the limited residential criteria based contaminant plume. This is to be accomplished by capturing the portion of the contaminant plume that exceeds the health-based residential standards and by maintaining hydraulic control of leachate on the property, and

2. Constructing remedial measures to eliminate the potential for future spread of contaminants, and

3. Establishing controls and measures to achieve a condition where contaminated leachate is no longer leaving the site, and

4. Achieving a cleanup state such that the state can recommend removal of the Property from the National Priorities List (NPL), and

5. Establishing exposure controls to eliminate human health and environmental hazards.

The RAP is intended to remediate the facility in compliance with Sections 20118, 20120a, and 20120b of the Natural Resources and Environmental Protection Act. The Remedial Action Plan consists of ten major tasks. These tasks include the following:

1. Determine appropriate method for management of groundwater and leachate encountered during construction of the remediation systems.

2. Install a groundwater interceptor and impermeable barrier to prevent groundwater inflow and subsequent leachate.

3. Install a leachate collection system to remove leachate from the landfill and prevent leachate from migrating off-site.

4. Install and operate a contaminated groundwater and leachate disposal system(s), including construction and operation of all necessary treatment systems.

5. Re-grade and cap the surfaces of the landfills to stimulate surface water flow and reduce infiltration potential. Estimates of resultant surface water run-off flows are provided in Attachment II.

6. Install a final vegetative cover system to inhibit erosion and protect the cap.

7. Install a system of groundwater extraction wells.

8. Install and maintain a landfill gas venting system (refer to Appendix L, "Landfill Gas Vent and Probe Plan").

9. Place deed restrictions and perform long term monitoring.

10. Operate and maintain all systems in accordance with approved plans.

This RAP includes regrading of the Property to an approximate, continuous 1% slope. The continuous slope design with its long shallow slopes represents a worse case scenario for the analysis of leachate production and subsequent groundwater contamination. The continuous slope design is used for all calculations.

As part of this RAP, SMDA has considered the appropriate balance between improving the final cover system so as to minimize percolation into the landfill and subsequent leachate formation, and the design of groundwater interceptor and leachate collector systems. Existing leachate is to be removed for treatment and disposal with the proposed leachate collection system. The propose groundwater interceptor is to remove another source of leachate formation by preventing the inflow of groundwater into the landfill.

1.0 Introduction

This remedial action plan (RAP) for the Macomb County Landfill is designed to remediate the facility in accordance with the applicable regulations and court decisions. The landfill site(s) have been closed since the mid 1970's with approximately 680,000 cubic yards of municipal solid waste deposited in Property 9 and approximately 1,200,000 cubic yards of municipal solid waste deposited in Property 9A. More detail describing the quantities and type of waste is detailed in other reports.

This Remedial Action Plan includes the Engineering and Construction related activities to remediate the Property and those adjacent properties impacted by the contaminant plumes. Operation, maintenance and monitoring of the constructed remedial measures are discussed in an Appendix D, "Performance Monitoring Plan" (PMP) and Appendix H, "Operations and Maintenance Plan" (O&M) submitted as part of this RAP. The main focus of this RAP is to design and install the necessary measures to prevent or minimize leachate formation as well as ensure capture of groundwater, landfill gas control, and restrictions on property uses.

Within the time frame of the remediation system's operation, (1) leachate levels within the landfills will be greatly diminished, (2) leachate and contaminated groundwater will be prevented from migrating off-site, and (3) contamination outside of the landfill boundaries will be eliminated. The final remediation goal is a condition where leachate

formation and water contamination from the landfill no longer pose a threat to human health or the environment and the site is de-listed from the NPL.

This RAP specifically addresses administrative, engineering and construction issues relating to the remediation of the facility. This RAP is written and implemented within the parameters of the regulatory requirements of Part 201 of the NREPA. Operational and monitoring issues are addressed in Appendix D, "Performance Monitoring Plan" (PMP).

1.1 Location (including a map).

The Macomb County Landfill Properties 9 and 9A are located in Macomb Township, Macomb County, Michigan approximately 17 miles north/northeast of Detroit, Michigan. The landfill is located immediately south of 24 Mile Road at the intersection of 24 Mile Road and Foss Road. The Property location is identified on Plan Sheet #1, "Title Sheet".

1.2 Overview of past and current use of properties, and hazardous substances.

The Macomb county landfill was a Type II Municipal Solid Waste Landfill under current Michigan DEQ rules that were operated as solid waste disposal areas under the provisions of the Garbage and Refuse Disposal Act 1965 PA 87, as amended. It is owned and was operated by the South Macomb Disposal Authority (SMDA). The Macomb County Landfill consists of two Properties, 9 and 9A. The landfill covers approximately 159 acres. Property 9 covers approximately 75 acres with approximately 65 acres utilized for solid waste disposal. The remaining 10 acres is utilized as buffers on the north and east sides. Property 9A covers approximately 84 acres with approximately 80 acres utilized for solid waste disposal. The remaining 4 acres is utilized as buffer on the west and south sides.

Property 9 was licensed to receive municipal solid waste from April 29, 1968 to September 1, 1975, a period of approximately 88 months. During this time it received approximately 680,000 cubic yards of municipal solid waste, an average of 7,727 cubic yards per month.

Property 9A was licensed to receive municipal solid waste from February 22, 1971 to September 1, 1979, a period of approximately 102 months. During this time it received approximately 1,200,000 cubic yards of municipal solid waste, an average of 11,765 cubic yards per month.

At no time was the Macomb County Landfill licensed to receive hazardous waste or hazardous substances for purposes of disposal. There is no record of any disposal operation involving hazardous materials.

1.3 Evidence property is "facility."

Previous property investigations have found groundwater samples at the Macomb County Landfill Properties 9 and 9A that show that hazardous substances are present which exceed drinking water standards developed pursuant to Section 20120a(1)(a) of NREPA. Constituents that exceed the criteria include vinyl chloride and chloroform. For additional information, refer to previous property investigation reports. These investigations are:

- "Final report on Hydrogeological Investigation, South Macomb Disposal Authority, Landfill Sites 9 and 9A", Dragun Corp., dated February 28, 1995, Project #3020.

- "Report on Refined Evaluation of Remedial Alternatives for South Macomb Disposal Authority Sites 9 and 9A", Dragun Corp., dated May 19, 1995, Project #8006.

- "Conceptual Design for Remedial Action, SMDA Sites 9 and 9A, Macomb County, Michigan", CRA, dated November 1998, Reference No. 11413(7).

- "Vertical Aquifer Sampling Results for 598R, 9712, 594R, 9795, 9711, 9715 and 9716 Locations, Supplemental Plume Delineation Activities", CRA, dated November 16, 1999, Reference No. 11413.

- "Supplemental Plume Delineation Report", CRA, dated June 2000, Reference No. 11413(21).

- "Pre-Design Investigation Report", CRA, dated August 2000, Reference No. 11413(20)

Therefore the property is a "Facility" as defined under Part 201 sections 20120a(1)(a) and (17).

1.4 Purpose and scope: criteria category(ies) plan satisfies.

The off property clean up category for this project is generic residential for contaminated areas outside of the property's limits. The on-property clean up category is site-specific standards inside the property limits, are consistent with restrictive covenant and the consent decree (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

The plan for the landfill property is based upon "site specific" criteria per Section 20120a(2). No site reuse will be allowed unless a site specific risk assessment for an alternative use is conducted as described in the restrictive covenant(refer to Appendix K, "Restrictive Covenant for Landfill Properties").

The restrictive covenant for the landfill property will limit the future use (or no use), unless and until a site specific risk assessment for an alternate use is performed by SMDA and approved by the MDEQ. The restrictive covenant will also include other restrictions, such as, prohibit the installation of water wells other than what is needed for response activity purposes, and no disturbing of the cap. The RAP anticipates no future use unless allowed by a site specific risk assessment.

For properties other than the landfill property, the plan proposes to satisfy the generic residential criteria by capturing and remediating all groundwater that exceeds the health-based drinking water criteria and eliminating migration of leachate. By cutting off any additional loading to the aquifer, it is expected that natural processes will allow the portion of the aquifer that exceeds the aesthetic based criteria to reach the generic residential criteria (or the MDEQ approved background levels, if higher).

2.0 Facility Characterization, Analysis, and Remedial Actions

The following characterizations and analyses performed for the Macomb County Landfill Sites 9 and 9A are derived from previously submitted reports.

2.1 Facility Characterization: Description of nature and extent of contamination.

Refer to the previously submitted remedial investigative reports and data (listed in Section 4.1) for a detailed description of the nature and extent of the site's groundwater contamination. The groundwater contamination is in three plumes located in three interconnected aquifers. The known extent of the Aquifer #1 plume exceeding the health-based generic residential criteria extends to the northwest and northeast of the property to a maximum distance of approximately 400 feet. The known extent of the Aquifer #2 plume exceeding the health-based generic residential criteria extends northeast of the property to a maximum distance of approximately 1,250 feet. The known extent of the Aquifer #3 plume exceeding the health-based generic residential criteria extends south of the property to a maximum distance of approximately 1,000 feet. There is a plume that exceeds aesthetic based criteria which is larger than the plume that exceeds the health based criteria.

The types of contaminants found in groundwater include volatile organic compounds (VOCs) such as vinyl chloride and chloroform. Other contaminants include elevated biochemical oxygen demand (BOD) in the landfill leachate and high concentrations of metals in the groundwater. No significant contaminants have been found in surface water except for those incidents where leachate outbreaks have occurred along the south side of Property 9A. RAP activities include the submittal of groundwater analyses reports quarterly.

These are described in greater detail in a plume delineation report "Supplemental Plume Delineation Report, SMDA Properties 9 and 9A, Macomb County, Michigan, Reference No. 11413(21)", Conestoga-Rovers Associates, dated June 2000.

2.2 Facility Analysis/Conditions Evaluation:

2.2.1 Control of hazardous substance sources.

SMDA, as both the Operator and the Person Proposing Plan (PPP), has obligations under Part 201 Section 14 including 20114(h) for the remediation of the landfill:

"(h) Upon written request by the department, take the following actions:

(i) Provide a plan for and undertake interim response activities.

(ii) Provide a plan for and undertake evaluation activities.

(iii) Take any other response activity determined by the department to be technically sound and necessary to protect the public health, safety, welfare, or the environment.

(iv) Submit to the department for approval a remedial action plan that, when implemented, will achieve the cleanup criteria specified in this part and the rules promulgated under his part.

(v) Implement an approved remedial action plan in accordance with a schedule approved by the department pursuant to this part."

The hazardous substances are not containerized and do not exist as free phase liquid. With the landfill being closed by September 1979, original releases occurred prior to the regulatory date of June 6, 1995. This original release remains ongoing, without separate or subsequent releases. The metals and organic compounds that have contaminated the local groundwater originate in the municipal solid waste disposed of in the landfill's Property 9 and 9A. Since the solid waste that is the source of the groundwater contamination remains in place, an analysis of source control is appropriate. A synopsis of a detailed examination of remedial alternatives ("Report on Refined Evaluation of Remedial Alternatives for the SMDA Properties 9 and 9A", Dragun Corporation, dated May 1995) is provided in Section 3.3.

2.2.2 Groundwater contamination risks to drinking water uses.

Residential wells that have been impacted above health based drinking water standards have been provided access to municipal water. As part of its base line risk assessment for the site, CH2M-Hill in its August 1990 "Remedial Investigation Report, South Macomb Disposal Authority, Macomb County, Michigan, EPA WA No. 193-5LS4" (RIR), performed exposure assessments for groundwater and other potential contaminant pathways. However, off-property groundwater is utilized at several residential wells, each of which is considered a

separate exposure point per EPA guidance (EPA1989a). A primary route of exposure is ingestion. Exposure may occur from various other household activities such as inhalation of volatiles while showering.

Contaminants have been detected in the groundwater that exceeds both the generic residential health based and aesthetic drinking water criteria. For example, vinyl chloride in leachate (160 ug/l) and off-property monitoring wells (6 ug/l) exceeds the generic residential criteria of 2 ug/l. Chloroform in groundwater has been measured at 10,000 ppb in excess of safe drinking water standards of 100 ppb. Other examples can be found in the "Supplemental Plume Delineation Report", CRA, dated June 2000, Reference No. 11413(21). A complete table of all available groundwater sample and analysis results is provided in Appendix A, "Site Specific Health and Safety Plan" (HASP).

In accordance with the Consent Decree and the PMP, groundwater contamination concerns are primarily focused on first providing municipal water and on removing all health based risk, and secondly on removing or monitoring the constituents exceeding the aesthetic standards. As such, the RAP is designed to address these aesthetic concerns. By intercepting groundwater along the perimeter of the landfill, extracting groundwater from deeper aquifers with wells, and by intercepting leachate before it can leave the landfill, the RAP will remediate those factors affecting groundwater health based risk parameters. Groundwater will be extracted and treated until health-based drinking water standards are achieved.

The RAP and PMP will emphasize the more stringent levels established by aesthetic concerns as well as the health based drinking water standards. In all cases, free phase liquid contaminants have not been detected.

There is no evidence of significant contamination due to the presence of friable asbestos or asbestos containing material (ACM). Asbestos has not been detected in groundwater samples.

2.2.3 Groundwater contamination risks from dermal (utility work) exposures.

Based on available data contamination detected in the leachate and groundwater do not exceed the generic groundwater contact criteria developed by the MDEQ as listed in the most recent version of Environmental Response Division (ERD), Operational Memorandum #18. During the construction of the remediation system and its associated groundwater interceptors and leachate collectors, precautions will be taken in accordance with the site's Health and Safety Plan (HASP) to ensure dermal exposures do not occur. A copy of this HASP is provided in Appendix A. Free phase liquid contaminants have not been detected. No contaminant concentrations capable of presenting flammability and explosivity hazards have been detected.

Due to the potential for the leachate to exceed these criteria, the restrictive covenant for the landfill property shall prohibit direct contact with shallow groundwater and leachate or prescribe the necessary precautions and handling procedures when workers could be exposed to potentially contaminated leachate or groundwater (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

2.2.4 Groundwater contamination risks for indoor air hazards.

As part of CH2M-Hill's RIR, an exposure assessment for air as a potential contaminant pathway was performed. The RIR concluded that there were three potential air borne contaminant pathways: migration of soil gas into nearby home, wind erosion of contaminated surface soils, or releases of contaminants to ambient air from the waste material. Sampling indicated that while methane appeared to be migrating from the site, the other contaminants could not be confirmed. There is no evidence that methane has entered any nearby residence. Should gas exceed action levels; we will address methane as described in Appendix E, "Contingency Plan".

The maximum levels of vinyl chloride in the leachate (160 ug/l) exceed the generic residential groundwater volatilization to indoor air inhalation criteria (110 ug/l) contained in ERD Operational Memorandum #18. The restrictive covenant for the landfill property will prohibit construction of structures (refer to Appendix K, "Restrictive Covenant for Landfill Properties"). Groundwater outside the Property does not exceed the generic residential criteria for indoor air inhalation.

2.2.5 Groundwater contamination risk of hazard to surface water resources.

As part of CH2M-Hill's RIR, an exposure assessment for surface water and sediment as potential contaminant pathways was performed. The RIR concluded that exposure may occur either directly during post closure site use or through various indirect routes. The maximum levels of vinyl chloride in the leachate (160 ug/l) exceed the generic groundwater surface water interface criteria (15 ug/l) contained in the ERD Operational Memorandum #18. Therefore, this is a pathway that needs to be addressed by the remedial action. Indirect pathways for exposure include: fish ingestion, release of volatile organics during irrigation, and the taking up of contaminants by plants that are later consumed.

Though the general direction of regional groundwater flow adjacent to the Macomb County Landfill Properties 9 and 9A is to the south and southeast, towards the McBride Drain, with the exception of leachate outbreaks, there does not appear to be a groundwater/surface water interface (GSI) that involves any of the established contaminant plumes. The contaminant plume in the highest aquifer (Aquifer #1) is confined to the limits of waste and adjacent areas north of both Properties 9 and 9A. The next lower aquifer (Aquifer #2) shows evidence of a contaminant plume extending to the east and northeast of Property 9A. The

lowest aquifer (Aquifer #3) does show a contaminant plume extending southwards from Property 9A towards the McBride Drain, but is apparently a low enough depth to prevent hydraulic contact between the contaminated groundwater and the surface water in the drain. In all cases, free phase liquid contaminants have not been detected.

The proposed leachate and groundwater management systems will prohibit migration of either leachate or contaminated groundwater towards the McBride Drain or other surface water resources. See Appendix J, "Leachate and Groundwater Management Plan".

2.2.6 Soil contamination risks from direct contact exposures.

As part of CH2M-Hill's RIR, an exposure assessment for soil as potential contaminant pathways was performed. The RIR concluded that aside from incidental ingestion of soil on the hands by individuals who eat, drink or smoke following property exposure, the risk of exposure is insignificant.

Given the depth to the groundwater contaminant plumes, the potential for soil concentration at the surface that could cause adverse health effects due to long-term ingestion or dermal exposure is insignificant. However previous soil sampling was limited in scope with documented contaminant levels exceeding direct contact criteria.

Continued implementation of groundwater and leachate collection is expected to be adequate to address this pathway. As much as possible the proposed final cover system will be constructed with clean borrow soil provided by off-property sources. Along the south of Property 9A during construction of the leachate line, SMDA will ensure that the use of off-property soils will greatly reduce the potential for soil contamination risks during and after the construction of the proposed final cover system. The improved landfill cover is expected to provide an adequate direct contact barrier to prevent potential exposure to contaminated soil and waste within the landfill. The use of clean borrow soil as part of the cover (especially at the south edge of property 9A) will eliminate the potential for future exposure to the surface soil that may have become contaminated due to leachate break outs. Continued operation of the improved groundwater and leachate collection system is expected to be effective in preventing reoccurrence of leachate breakouts.

2.2.7 Soil contamination risks from ambient air inhalation exposures.

There have been no detected contaminant concentrations either in groundwater or in soil that could yield an ambient air concentration that would cause adverse human health effects through inhalation in a industrial, residential or commercial land use. The concentrations detected in the soil are below the generic residential infinite volatile soil inhalation criteria for ambient air and the particulate soil

inhalation criteria listed in the ERD Operational Memorandum #18. Therefore, this is not considered a relevant pathway.

2.2.8 Soil contamination risks from indoor air inhalation exposures.

Established contaminant plumes are associated with local aquifers, not with soil concentrations. The concentrations detected in soil are below the generic residential soil volatilization to indoor air inhalation criteria listed in the ERD Operational Memorandum #18. , this is not considered a relevant pathway.

2.2.9 Soil contamination risk of injury to drinking water uses of groundwater.

Soil contamination is not the potential source for contaminants affecting the local groundwater utilized for drinking water purposes. The concentrations detected in the soil are below the generic residential drinking water protection criteria for soil listed in the ERD Operational Memorandum #18. The source for contamination is the deposited waste in Properties 9 and 9A. Existing groundwater contamination derives from the waste, not from adjacent soils. As such, the soil contamination levels do not exceed twenty times the residential drinking water criterion and the residential drinking water soil-water partitioning (SWP) criterion.

2.2.10 Soil contamination risk for groundwaters to pose dermal contact hazard.

The concentrations detected in soil are below the generic residential soil criteria for the protection of direct contact with groundwater listed in the ERD Operational Memorandum #18. During the construction of the remediation system and its associated groundwater interceptors and leachate collectors, all applicable precautions will be taken in accordance with the site's Health and Safety Plan (HASP) to ensure dermal exposures do not occur. A copy of this HASP is provided in Appendix A.

2.2.11 Soil contamination risk for groundwaters to pose hazard to surface water.

As described in section 2.2.5 above, there does not appear to be a groundwater/surface water interface (GSI) that involves any of the established contaminant plumes. The concentrations detected in soil are below the generic residential soil criteria for the protection of groundwater venting to the surface water listed in the ERD Operational Memorandum #18.

2.2.12 Risk of contaminated soils runoff to surface waters.

The site's contamination is confined to underlying groundwater. There is no evidence of significant quantities of contaminated soil. However, there is the potential for contaminated soil or contaminated leachate to run overland to the McBride Drain. During trench excavation and side regrading operations, there is the potential for contaminated soil to be excavated from lower depths. This

potential will be minimized by the fact that the proposed final cover grades do not cut significantly into existing cover soil, and trenching operations are to occur wherever possible outside the limits of waste.

All temporary soil stockpiles will be appropriately managed to ensure that there is no significant potential for the contaminated soil to run-off to adjacent surface waters such as the McBride Drain. These measures will include, as needed, silt fencing around the perimeter of the stockpiles and/or use of tarps to cover the stockpiles.

2.2.13 Surface water sediment contamination risks.

Though there have been past leachate outbreaks along the south side of Property 9A which have adversely affected flora and fauna in the McBride drain, there is currently no significant potential for sediment contamination of adjacent surface waters. Samples from the McBride Drain did not detect contaminants at levels of concern. The potential for sediment contamination will be rendered insignificant by the measures taken to ensure that the potential for contaminated soil runoff is minimized. Therefore, this is not considered a relevant pathway.

2.2.14 Acute toxic and physical hazard risks.

There is no evidence either in samples of leachate or contaminated groundwater for the existence of hazardous materials in the landfill that may cause acute inhalation toxicity, flammability, explosivity, corrosivity, ignitability, or reactivity as defined in the Resource Conservation and Recovery Act (RCRA 40 CFR 261).

The properties are generating modest amounts of explosive landfill gas (methane) that may present a hazard during construction of the remediation system. During regrading, trenching and excavation operations, methane detectors will be utilized to ensure that landfill gas concentrations remain below their lowest explosive limit. Workers are to never enter an excavated or confined area without adequate safety precautions and respiratory equipment.

There are also potential risks to other future workers who may excavate on property for whatever reason (e.g., construction, utility work). Also, there are potential risks associated with potential methane migration to and/or beyond the property boundary (e.g., should the methane accumulate in a building foundation or basement). Recent sampling of gas probes has detected high methane concentrations in three perimeter gas probes (Pre-design Investigation Report, Conestoga-Rovers and Associates (CRA), August 2000). These probes were placed outside the landfill.

SMDA will conduct a further investigation to determine the extent of the methane migration in these areas. This investigation will proceed as part of the overall remediation effort. If monitoring shows that there is an exceedance of 25 percent

of the lower explosive limit at the property boundary, immediate actions will be implemented to address this hazard, including installing gas vents.

2.2.15 Ecological and aesthetic impacts.

Aesthetic impacts of the contaminated groundwater are primarily associated with drinking water concerns in accordance with the PMP (see Section 2.2.2). There is no significant evidence of phytotoxicity, food chain contamination, adverse impacts to soil organisms, or adverse impacts to wildlife. No evidence of such problems (soil discoloration or odors, stressed vegetation, or injured wildlife) has been uncovered. Since the main goal of the RAP is to remediate groundwater sources of drinking water, the RAP is also protective of ecological hazards. Based on available evidence, an ecological risk assessment is not warranted. Past and proposed remedial actions will adequately address this pathway and eliminate the potential for ecological or aesthetic impacts.

There have been historical issues with groundwater posing aesthetic problems when groundwater entered basements of homes along 24 Mile Road. This lead to SMDA purchasing and demolishing one home. The installation of a slurry wall and leachate collection line along the north side of Property 9 seem to have alleviated this condition. It has also been noted that there has been some staining in a small surface water pond just south of McBride Drain. The proposed remedial actions include leachate and groundwater collection should preclude a reoccurrence of these problems.

2.2.16 Any other hazardous substance risks at or posed by the facility.

There are no other hazardous substances or risks posed by the facility.

2.3 Proposed/Completed Remedial Actions: Details of completed/planned response activities

In summary, the proposed remedial actions include: construction of an improved final cover system, installation of a groundwater interception system, the installation of a groundwater extraction system, the operation of a groundwater treatment system, the installation of a leachate collection system, the operation of a leachate pre-treatment system, the installation of a landfill gas venting system, and the operation of associated monitoring systems (refer to Appendix L, "Landfill Gas Vent and Probe Plan").

In addition to the above engineering and construction efforts, drinking water will be provided to residents under certain conditions. The following conditions will be adhered to:

"Residential Water Supplies: At any time after the effective date of the Consent Decree, if SMDA becomes aware of information that shows that groundwater from any residential well being used for household use that is located within the area which is

within the boundary made by connecting the outer most "sentinel wells" (as defined in the PMP) exceeds Part 201 residential health-based standards in effect as of the date of July 9, 1999 or background (as determined pursuant to the PMP), whichever is higher, SMDA shall within 10 days provide the residence with drinking water meeting all Part 201 of Natural Resources and Environmental Protection Act, 1994 PA 451, MCL 324.20101 et seq. (NREPA) criteria. SMDA may test any such well periodically to determine whether the condition of exceeding the higher of such residential standards or background persists.

A. The quantity of water will be sufficient to meet all potable water needs.
B. SMDA will connect the residence to the municipal water supply if the condition appears to be persistent or long term, and if such municipal water is reasonably available. If not, SMDA will arrange for other alternative water.
C. SMDA will not be required to take action if it is demonstrated to the MDEQ's satisfaction that the detected contamination is not attributable to a release from Properties 9 or 9A."

Also, for the case of an aesthetic exceedance in a residential well the owner of the residence will be offered the choice of: (1) Installation of a water softener at SMDA's expense, or (2) Payment to the owner of the residence the equivalent of the cost of a water softener to be used towards hook up to municipal water, if municipal water is available.

2.3.1 Engineering Analyses

The following analyses were performed to provide a rationale for the remedial activities.

2.3.1.1 Leachate and Contaminated Groundwater Management

Leachate and contaminated groundwater can only be disposed through a permitted activity. A leachate and groundwater management plan has been submitted to MDEQ for review (refer to Appendix J, "Leachate and Groundwater Management Plan"). Once a permit(s) is (are) issued, the disposal mechanism will be constructed and the leachate and groundwater system will be started. Contaminated water will be disposed until clean up reaches the levels described by the Consent Decree or approved PMP. Once the PMP levels have been achieved, SMDA will petition to turn off the system.

Leachate and contaminated groundwater can be disposed through various permitted methods. It is the intent of this RAP to design, permit and construct a combination of treatment technologies to remediate the site. Furthermore, as discharge permits are approved, we anticipate the SMDA will implement the most economical means available for safe remediation.

Several water disposal options have been preliminarily engineered for permitting and construction. Incomplete and/or lapsed permits will be updated for property use. The following is a brief on the status of various disposal options.

A. Surface Water Discharge. Treated, clean groundwater and leachate can be prepared and discharged to the waters of the state with an NPDES permit to operate. Evidence suggests that the groundwater and potentially leachate can be effectively treated for discharge to adjacent surface bodies of water, the McBride Drain. Appropriate NPDES permit(s) will be obtained prior to this operation. A copy of this application is provided in Appendix G. A draft Permit #MI0055069, by Dragun Corp., dated August 6, 1996, contemplated an earlier action.

B. Sewer Discharge. Available analytical data indicate that the leachate and contaminated groundwater may be able to be discharged to the sanitary sewer owned by Macomb Township that flows to a POTW owned by the Detroit Metropolitan Sewer District. Further sampling and analysis will be performed on leachate and contaminated groundwater to determine, permits, pre-treatment, and other characteristics to meet the requirements for disposal into the sanitary sewer. An agreement has been realized with Macomb Township for a sewer discharge permit. A copy of this application is provided in Appendix F.

C. Transport and Disposal. Currently, contaminated water and leachate is pumped, transported and disposed off-site. Until other methods (permits) are made available, the remedial actions will be limited to activities that can be accomplished with this disposal method.

D. Irrigation and Phytoremediation. Groundwater may be used for on property irrigation to ensure the establishment of dense vegetative cover. Treatment standards required for irrigation will be achieved prior to this operation. The existing wetland located immediately south of Property 9 provides the potential for on property phytoremediation. Any irrigation or phytoremediation option would comply with all applicable rules and regulations and all necessary permits would be acquired (groundwater discharge, monitoring, or associated wetland permit).

The proposed leachate and contaminated groundwater management plan (refer to Appendix J, "Leachate and Groundwater Management Plan") primarily relies upon sanitary sewer discharge but may be later revised to include several of these options. By proposing and using several alternatives, SMDA will achieve a leachate management plan tailored to property conditions while providing maximum operational flexibility.

2.3.1.2 Groundwater Interception

Available data suggests that groundwater inflow and percolation of precipitation through the cover are the primary sources of leachate formation for both landfills.

The most effective leachate management system would prevent the formation of leachate in the first place by cutting off the source of the leachate. Therefore, a perimeter interceptor will be installed to prevent further inflows into the landfills. However, since this perimeter interceptor will be located adjacent to the landfills' established limits of waste, any groundwater which enters this system is to be considered as leachate due to the close proximity of deposited waste. Furthermore, to ensure intimate contact with waste and accumulated leachate within the landfill, a series of lateral pipes are to be installed which branch off of this perimeter collector into the landfill.

Prior property investigations indicate that the floors of the landfills slope from the north and northwest to the south of Property 9 and the southeast of Property 9A (refer to Plan Sheet #3, "Bottom of Waste Grades", and Plan Sheet #7 "Perimeter Collector Profiles"). We assume within the landfill, that leachate flows follow this gradient. Groundwater inflows would also conform to these flow gradients, generally entering the landfills through the north and northwest boundaries flowing towards the south and southeast and the McBride Drain.

There is one potentially significant exception to the above flow regime. For much of Property 9, including the entire east side, there is no "floor" to the landfill. The waste is in direct connection with the sand of the underlying aquifer (Aquifer 2). Since there is no "floor," it is not expected that leachate will flow along the base of the waste to the south-southeast. Based on groundwater potentiometric surface maps, groundwater generally flows radially in the refuse/Aquifer1 in Property 9. There is also a strong downward component from the refuse/Aquifer 1 to Aquifer 2. It is likely that much of the leachate in Property 9 will continue to migrate down into Aquifer 2 and then migrate to the east.

The perimeter collector trench is to be installed at 15 feet to 20 feet below ground surface and will collect leachate exiting directly from the landfill. The exact locations of the extraction wells will be determined, and the wells will be installed when we have identified the downward and easterly flow of contaminated groundwater away from the landfill in Aquifer 2 that results from the first stage of groundwater and leachate extraction operations. Both the location and number of the groundwater extraction wells are contingent upon analysis of the groundwater contamination. It is intended that at least one groundwater well will be installed.

Groundwater which comes into contact with deposited waste along the landfill limits (thereby becoming leachate) will be intercepted along the northwest and north boundaries of Property 9 as shown, and the north and west boundaries of Property 9A before it can enter the landfill. The perimeter interceptor will initially be used for leachate collection and discharge from lateral pipelines set into the landfill. Once the leachate mound has been removed from the landfill, the valves connecting the laterals to the perimeter pipeline will be closed to prevent groundwater inflow and allow the perimeter pipeline to carry groundwater around the landfills to its potential NPDES discharge point(s). The groundwater

interceptors will also effectively draw back contaminated groundwater from areas adjacent to the landfill, especially on the east side of Property 9A. Refer to Attachment IV for interceptor flow capacity estimates and Attachment V for interceptor pipe stability.

Additional groundwater interception will be provided by auxiliary groundwater extraction wells. The location, depth and number of these may be revised based on the results after the first six months of groundwater monitoring is known. It is intended that at least one groundwater extraction well will be installed. More groundwater extraction wells will be installed unless groundwater monitoring results indicate that both chemical containment and hydraulic control are being achieved without them. Any decision to not install these groundwater extraction wells will only be made with the concurrence of MDEQ. Of primary concern is the contaminant plume affecting Aquifer two in the area east of Property 9A. This area will receive at least three groundwater extraction wells, depending on the results of the PMP monitoring. Furthermore, at least one groundwater extraction well will be installed on Property 9A to extract contaminants from Aquifer #3. Plan Sheets #8, #8A, #8B, and #8C show the extent of the groundwater contamination plumes and the monitoring wells used to measure the extent of each aquifer's contaminant plume.

2.3.1.3 Leachate Collection

According to available information, the bottom of the waste slopes from the north to the south in Property 9, and from the north and northwest to the southeast in Property 9A (refer to Appendix C, "Technical Specifications", and Plan Sheet #3, "Bottom of Waste Grades"). Leachate built up will flow along these slope gradients in a south and southeasterly direction. Any potential for leachate to leave the landfills along their northern or western boundaries will be as the result of excessive build up of leachate within the landfill. The leachate head build up could cause a localized reversal in leachate flows in a direction opposite of the general flow gradient. However, the interceptor pipe along the landfill boundary will effectively prevent leachate migration in this direction by diverting leachate to the sanitary sewer discharge. On the east side of Property 9, where there is no continuous low permeability soil layer for the interceptor pipe trench to tie into, some leachate may follow its current path below and out of the landfill. This potential contaminant source will be managed by the auxiliary groundwater extraction system to be installed east of Property 9, and problems detected under the PMP.

Leachate formation appears to be the result of both groundwater inflow and surface water infiltration. Each lateral pipeline will be connected to the perimeter pipeline with a shut-off valve which can effectively prevent further inflow of groundwater back into the landfill. Once the leachate mound within the landfill has been eliminated, these valves will be turned off allowing the perimeter pipeline to carry groundwater. Without the significant contribution of

groundwater into the landfill, and with only a relatively small amount of percolation through the final cover, leachate head within the landfill will diminish by removing water. Leachate will be removed from the low areas of the landfill floors defined by the bottom of waste grades. Refer to Attachment IV for interceptor flow capacity estimates and Attachment V for interceptor pipe stability.

2.3.1.4 Landfill Gas Management System

Though both landfills are well past their peak gas production stages, enough landfill gas (LFG) may still be generated at both properties to require a management system. A system of passive LFG vents will be installed along the perimeter of the landfill. The locations and spacing of the LFG vents may be determined based on the results after the first six months of LFG monitoring. If LFG monitoring indicates a more wide spread gas migration problem, vents will be installed along the perimeter(s) of the landfills where such problems are evident. Additional venting will also be considered for the interior of the landfills, especially if vegetative stress is apparent. Should LFG cause distress of the final cover vegetation, additional LFG vents will be installed at those locations where vegetative stress is evident. These LFG vents will be installed unless LFG monitoring results indicate that LFG migration off-property is not occurring. LFG monitoring will continue over the duration of the remediation effort to ensure that LFG is being managed properly. Any decision to not install these LFG vents will only be made with the concurrence of MDEQ. The primary focus of this management system will be to prevent the off-property migration of landfill gas into surrounding properties.

SMDA will be pursuing a definition of the extent of the LFG problems in the three perimeter areas where high levels of methane have been detected. If landfill gas is detected at 25 percent of the lower explosive limit at or beyond the property boundary, or in structures, immediate actions must be taken to address the situation.

It is SMDA's responsibility to manage landfill gas such that there is no unacceptable exposure to harmful gas and that there is no fire and explosion hazard. Any active end use plan will discuss the potential for people to be exposed to potentially toxic or explosive gases and the steps taken to prevent such exposures.

2.3.1.5 Landfill Contouring and Final Cover

Both landfills will be graded in preparation for the installation of the final cover. The regrading design is based on both available property aerial surveys, prior investigations, and field investigations of final cover thickness performed by SMDA and others (refer to Appendix C, "Technical Specifications" 02100, 02210, 02220, 02247 and Plan Sheet #2).

The grading plan is engineered to create a new surface with a consistent minimum one percent slope gradient (refer to Plan Sheet #4). The elevations of the grades will also provide a rough balance between cuts and fills, minimizing off-property borrow soil requirements. The regrading design largely confines cut activities to the existing soil cover layer, thereby minimizing the need for excavation and relocation of waste. As such, the designed grades conform to the existing grades to a large extent. Given the shallow grade of the designed slopes, channelized run-off is not necessary and may even result in gully formation or ponding of surface water. Refer to Attachment VI, "Cut and Fill Volumes" for an estimate of the soil requirements for final cover grading. These volume estimates are based on the existing surface grades shown on Plan Sheet #2 and the proposed top of final cover grades shown on Plan Sheet #4.

At no time is it anticipated that significant areas of waste will be exposed during the construction of the final cover or the installation of the groundwater interceptors or leachate collectors. Most activities will occur almost completely within the existing cover or outside of the limits of waste (refer to Appendix C, "Technical Specifications" 02100, 02210, 02220, 02247 and Plan Sheet #4, "Top of Final Cover Grades"). Any waste encountered during the course of remediation construction will be disposed of in accordance with applicable regulations.

2.3.1.6 Remedial Action Plan Sequence and Evaluation

The overall sequence for this remedial action plan will conform to the project schedule and is described as follows:

1. Analysis of leachate and groundwater contamination levels

2. Determination and construction of the appropriate method(s) for leachate and contaminated groundwater management and disposal.

3. Construction of leachate and groundwater treatment systems.

4. Installation of the groundwater interceptors and the impermeable barrier

5. Construction of groundwater extraction wells.

6. Installation of the leachate collectors.

7. Regrading of the landfills and the placement of final cover

8. Construction of the landfill gas venting system (refer to Appendix L, "Landfill Gas Vent and Probe Plan").

9. Monitoring of the effectiveness of the remediation action in accordance with the PMP

10. Long-term operation and maintenance of the remediation systems.

11. Placement of deed restrictions and institutional controls.

Each effort is to be evaluated in regards to its effects on groundwater contamination. The systems may be revised as needed, depending on the results of these evaluations. Furthermore, should the groundwater monitoring results show that contamination containment and remediation have been achieved after any one of these stages, further remediation efforts may be postponed to allow assessment of the effectiveness of the current stage of remediation. Approval of the MDEQ will be obtained prior to any postponement or deletion of any of the specified remedial components or stages, consistent with the Consent Decree.

2.3.1.7 Engineering Computations

The engineering computations evaluating the performance of the remedy are included in the attachments to this report. These include a description of the purpose and objective, design assumptions and conditions, methodology, material characteristics, the computations, and conclusions.

2.3.2 Construction Work Plan

Construction efforts will be performed in accordance with the applicable Technical Specifications (see Appendix C). These technical specifications are attached and made part of this RAP.

2.3.2.1 Leachate and Contaminated Groundwater Management System

The configurations of the various leachate and groundwater management systems will conform to the requirements of their permits. Ultimately, it is intended that contaminated groundwater and leachate be discharged to the sanitary sewer. Refer to Appendix J, "Leachate and Groundwater Management Plan".

2.3.2.2 Groundwater Interceptor System

The groundwater interceptor will be a trench drain consisting of a perforated collection pipe and suitable drainage backfill. This drainage backfill will consist of washed gravel. The groundwater interceptor will be installed along the northern and western boundaries of the landfill (refer to Appendix C, "Technical Specifications" 02221 and 02426; and Plan Sheets #5, #6A, #6B, and #6C).

The groundwater interceptor invert elevations and the resulting pipe flow gradients will conform to the bottom of waste grades along the northern and

western landfill boundaries of Property 9 and 9A. Along the eastern boundary of Property 9, the groundwater interceptor will be installed at a depth that allows it to remove contaminated groundwater from those areas of Aquifer immediately east of Property 9.

Based on available data, the lowest bottom of waste elevations along these boundaries are located in the north central and southwest corner of Property 9A. Perimeter interceptors and four groundwater extraction sumps will be installed. All intercptors will flow to extraction sumps. The leachate collected by the interceptors will be pumped via force main to the site's proposed pretreatment system and sanitary sewer discharge (refer to Plan Sheets #9A and 9B).

In addition to the groundwater interceptor piping system, one or more groundwater extraction wells will be installed. Tentative locations for the extraction wells are indicated on Plan Sheet #5 in Appendix I. The final number, depth, location and pumping rate of the extraction wells to be installed will be identified in the "Extraction Well Design Plan". The design of the extraction well system will be sufficient to meet the performance monitoring standards identified in the Performance Monitoring Plan (refer to Appendix D) taking into account the analyses of the effects of the leachate collection system on the contaminant plumes. The "Extraction Well Design Plan" will be submitted and the groundwater wells will be installed no later than as indicated on "The Schedule" (refer to Attachment VII).

2.3.2.3 Leachate Collection System

To prevent leachate from exiting the landfills along their southern and eastern boundaries, a leachate capture and collection system will be installed. This will consist of a trench drain consisting of a perforated collection pipe and drainage backfill (refer to Appendix C, "Technical Specifications", 02221 and 02426; and Plan Sheets #5, #6A, #6B, and #6C).

The pipe invert elevations and the resulting pipe flow gradients will conform to the bottom of waste grades along the southern boundary of Property 9 and the eastern and southern boundaries of Property 9A. Based on available data, the lowest bottom of waste elevation is located in the southwest corner of Property 9A. Two leachate collectors and one leachate extraction sump will be installed. Both collectors will discharge into a leachate collection and extraction sump to be installed at the low point.

The existing leachate management system will continue to be utilized during the remediation effort.

2.3.2.4 Gas Venting System

A gas collection and venting system will be installed along the perimeters of both landfills; as much as possible using the existing and proposed leachate collection systems (refer to Technical Specification 02433). Given the relatively small amounts of landfill gas currently being generated, passive vents will be utilized. The spacing and locations of the vents will be determined from the results of LFG monitoring. The vents will consist of 4-inch diameter PVC or HDPE standpipes set in the gravel trenching of the existing leachate collection system. The depth of each standpipe will vary with depth of gravel and adjacent bottom of waste elevations. The standpipes will be topped with 4-inch diameter PVC or HDPE inverted u-bends. Should it be required by the final end use, appropriate safety and efficiency modifications will be made to the venting system.

2.3.2.5 Final Cover and Vegetation

Final cover will consist of a 24-inch thick soil layer having a hydraulic permeability less than 1×10^{-5} cm/sec (refer to Appendix C, "Technical Specifications", 02100, 02200 and 02210, 02210A and 02270, and Plan Sheet #4, "Top of Final Cover Grades"). These soils will meet or exceed the permeability requirements set forth in the engineering computations. Wherever possible, existing in-place cover soil will be utilized if it meets these thickness and permeability requirements. Additional soil will be obtained, as much as possible, from on-property sources resulting from excavation and regrading operations. The final surface grades will conform to design slopes and elevations. The final surface will be fertilized, seeded and mulched to establish a permanent vegetative cover.

SMDA will perform construction dust control. Water wagons, water trucks, and/or sprinkler systems will be used to limit dust production. Construction methods (capping with off property borrow soil) and active dust suppression will ensure that no potential exists for the existing cap to form a dust exposure pathway. Furthermore, nuisance dust (fugitive dust) from the construction effort will similarly be controlled with the dust suppression and pavement sweepers. The property supervisor and Health Safety Officer (HSO) will document visual observations and direct dust suppression efforts. The property supervisor and HSO have the authority to shut down operations if dust becomes a concern. PM10 monitoring will be performed when specifically directed by the MDEQ. See the "Contingency Plan", Appendix E, for response to excessive dust.

If uncovering the waste causes odors that violate Rule 901 of Air Quality rules, then SMDA shall immediately control the emissions using clean fill or foam. SMDA shall have available on site, the equipment for foam cover or clean fill for this purpose.

3.0 Implementation details and documentation (as relevant for the types of remedial actions proposed/implemented).

3.0A For All RAPs

3.1 Documentation that criteria are appropriate for the site.

The criteria for the landfill property are site specific. No site reuse will be allowed unless a site specific risk assessment for an alternative use is conducted as described in the restrictive covenant (refer to Appendix K, "Restrictive Covenant for Landfill Properties"). The property is zoned agricultural.

The property will be used within the guidelines of the restrictive covenant.. Upon the approval of the MDEQ, other uses will be allowed if a demonstration is made that the exposures associated with the proposed use are consistent with (or less than) the exposure assumptions in the RAP.

The receptor that would have the most potential exposure is the groundskeeper. The exposure assumptions for a groundskeeper are consistent with the exposure assumptions used to derive the site specific criteria. No site reuse will be allowed unless a site specific risk assessment for an alternative use is conducted as described in the restrictive covenant (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

The criteria for areas outside the landfill property is generic residential. This is appropriate as these areas are zoned and used for residential or agricultural purposes.

3.2 Identification of rationale for indicator chemicals.

Petro will test for indicator chemicals only to adhere to the discharge permits' requirements. Discharge sampling must fully comply with all permit requirements including any sampling and analysis requirements. Groundwater sampling will need to comply with the PMP, which is attached to the RAP. Per the PMP, sampling will include analyses for VOCs, metals and specified general chemistry parameters. After the first year of monitoring an assessment will be performed, subject to MDEQ approval, to determine which general chemistry parameters to continue analyzing. After two years, MDEQ will be petitioned to reduce the number of parameters analyzed and/or the frequency of monitoring.

3.3 Source control analysis.

The 1993 Review of Remedial Alternatives and the 1995 Report on Refined Evaluation of Remedial Alternatives for the SMDA Properties 9 and 9A prepared by the Dragun Corporation included the analysis of several source control options, including, excavation and off-property disposal of the waste, installation of a liner beneath the refuse and complete encapsulation of the waste materials. Each of these options was deemed inappropriate because of significant implementability problems as well as not being cost

effective. SMDA concurs with these conclusions and proposes a remedial action plan that does not require mass excavation and relocation of existing waste.

Previous actions, such as the installation of a slurry wall on the north side of Property 9 and the installation of leachate collection lines, have served to help control the on-going release from the waste materials. The proposed remedy includes improvements to the landfill cover to reduce infiltration of water into the waste mass. This along with the proposed leachate collection and groundwater interceptor trenches around the perimeter of the landfill will serve to control the leaching of contaminants from the source. The proposed restrictive covenant will serve to prevent activities that interfere with the containment of waste and prevent direct contact with the waste (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

HELP Model analyses (see Attachment III) estimate that existing conditions result in approximately 6.10 inches of percolation through the cover each year. The proposed soil final cover is estimated to reduce this percolation rate by 99.5% to only 0.03 inches per year. An additional geomembrane layer installed as part of the proposed final cover would result in only an incremental further decrease in annual percolation. This further reduction is not justified given the cost of installing a geomembrane, protective soil cover and lateral drainage layer. Note that the assumptions used to run the HELP Model are based on best available information.

3.4 Schedule.

Refer to Attachment VII "Schedule".

3.5 Implementation/construction monitoring.

Construction implementation and monitoring details are provided in separate technical submittals. Attachment VII, "The Schedule" is a schedule of these technical submittals. Each of the submittals are intended to be reviewed and approved, as necessary, incompliance with "The Schedule" in the RAP, although the remedial actions cannot be fully implemented without the completed and implemented actions of these separate submittals. For instance, groundwater disposal is implied in this RAP; however, the actual discharge is detailed by permit.

Refer to the "Quality Assurance Program Plan" in Appendix B, and "Technical Specifications" in Appendix C. Additional technical specifications and design parameters will be prepared and submitted to the MDEQ for review and comment for: (1) Extraction well design, including the number of wells, location of wells, materials, construction procedures, the vertical place of screens for these wells, and associated piping system; (2) Design of any necessary groundwater/leachate treatment systems, including the design associated with disposal of treated effluent; (3) Installation of additional monitoring wells and piezometers; (4) Installation of gas probes; (5) Any other elements to be constructed that do not have design details presented in the technical

specifications included in the RAP (see "The Schedule", Attachment VII). Upon completion of construction, as-built drawings will be submitted to MDEQ.

3.6 Operation and Maintenance plans.

The remediation systems will be maintained over the duration of the property clean up in order to ensure that they operate as required. The final cover layer and associated vegetative cover will be inspected in accordance with the "Operations and Maintenance Plan" (O&M) provided in Appendix H. Should evidence of erosion and vegetation loss be observed, additional soil placement and seeding will be performed. If necessary, temporary erosion control structures (silt fences and straw bales) will be installed until vegetation is reestablished. Erosion estimates and a copy of the erosion control permit are provided in Attachment I.

Mechanical and electrical components of the groundwater extraction wells, groundwater interception and leachate collection systems will be operated and maintained in accordance with manufacturer's recommendations. Collection pipes for both systems will be inspected and if necessary flushed to remove accumulated sediments.

Structures and facilities associated with NPDES or sanitary sewer discharge will also be operated and maintained in accordance with manufacturer's recommendations. The structures, facilities and equipment associated with the NPDES discharge or sanitary sewer discharge will be operated and maintained in accordance with their respective permits as well as manufacturer's recommendations. Permit documentation, submittals and renewals will be performed as required. Refer to Appendix H, "Operations and Maintenance Plan" (O&M) for a more detailed description of the operations and maintenance standards.

Updates to the O&M plan will be prepared and sent to the MDEQ for review and comment upon: (1) Completion of the additional design elements; (2) Completion of construction; (3) When modifications are made to the remediation system; and (4) Every five years or as otherwise appropriate.

3.7 Plan for well abandonment.

Wells are to be abandoned when they either: (a) go dry, or (b) chemical parameters are sufficient in accordance with the PMP and water head data is no longer necessary. Refer to Appendix C, "Technical Specifications", Section 02433 "Gas and Leachate Extraction/Wells".

SMDA will submit a plan for abandonment of wells to the MDEQ in accordance with the requirements of the consent decree:

" 5.9 Abandonment of Wells Not Used for Long-term Monitoring: Within forty-five (45) days after entry of this decree, SMDA shall submit a proposed plan and implementation schedule to the MDEQ for the identification and removal or plugging of

monitor wells that will not be utilized for long term monitoring at the Facility. Upon receiving MDEQ approval, SMDA shall properly remove or plug the identified monitor wells in accordance with the approved plan and the specifications set forth in ASTM Standard D 5299-92 (Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities) or other relevant or applicable standards that are in effect at the time the wells are abandoned. SMDA shall report to the MDEQ the status of the plugging and abandonment of monitor wells in the Progress Reports to be submitted pursuant to Paragraph 5.13 of this Order.

5.10 Abandonment of Wells Used for Long-term Monitoring: SMDA shall, upon completion of long-term monitoring, submit a proposed plan and implementation schedule to the MDEQ for the identification and removal or plugging of all remaining monitor wells at or related to the Facility. Upon receiving MDEQ approval, SMDA shall properly remove or plug the identified monitor wells in accordance with the approved plan and the specifications described in ASTM Standard D 5299-92 (Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities) or other relevant or applicable standards that are in effect at the time the wells are abandoned. SMDA shall report to the MDEQ the status of the plugging and abandonment of monitor wells in the Progress Reports to be submitted pursuant to Paragraph 5.13 of this Order."

3.8 Monitoring plans.

The evaluation of the performance of the remedy will be in accordance with the requirements of the PMP. The PMP includes all aspects associated with operating and monitoring the site; it addresses how to monitor the effectiveness of the leachate and groundwater capture systems and includes some specific actions to be taken if certain conditions are encountered. The PMP does not address other necessary monitoring, such as, monitoring associated with treatment systems, discharge permits, landfill gas management, compliance with use restrictions, etc. Aspects relating to operation and maintenance are contained in the O&M plan. The PMP addresses the following:

1. Capture of health based contaminant plumes

2. The installation and operation of monitoring wells, and associated sampling and testing

3. Evaluation of leachate and groundwater elevation conditions

4. Chemical monitoring of the groundwater and leachate samples

5. Periodic review of the performance of the remediation

6. Modification (if necessary) of the remediation system, including removal of wells

7. Groundwater and leachate collection pumping system performance

After the first year of monitoring an assessment will be performed to determine which general chemistry parameters will continue to be analyzed for pursuant to the PMP. After two years, SMDA/Petro can petition the MDEQ to reduce the number of parameters analyzed and/or the frequency of monitoring. Refer to Section 5 "Monitoring Wells" of Appendix D, "Performance Monitoring Plan".

3.9 Contingency Plans.

Refer to Appendix E, "Contingency Plan"

3.0B For RAPs Proposed to Meet "Generic" Criteria Categories other than Residential

3.10 NAER.

Not Applicable.

3.11 Evidence of zoning.

Not Applicable.

3.12 Statement confirming exposure assumptions.

Not Applicable.

3.13 Possibility of exposures above generic at nearby properties.

Not Applicable.

3.0C For All RAPs Proposed to Meet "Limited" Criteria Categories or a Site Specific Criteria

3.14 Evidence of zoning.

The Macomb County Landfill Properties 9 and 9A are currently zoned as "agricultural" by Macomb Township. As such it does not conflict with the site-specific cleanup category described by the RAP. A zoning map is included (refer to attached Figure 1, "Official Zoning Map").

3.15 Language for restrictive covenants/local ordinances/other institutional controls.

Restrictive covenants are a practical means to prevent the use of groundwater for personal use (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

Pursuant to the Consent Decree, any activities that interfere with the remediation effort, operation and maintenance of the remediation system, groundwater performance monitoring, or any other component of the remediation system will be strictly prohibited. This includes all activities that may result in exposures above the levels established in the PMP such as excavation or otherwise breaching the final cover layer. A restrictive covenant is to be placed on the landfill properties, and statements from the property owners that they agree to such restrictions and agree to have it recorded with the register of deeds (refer to Attachment K). The restrictive covenant includes provisions to comply with §20120b(4) (a) through (f). In addition to limitations on excavation and other activities that interfere with the remedial operations, the covenant prohibits installation of groundwater wells other than wells for response activity. The restrictive covenant limiting interference with the integrity of the cap, for example, limiting excavation into the cap, require repairs to accidental damage to the cap, mow grass, maintain fence (as appropriate).

The restrictions limit the future use to no use, unless and until a site-specific risk assessment for an alternate use is performed and approved by the MDEQ. Also, the restrictive covenant prohibits placement of structures on the landfill cap. The covenant also prohibits structures unless design details for such structures and a methane mitigation plan are submitted to the Michigan DEQ for review and approval.

If structures to be constructed on the landfill cap are proposed, MDEQ would first need to review the design details to determine all potential safety and implementation issues were adequately addressed. Assuming the MDEQ concurred with the design and assessment, the restrictive covenant could then be modified.

The final RAP also includes a statement from the property owners that they will place these restrictions on the property. As is stated in the Consent Decree, "5.7 Deed Restrictions: Within twenty-one (21) days of SMDA's completion of construction of the leachate collection/treatment system, SMDA shall record with the Macomb County Register of Deeds the appropriate deed restriction included herewith as Appendix K. SMDA shall provide a true copy of the recorded restrictive covenant to the MDEQ within ten (10) days of its receipt of a copy from the Register of Deeds."

Pursuant to the Consent Decree, fourteen (14) days prior to conveyance of the title, easement or other interest in the property, the property owner will notify the MDEQ of the potential transaction. No property transaction will be finalized until the owner makes provisions for continued compliance with the remedial action plan.

It is currently planned that the property be used for activities allowed by a site-specific risk assessment after remediation is completed. Land use restrictions will be posted at the entrance to the site.

Within the guidelines of the site's Health and Safety Plan (HASP), representatives of MDEQ will be granted access to the property at reasonable times during and after the remediation effort for the purposes determining monitoring compliance with the remedial action plan. A copy of this HASP is provided in Appendix A. Applicable restrictions to property activities may be enforced by MDEQ.

3.16 Monitoring plans.

Refer to Section 3.8.

3.17 Operation and maintenance plans.

Refer to Section 3.6.

3.18 Specifications for permanent markers.

Permanent markers consisting of plaques on concrete piers will be utilized as informational markers. The main "informational" marker(s) need to be located at points of ingress/egress.

The markers will include the following information: (1) a map delineating the area of concern; e.g. the boundary of a capped area where excavation restrictions have been imposed, along with a "you are here" reference; (2) an inscription which states that the property is contaminated (or is a solid waste disposal area) and has been the subject of environmental remediation under state law; (3) a general description of the restrictions applicable to the property (e.g., no excavation); and, (4) the liber and page number of the restrictive covenant as recorded in the appropriate county Register of Deeds office.

Smaller numbered "satellite" markers will also need to be placed around the site's perimeter at each corner. The numbered markers would also be delineated on the map(s) contained on the main marker(s).

The map satisfies the requirement of Section 20120b(3)(d), which states that the permanent markers must describe the restricted area. The reference to the recorded restrictive covenant (including liber and page number) satisfies the requirement that the permanent marker specify the nature of any restrictions, provided a general statement is included in the main marker(s).

The restrictive covenant will also have a survey that delineates the extent of the landfilled areas and shows their relationship to the property boundaries. A registered land surveyor will prepare the survey.

3.19 Proposed financial assurance mechanism.

The facility includes property that is owned by Macomb Township and the SMDA (who is the liable party), whose municipal entities have the power to levy taxes and therefore do not need a financial assurance mechanism.

3.20 Proposed legally enforceable agreement.

The legally enforceable agreement is the Consent Decree to which this RAP is attached.

3.0D For all RAPs that Address Aquifer Contamination

3.21 Aquifer monitoring plan (may be part of 3.8 or 3.16).

Refer to section 3.16.

3.22 Rule 705 Waiver Request(s) (if not R705(5) and/or (6) compliant).

Rule 705(5) reads as follows:

"Rule 705. (5) The horizontal and vertical extent of hazardous substance concentrations in an aquifer above the higher of either the concentration allowed by R 299.5709 Section 20120A(1)(A) of the Act and the relevant Rules in Part 7 of these Rules shall not increase after the initiation of remedial actions to address an aquifer, except as provided in section 20118(5) and (6) of the Act and Subrule (7) of this Rule."

A waiver of Rule 705(5) was requested on May 15, 2001 against the possibility that the extent of the plume that exceeds aesthetic based residential standards may expand somewhat immediately after installation of the remediation systems. Rule 705(5) states that the horizontal and vertical extent of hazardous substance concentrations in an aquifer shall not increase after the initiation of remedial actions to address the aquifer, except as approved by the director of MDEQ. The intent of the RAP is to capture and remediate the groundwater plume that exceeds the health-based residential standards, however, there is a larger plume that exceeds the aesthetic based residential standards. Since the remediation system will not be designed to capture this larger plume, it is reasonable to expect that it may expand for some period of time after the remediation is initiated. Over a longer period of time it is anticipated that this plume will diminish, as continued loading to the aquifer is eliminated by the remediation system. Therefore this RAP would require a waiver to allow expansion of the aesthetic plume during initial stages of remediation.

3.0E For all RAPs where Groundwater Vents to Surface Water

3.23 Evidence of Part 31 compliance; mixing zone based discharge criteria (if relevant).

Not used.

3.0F For RAPs where Facility does or may Impact Great Lakes

3.24 Compliance with Great Lakes Water Quality Agreements.

Not used.

3.0G For RAPs where Department has not Calculated a Criterion for a Hazardous Substance for a Given Exposure Pathway

3.25 Data for calculation of a new criterion.

Not used.

4.0 Referenced and/or appended supporting information.

4.1 Remedial investigation reports and data.

The following is a list of investigative reports utilized in the writing of this RAP:

- "Remedial Investigation Report, South Macomb Disposal Authority, Macomb County, Michigan, EPA WA No. 193-5LS4", Ch2M-Hill, dated August 1990.

- "Hydrogeological Investigation, South Macomb Disposal Authority Landfill, Sites9 and 9A", Dragun Corporation, dated September 1994.

- "Final Report on Hydrogeological Investigation, South Macomb Disposal Authority Landfill, Sites9 and 9A", Dragun Corporation, dated February 1995.

- "Boring Logs (Domestic Wells, NTH Wells and Borings, SMDA 88xx Series, GZA Borings, ICF/SRW Borings", Dragun Corporation, compiled September 1998.

- "Well and Sump Test Results (LCS Pump Test Work Plan, raw Data and Analysis from Single Well Tests, Data from LCS Pump Test)", Dragun Corporation, compiled September 1998.

- "Vertical Aquifer Sampling Results for 598R, 9712, 594R, 9705, 9715, and 9716 Locations, Supplemental Plume Delineation Activities, SMDA Sites 9

and 9A, Macomb County Michigan, reference No. 11413", Conestoga-Rovers Associates, dated November 1999.

- "Supplemental Plume Delineation Report, SMDA Sites 9 and 9A, Macomb County, Michigan, Reference No. 11413(21)", Conestoga-Rovers Associates, dated June 2000.

4.2 Feasibility study reports and data.

The following is a list of feasibility studies utilized in the writing of this RAP:

- "Progress Report on Bench-Scale Treatability Study, SMDA Landfill, Site 9and 9A", Dragun Corporation, dated October 1994.

- "Report on Refined Evaluation of Remedial Alternatives for South Macomb Disposal Authority Sites 9 and 9A", Dragun Corporation, dated May 1995.

- "Conceptual Design for Remedial Action, SMDA Sites 9 and 9A, Macomb County, Michigan, reference No. 11413 (20)", Conestoga-Rovers Associates, dated November 1998.

- "Pre-Design Investigation Report, SMDA Sites 9 and 9A, Macomb County, Michigan, reference No. 11413 (20)", Conestoga-Rovers Associates, dated August 2000.

4.3 Site specific risk assessments.

Refer to "Remedial Investigation Report, South Macomb Disposal Authority, Macomb County, Michigan, EPA WA No. 193-5LS4", Ch2M-Hill, dated August 1990. The cleanup categories in the RAP do not rely on the risk assessment contained in the remedial investigation report. No site reuse will be allowed unless a site specific risk assessment for an alternative use is conducted as described in the restrictive covenant (refer to Appendix K, "Restrictive Covenant for Landfill Properties").

4.4 Treatability test results.

Refer to "Progress Report on Bench-Scale Treatability Study, SMDA Landfill, Property 9and 9A", Dragun Corporation, dated October 1994 and "Report on Refined Evaluation of Remedial Alternatives for South Macomb Disposal Authority Sites 9 and 9A", Dragun Corporation, dated May 1995.

4.5 Process and materials specifications (for treatment, recovery, and/or isolation systems).

Refer to the Technical Specifications in Appendix C.

4.6 Maps, photos, diagrams, and flow charts.

Refer to Appendix I, "Drawing Set".

4.7 Design details.

Refer to Appendix I, "Drawing Set".

4.8 Related permits obtained or anticipated.

The following permits may be obtained in addition to this RAP:

- A discharge permit that will allow the discharge of pretreated contaminated groundwater and leachate to a sanitary sewer system and wastewater treatment plant owned by the Detroit MSD.
- A soil and erosion permit from Macomb County.
- Possible air quality permit from MDEQ.
- Permit to work in forested wetland south of Property 9.

4.9 Analytical and statistical methodologies used and to be employed.

"Student T" with 3 standards deviations will be the statistical methodology. This methodology will be used to calculate background levels

The analytical methods to be used are described in the PMP and the QAPP.

The only statistical methods to be employed will be for the calculation of background levels in groundwater. Facility specific background levels will be determined using an appropriate data set by calculating the mean plus three standard deviations. An appropriate data set will consist of data from at least three background wells collected over at least four quarters. Comparison of facility data to the background levels will be on a point by point basis.

4.10 Request and support for mixing zone based GSI criteria (pursued prior to RAP).

Not used.

4.11 QA/QC protocols.

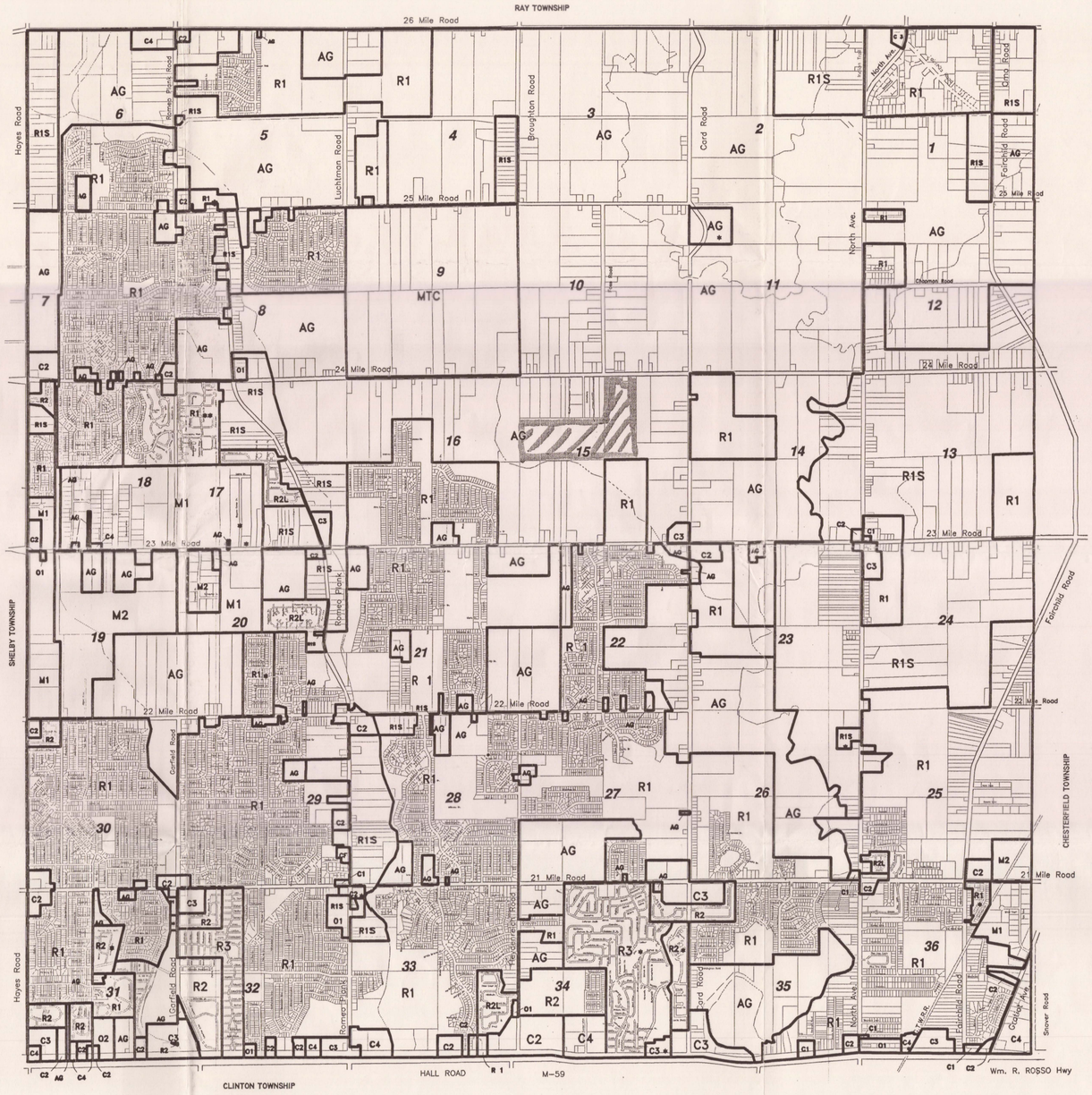
Refer to Appendix B, "Quality Assurance Program Plan (with Chain of Custody)".

4.12 Clean up verification demonstrations (VSR results etc.).

Refer to Appendix D, "Performance Monitoring Plan" (PMP) and Appendix H, "Operations and Maintenance Plan" (O&M).

4.13 Section 20d(3) public notice information (if relevant and available).

Because of the "site-specific" cleanup category and the waiver of Rule 705(5), public notice will be required. This will be in conformance with the public notice required by the court process that meets the Part 201 requirements.



MTC	MACOMB TOWN CENTER
AG	AGRICULTURAL
R1S	RESIDENTIAL, ONE FAMILY SUBURBAN
R1E	RESIDENTIAL, ESTATE ONE FAMILY
R1	RESIDENTIAL, ONE FAMILY URBAN
R2L	RESIDENTIAL, MULTIPLE-LOW DENSITY
R2	RESIDENTIAL, MULTIPLE-MEDIUM DENSITY
R2H	RESIDENTIAL, MULTIPLE-HIGH DENSITY
R3	RESIDENTIAL, MOBILE HOME PARK
CF	COMMUNITY FACILITIES
O1	OFFICE, LOW RISE
O2	OFFICE, HIGH RISE
C1	COMMERCIAL, LOCAL
C2	COMMERCIAL, GENERAL
C3	COMMERCIAL, SHOPPING CENTER
C4	COMMERCIAL, GENERAL HIGHWAY
WH	WAREHOUSE
MR	INDUSTRIAL, RESEARCH
M1	INDUSTRIAL, LIGHT
M2	INDUSTRIAL, HEAVY
SLD	SPECIAL LAND USE
* CJ	CONSENT JUDGMENT
** PUD	PLANNED UNIT DEVELOPMENT

THIS IS TO CERTIFY THAT THIS IS THE OFFICIAL ZONING MAP REFERRED TO IN ORDINANCE NUMBER 10 OF MACOMB TOWNSHIP, MACOMB COUNTY, MICHIGAN.

John D. Brennan
TOWNSHIP SUPERVISOR

Norman J. Snay
TOWNSHIP CLERK

OFFICIAL ZONING MAP

ADOPTED DATE: NOVEMBER 10, 1973
UPDATED: JANUARY 1, 2000

SCALE

MACOMB TOWNSHIP PLANNING COMMISSION

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Attachment I
Erosion Control

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513(489-7208

PROJECT / PROPOSAL NAME	PREPARED BY: _____ DATE: _____	CHECKED BY: _____ DATE: _____	PROJECT / PROPOSAL NUMBER

SUBJECT:

Potential Erosion of the Proposed Final Grades.

PURPOSE AND OBJECTIVE:

The following computations were performed to estimate the potential for erosion of the final landfill cover. The computations utilized the Universal Soil Loss Equation.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The final cover is constructed in conformance with the design grades and elevation.
2. Complete vegetation is established over the final cover in conformance with the design.

METHODOLOGY:

The erosion estimates are derived from the Universal Soil Loss equation:

$$A = R * K * LS * C * P$$

Where,

A = Annual soil loss in tons per acre
R = Rainfall and run-off erosivity index (dimensionless)
K = Soil erodibility factor (dimensionless)
LS = Slope-length factor (dimensionless)
C = Cover/vegetation management factor (dimensionless)
P = Practice factor (dimensionless)

MATERIAL CHARACTERISTICS:

The site is located in southeastern Michigan and therefore has an R = 100. It is assumed that sandy clay common to the region, with a K = 0.13, are utilized in the final cover layer. The slope grade is constructed at 1% with varying slope lengths for each watershed. LS therefore varies for each watershed. A final vegetative establishment equivalent to a moderate meadow is anticipated with a C value of 0.01. Track walking of the final cover prior to seeding would result in a P = 0.9.

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513(489-7208

SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

COMPUTATIONS:

See attached spreadsheets and supporting documentation.

CONCLUSIONS:

Given the very shallow final grades proposed for the landfill, maximum anticipated erosion is equivalent to 0.04 tons per acre. This is well below regulatory standards for erosion control.

The earthwork will require a soil erosion control and sedimentation permit. All work will be done in accordance with that permit and that as a part of the permit requirements, a soil erosion and sedimentation control plan has been prepared.

REFERENCES:

Soil and Erosion Permit #57738 issued by Macomb County on March 30, 2001 (see attached).

PERMIT

PART 91 OF ACT 451 OF 1994

APPROXIMATE STARTING DATE 05/01/2001

APPROXIMATE COMPLETION DATE 03/20/2002

Applicant: PETRO ENVIRONMENTAL TECHNOLOGIES Telephone: 513-489-6789

Date Issued: 03/20/2001 Permit Number: 57738

Expiration Date: 03/20/2002

Location: MACOMB TWP

Review plans		$	37.00
Permit		$	30.00
Insp.	3	$	90.00
FEE:		$	20.00
			177.00

Under the provisions of Part 91 of Act 451 of 1994 authority is hereby granted to:

INSTALL & MAINTAIN SEDIMENT CONTROL AT LAND FILL REMEDIATION

**N.P.D.E.S. PERMIT REQUIRED

in the county of Macomb. (Section 15, N 1/2 T R)

Plat: SOUTH MACOMB DISPOSAL Lot: PARCEL

Address: UNKNOWN Street: 24 MILE

Work to be done under authority of this permit is subject to the following special restrictions, limitations and instructions:

SEE CONTROL PLAN ~~ATTACHED~~ ON PRINT

For information call 469-5327.

PERMIT NOT TRANSFERABLE
FEES NOT REFUNDABLE
PERMIT EXPIRES ONE YEAR FROM DATE OF ISSUE

THIS PERMIT DOES NOT OBVIATE THE NEED FOR OTHER LOCAL, STATE AND FEDERAL PERMITS

ANTHONY V. MARROCCO
County Soil Erosion
& Sediment Control Agent
Macomb County, Michigan

By: _____
for ANTHONY V. MARROCCO

77 38

APPLICATION FOR PERMIT
(PART 91 OF ACT 451 OF 1994)
ENVIRONMENTAL PROTECTION ACT

FOR OFFICE USE ONLY ↓

Install & Maintain Sediment Control @ Land Fill Remediation
(Indicate type and size of earth change proposed)

1. Approximate starting date: 4-1-01
   Approximate completion date: 4-1-02
2. Project located in part of N 1/2 Section 15
   Municipality Macomb County of Macomb, T 3N R 13E
3. Legal description of property at project site: (SMDA 9, 9A)
   Name of Plat South Macomb Disposal Athority Bldg _____ Lot Parcel
   Address of site 24 mile Rd

If the applicant is not the land owner or authorized agent of the above described property, attach the name, address and phone number of record land owner or authorized agent.

4. Soil Type: _____
5. Gross Acres: 160 Acres Estimated Cu/Yds. _____
6. Application Fee: $ 37 + 30 + 90 + 20 = $ 177.00
7. Remarks: NPDES required
8. Nearest water course: 100' ± Name: McBride Drain
   (distance)

APPLICANT: PLEASE FILL OUT BELOW ↓

Signature: Daniel P. Duffy
Typed or printed name: Daniel P. Duffy (Project Manager)
Company Name: Petro-Environmental Technologies, Inc.
Address: 7851 Palace Drive
City, State, Zip Code: Cincinnati Ohio 45249
Phone Number (Include area code): 513-489-6789
513-489-7208 (fax)
Date: January 22, 2001

Return completed application and accompanying material to:

ANTHONY V. MARROCCO
Macomb County Public Works Commissioner
County Soil Erosion & Sediment Control Agent
115 South Groesbeck Highway, PO Box 806
Mount Clemens, Michigan 48046-0806
(810)469-5327

APPLICATIONS NOT FULLY COMPLETED WILL BE RETURNED
(See instructions on reverse side)

Petro Environmental Technologies, Inc.
7051 Palace Drive
Cincinnati, Ohio 45249

Date: ##########
Project: Macomb County Landfill

* : Values inputted manually

I. Watershed, Site 9	9-1		9-2		9-3	
* A. R-value = (southeastern Michigan)	100.00		100.00		100.00	
* B. K-value = (sandy clay with 2% organics, assumed)	0.13		0.13		0.13	
* C. LS-value = (refer to attached table)	0.25	(900',1%)	0.24	(800', 1%)	0.31	(1500', 1%)
* D. C-value = (equivalent to moderately productive meadow)	0.01		0.01		0.01	
* E. P-value = (trackwalked slope)	0.90		0.90		0.90	
F. Annual soil loss, A = (R * K * LS * C * P)	0.03	ton/acre	0.03	ton/acre	0.04	ton/acre
	58.50	lbs/acre	56.16	lbs/acre	72.54	lbs/acre
G. Annual soil loss volume, Av = (120 pcf density)	0.49	cf/acre	0.47	cf/acre	0.60	cf/acre
H. Watershed area, am = (refer to attached map)	15.49	acre	5.89	acre	22.48	acre
I. Annual soil accumulation, Aa = (Av * am,acre)	7.55	cf	2.76	cf	13.59	cf

II. Watershed, Site 9A	9A-1		9A-2		9A-3		9A-4	
* A. R-value = (southeastern Michigan)	100.00		100.00		100.00		100.00	
* B. K-value = (sandy clay with 2% organics, assumed)	0.13		0.13		0.13		0.13	
* C. LS-value = (refer to attached table)	0.20	(400', 1%)	0.26	(1000',1%)	0.26	(1050',1%)	0.16	(200',1%)
* D. C-value = (equivalent to moderately productive meadow)	0.01		0.01		0.01		0.01	
* E. P-value = (trackwalked slope)	0.90		0.90		0.90		0.90	
F. Annual soil loss, A = (R * K * LS * C * P)	0.02	ton/acre	0.03	ton/acre	0.03	ton/acre	0.02	ton/acre
	46.80	lbs/acre	60.84	lbs/acre	60.84	lbs/acre	37.44	lbs/acre
G. Annual soil loss volume, Av = (120 pcf density)	0.39	cf/acre	0.51	cf/acre	0.51	cf/acre	0.31	cf/acre
H. Watershed area, am = (refer to attached map)	14.42	acre	30.85	acre	24.89	acre	0.99	acre
I. Annual soil accumulation, Aa = (Av * am,acre)	5.62	cf	15.64	cf	12.62	cf	0.31	cf

Ref. Lutton, R.J., et al, "Design and Construction of Covers for Solid Waste Landfills", EPA Report 600/2-79-165, August 1979

SECTION 10

WATER EROSION CONTROL

When raindrops strike bare soil cover at a high velocity, they shatter soil granules and clods and detach particles. Sheet erosion follows where detached soil particles are transported uniformly downslope. Rill erosion develops in channels only inches in depth when soil particles are detached by concentrated flow and by slumping of undercut sidewalls. The capability of runoff to detach soil increases approximately as the square of the shear stress. Consequently, rill erosion increases with increasing slope and channel length, while sheet erosion continues more uniformly between the rills; relative contributions to total soil loss differ with soil and surface conditions.

THE UNIVERSAL SOIL LOSS EQUATION

The most accurate soil loss prediction tool that is now field-operational is the USDA universal soil loss equation (USLE).[62] This equation has been used for agricultural erosion-control planning for more than a decade in the eastern states and is now also used to a limited extent in the western states, Hawaii, and several foreign countries. Development of the equation has involved the analysis of the records from more than 10,000 plot-years of erosion studies at 42 research stations. The USLE is applicable to soil cover over solid waste with limitations as discussed under USE OF USLE FOR DESIGN.

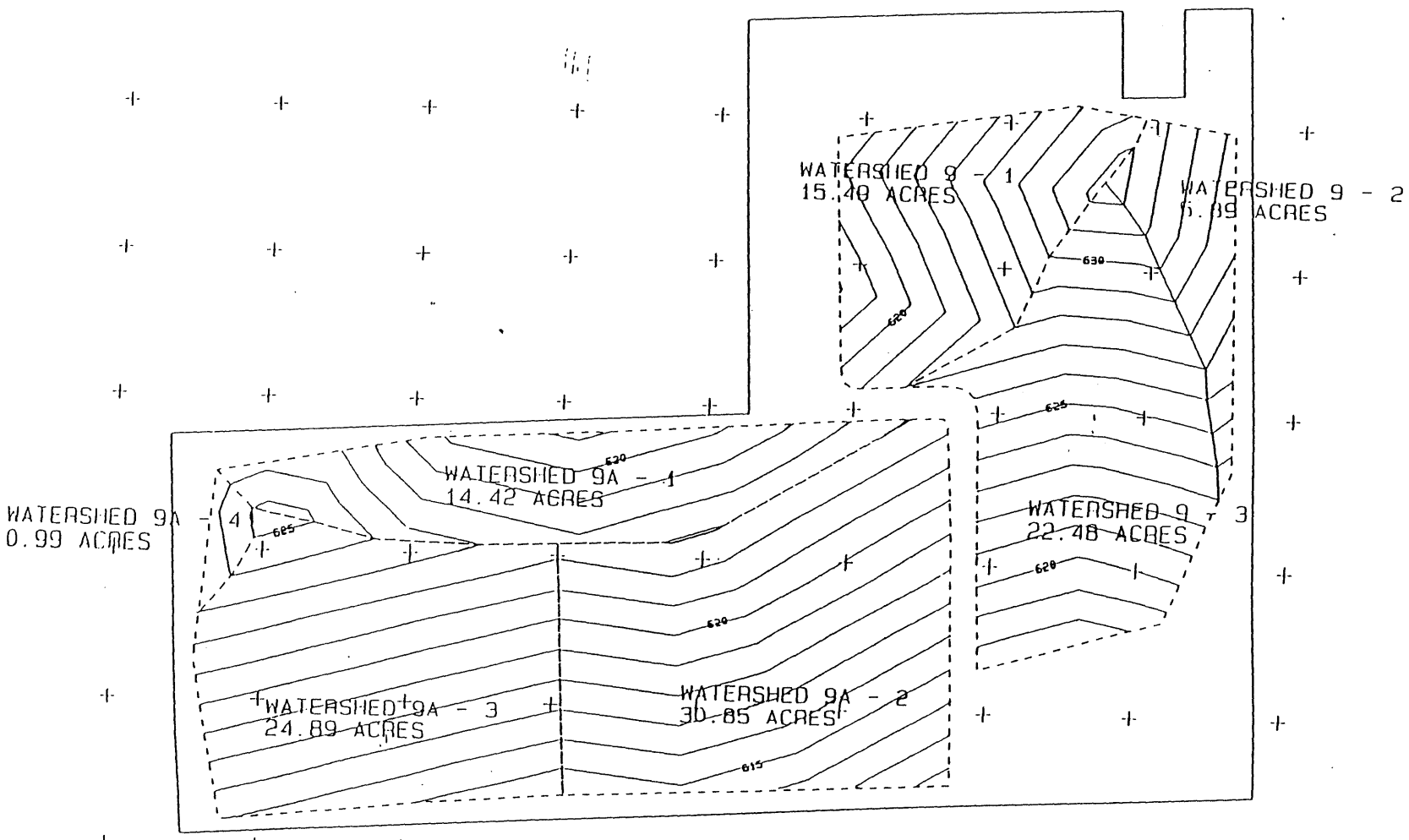
The USLE provides average soil loss as the product of two quantitative factors (soil-erodibility and rainfall-erosivity) and four qualitative factors. The equation is

$$A = RKLSCP \qquad (16)$$

where A = average soil loss, in tons per acre, for the time period used for factor R (e.g., annual)
R = rainfall and runoff erosivity index
K = soil erodibility factor
L = slope-length factor
S = slope-steepness factor
C = cover/management factor
P = practice factor

Rainfall and Runoff Erosivity Factor R

Factor R in the USLE usually equals the pertinent rainfall erosion index EI and is predictable from meteorological data. For average annual soil


WATERSHED 9 - 1
15.40 ACRES
WATERSHED 9 - 2
5.89 ACRES
WATERSHED 9 - 3
22.48 ACRES
WATERSHED 9A - 1
14.42 ACRES
WATERSHED 9A - 2
30.85 ACRES
WATERSHED 9A - 3
24.89 ACRES
WATERSHED 9A - 4
0.99 ACRES
630
625
620
615

loss. R can be obtained from Figure 59; for shorter specific time periods, it is the actual local EI for that period. EI is specifically the product of the maximum 30-minute rainfall intensity I in inches per hour and the rainfall kinetic energy E. The E term has been empirically approximated as

$$E = 916 - 331 \log_{10} i \text{ (ft-tons/acre-in.)} \qquad (17)$$

where i is intensity in inches per hour. A tabulation of values from the equation is also available.[50]

The EI of an individual rainstorm can be obtained by dividing the storm into successive increments of essentially uniform intensity, using the equation to compute E of each increment, and then summing. The relation of soil loss to EI is linear; therefore, individual-storm values of EI can be summed to obtain seasonal or refined annual values more representative than the generalizations presented in Figure 59. Nevertheless, the R values in the figure are useful approximations, being computed from 22-year rainfall records (1937-1958) for about 2000 locations fairly uniformly distributed over the states east of the Rocky Mountains. For computation of average annual EI values, continuous records of 20 years or more help to avoid bias from cyclical variations in the rainfall pattern.

The computed EI must be modified to evaluate R for the following two special cases:

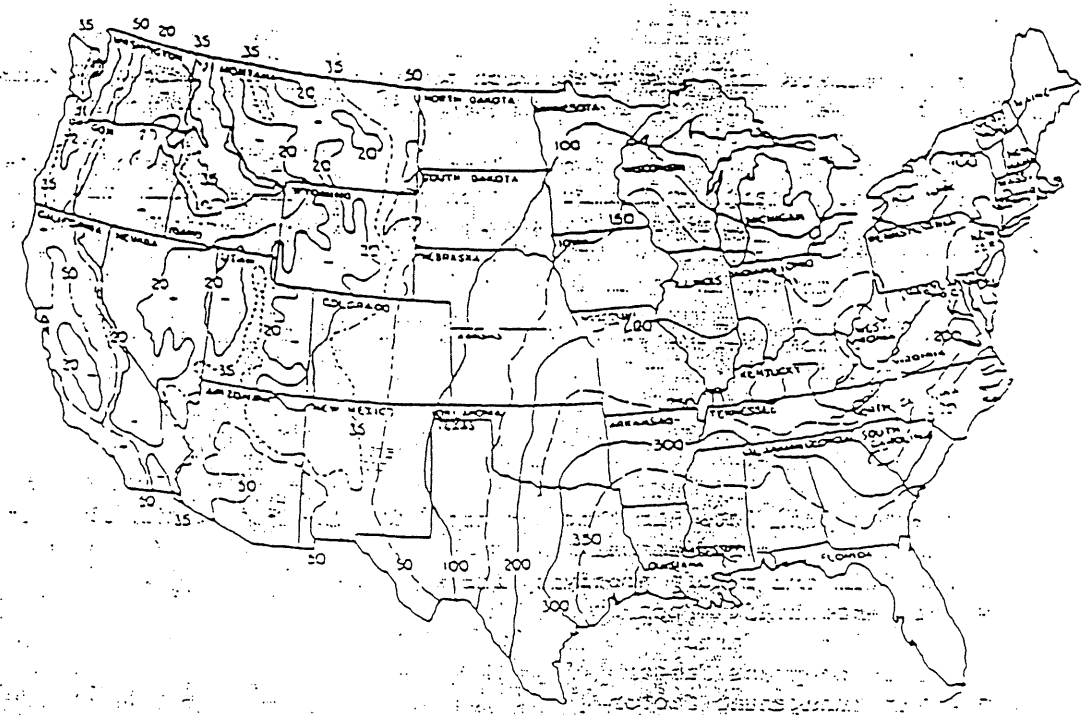


Figure 59. Average annual values of rainfall-erosivity factor R.[79]

a. Where snowmelt runoff on moderate to steep slopes is significant (adjust EI upward).

b. On the Coastal Plains of the Southeast (adjust EI downward). A maximum of 350 has been used temporarily, pending research.

Soil Erodibility Factor K

The average increase in soil loss with increase in EI differs from soil to soil even when rainfall, topography, cover, and management remain the same. The factor K is used to distinguish such differences and is the average soil loss in tons per acre, per unit of R, for a given soil on a "unit plot" (defined as 72.6 ft long with 9 percent slope, continuous fallow, and tilled parallel to the land slope). Long-term plot studies under natural rainfall produced K values ranging from 0.03 to 0.69.

Generally, it has been found that K is affected by particle-size distribution (percent sand, silt, and clay), organic-matter content, soil structure, and permeability. In regard to the grain sizes, very fine sand (0.05-0.10 mm) content is more effectively included with or classified as silt. The nomograph in Figure 60 has been developed from empirical relationships[81] in order to predict K for any soil.

The nomograph solution may be improved in accuracy for some special conditions. Separate K values can be obtained for clays in dry and wet seasons by using, along with normal ratings, increased permeability ratings appropriate for dry, cracked clays in the dry season. Occasionally, one can improve accuracy by regarding loose gravel or rock fragments on the surface as partial mulch cover and reducing the calculated K accordingly. The nomograph has been evaluated as inadequate for distinguishing erodibility of high-clay subsoil (such as excavated and used as solid waste cover); chemical properties of the soil become important here.[82] Standard textural classes (Table 27) are too broad to be accurate indicators of K for in situ agricultural soils but may be useful for first approximations of remolded waste-cover soils.

Topographic Features Factors L and S

The USLE incorporates effects of ground length and steepness in the combined topographic factor LS. The separate factors L and S are the ratios of soil loss in comparison with that from the "unit plot" with length 72.6 ft and slope 9 percent, other conditions remaining constant. The length of concern (Table 28) is from the entry of flow to an exit into a well-defined channel or to a slope decrease sufficient to initiate deposition. The effect of increased length is primarily toward greater accumulation and more channelization of runoff and, in turn, increased erosional capability. Also, runoff tends to increase linearly or greater with increases in steepness, and soil losses increase even more rapidly.

The research data used to derive LS factors in Table 28 were from field plots not longer than 270 ft nor steeper than 18 percent. LS values for greater dimensions and slopes are speculative, being based on extrapolations.

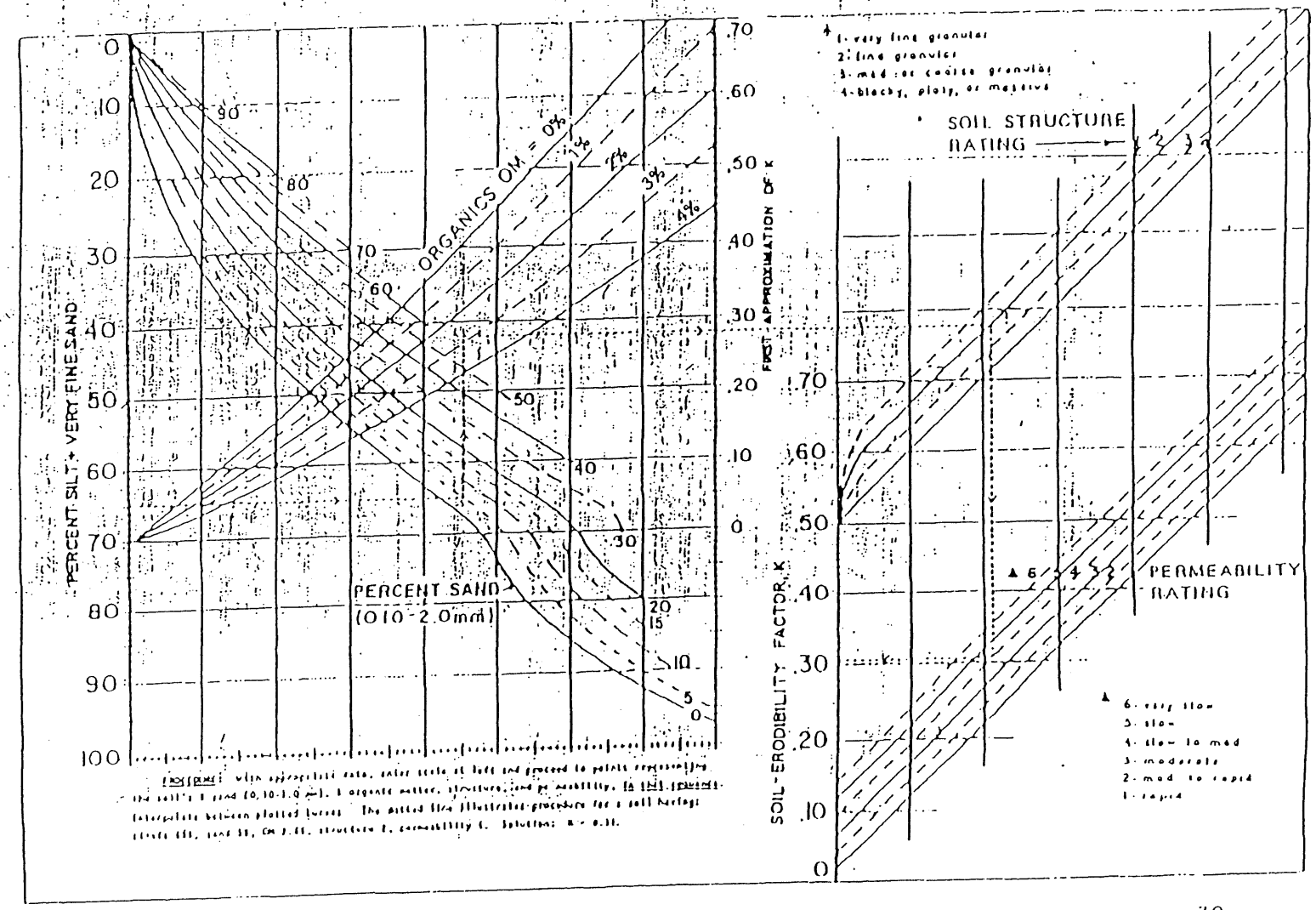


Figure 60. Nomograph for determining soil-erodibility factor K for U. S. Mainland.[79]

TABLE 27. APPROXIMATE VALUES OF FACTOR K FOR USDA TEXTURAL CLASSES[79]

Texture class	Organic matter content		
	<0.5%	2%	4%
	K	K	K
Sand	0.05	0.03	0.02
Fine sand	.16	.14	.10
Very fine sand	.42	.36	.28
Loamy sand	.12	.10	.08
Loamy fine sand	.24	.20	.16
Loamy very fine sand	.44	.38	.30
Sandy loam	.27	.24	.19
Fine sandy loam	.35	.30	.24
Very fine sandy loam	.47	.41	.33
Loam	.38	.34	.29
Silt loam	.48	.42	.33
Silt	.60	.52	.42
Sandy clay loam	.27	.25	.21
Clay loam	.28	.25	.21
Silty clay loam	.37	.32	.26
Sandy clay	.14	.13	.12
Silty clay	.25	.23	.19
Clay		0.13-0.29	

The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values.

Soil loss estimates for slopes steeper than about 30 percent are potentially subject to considerable error.

Shape of the slope is also important. An irregular slope can be evaluated as a series of segments with uniform gradients. For engineered landfills, two or three segments should be sufficient. Provided the segments are selected so that they are also of equal length, Table 28 can be used with certain adjustments that have been found[62] to be appropriate. Enter Table 28 with the total slope length for LS values corresponding to the percent slope of each segment. For three segments, multiply the chart LS values for the upper, middle, and lower segments by 0.58, 1.06, and 1.37, respectively. The average of the three products is a good estimate of the overall effective LS value. If two segments are sufficient, use the multiples 0.71 and 1.29.

TABLE 28. VALUES OF THE FACTOR LS FOR SPECIFIC COMBINATIONS OF SLOPE LENGTH AND STEEPNESS[79]

% Slope	Slope length (feet)											
	25	50	75	100	150	200	300	400	500	600	800	1000
0.5	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17	0.19	0.20
1	0.09	0.10	0.12	0.13	0.15	0.16	0.18	0.20	0.21	0.22	0.24	0.25
2	0.13	0.16	0.19	0.20	0.23	0.25	0.28	0.31	0.33	0.34	0.38	0.40
3	0.19	0.23	0.26	0.29	0.33	0.35	0.40	0.44	0.47	0.49	0.54	0.57
4	0.23	0.30	0.36	0.40	0.47	0.53	0.62	0.70	0.76	0.82	0.92	1.0
5	0.27	0.38	0.46	0.54	0.66	0.76	0.93	1.1	1.2	1.3	1.5	1.7
6	0.34	0.48	0.58	0.67	0.82	0.95	1.2	1.4	1.5	1.7	1.9	2.1
8	0.50	0.70	0.86	0.99	1.2	1.4	1.7	2.0	2.2	2.4	2.8	3.1
10	0.69	0.97	1.2	1.4	1.7	1.9	2.4	2.7	3.1	3.4	3.9	4.3
12	0.90	1.3	1.6	1.8	2.2	2.6	3.1	3.6	4.0	4.4	5.1	5.7
14	1.2	1.6	2.0	2.3	2.8	3.3	4.0	4.6	5.1	5.6	6.5	7.3
16	1.4	2.0	2.5	2.8	3.5	4.0	4.9	5.7	6.4	7.0	8.0	9.0
18	1.7	2.4	3.0	3.4	4.2	4.9	6.0	6.9	7.7	8.4	9.7	11.0
20	2.0	2.9	3.5	4.1	5.0	5.8	7.1	8.2	9.1	10.0	12.0	13.0
25	3.0	4.2	5.1	5.9	7.2	8.3	10.0	12.0	13.0	14.0	17.0	19.0
30	4.0	5.6	6.9	8.0	9.7	11.0	14.0	16.0	18.0	20.0	23.0	25.0
40	6.3	9.0	11.0	13.0	16.0	18.0	22.0	25.0	28.0	31.0	--	--
50	8.9	13.0	15.0	18.0	22.0	25.0	31.0	--	--	--	--	--
60	12.0	16.0	20.0	23.0	28.0	--	--	--	--	--	--	--

Values given for slopes longer than 300 feet or steeper than 18% are extrapolations beyond the range of the research data and, therefore, less certain than the others.

Cover/Management Factor C

Factor C in the USLE is the ratio of soil loss from land cropped under specified conditions to that from clean-tilled, continuous fallow.[62] Therefore, C combines effects of vegetation, crop sequence, management, and agricultural (as opposed to engineering) erosion-control practices. On landfills, freshly covered and without vegetation or special erosion-reducing procedures of cover placement, C will usually be about unity. Where there is vegetative cover or significant amounts of gravel, roots, or plant residues or where cultural practices increase infiltration and reduce runoff-velocity, C is much less than unity. C ranges from about 0.60 to less than 0.01 on cropped land and, therefore, is important to planning erosion control on landfill.

A field-tested routine adaptable to landfill planning modifies C to reflect the net effect of interrelated crop and management variables and local rainfall patterns or seasons. The first-year procedure amounts to distinguishing five crop stages: cover placement (rough fallow), seedling, establishment, developing-maturing crop, and sometimes residue-stubble. Probable calendar dates for successive periods are selected. The fraction of the local

annual EI that normally occurs during each crop stage is next estimated. These fractions are multiplied by estimated corresponding C values (Table 29), and the resulting products are summed to obtain the overall C.

In the second and subsequent years, the cover placement, seedling, and establishment stages are not normally repeated, and C values should be summed from developing-maturing and possibly residual-stubble stages only. Computed C values are in many cases available upon request from local SCS offices.

Supporting Practices Factor P

Factor P in the USLE is similar to C, except that it accounts for additional effects of practices that are superimposed on the cultural practices, e.g., contouring, terracing, and contour stripcropping. Approximate values of P, related only to slope steepness, are listed in Table 30. These values are based on rather limited field data, but P has a narrower range of possible values than the other five factors. Influences of the type of vegetation, residue management, rainstorm characteristics, and soil properties on the value of P have not been evaluated to the point of predictability.

TABLE 29. GENERALIZED VALUES OF FACTOR C FOR STATES EAST OF THE ROCKY MOUNTAINS[19]

Crop, rotation, and management	Productivity level: High	Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, RdR, fall TP, conv	0.54	0.62
C, RdR, spring TP, conv	.50	.59
C, RdL, fall TP, conv	.42	.52
C, RdR, wc seeding, spring TP, conv	.40	.49
C, RdL, standing, spring TP, conv	.38	.48
C-W-M-M, RdL, TP for C, disk for W	.039	.074
C-W-M-M-M, RdL, TP for C, disk for W	.032	.061
C, no-till pl in c-k sod, 95-80% re	.017	.053
COTTON		
Cot, conv (Western Plains)	0.42	0.49
Cot, conv (South)	.34	.40
MEADOW		
Grass & Legume mix	0.004	0.01
Alfalfa, lespedeza or Sericea	.020	
Sweet clover	.025	
SORGHUM, GRAIN (Western Plains)		
RdL, spring TP, conv	0.43	0.53
No-till pl in shredded 70-50% re	.11	.18
SOYBEANS		
B, RdL, spring TP, conv	0.48	0.54
C-B, TP annually, conv	.43	.51
B, no-till pl	.22	.28
C-B, no-till pl, fall shred C stalks	.18	.22
WHEAT		
W-F, fall TP after W	0.38	
W-F, stubble mulch, 500 lbs re	.32	
W-F, stubble mulch, 1000 lbs re	.21	

Abbreviations defined:

B - soybeans
C - corn
c-k - chemically killed
conv - conventional
cot - cotton
F - fallow
M - grass & legume hay
pl - plant
W - wheat
wc - winter cover

lbs re - pounds of crop residue per acre remaining on surface after new crop seeding
% re - percentage of soil surface covered by residue mulch after new crop seeding
70-50% re - 70% cover for C values in first column; 50% for second column
RdR - residues (corn stover, straw, etc.) removed or burned
RdL - all residues left on field (on surface or incorporated)
TP - turn plowed (upper 5 or more inches of soil inverted, covering residues)

TABLE 30. VALUES OF FACTOR P[79]

Practice	Land slope (percent)				
	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
	(Factor P)				
Contouring (P_c)	0.60	0.50	0.60	0.80	0.90
Contour strip cropping (P_{sc})					
R-R-M-M[1]	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting (P_{ci})	0.30	0.25	0.30	0.40	0.45
Contour terracing (P_t)[2]	[3] $0.6/\sqrt{n}$	$0.5/\sqrt{n}$	$0.6/\sqrt{n}$	$0.8/\sqrt{n}$	$0.9/\sqrt{n}$
No support practice	1.0	1.0	1.0	1.0	1.0

[1] R = rowcrop, W = fall-seeded grain, O = spring-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that rowcrop strips are always separated by a meadow or winter-grain strip.

[2] These P_t values estimate the amount of soil eroded to the terrace channels and are used for conservation planning. For prediction of off-field sediment, the P_t values are multiplied by 0.2.

[3] n = number of approximately equal-length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

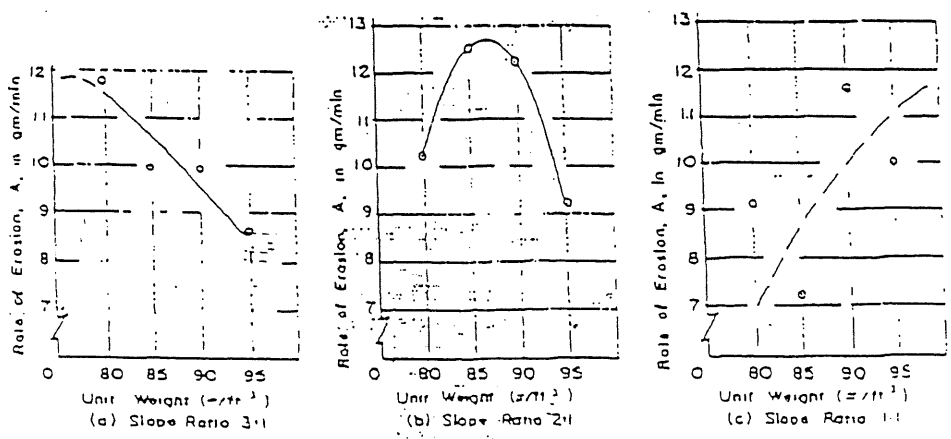


Figure 61. Effect of unit weight on erosion rate at three different slopes.[83] Soil is classified ML. (Reproduced by permission of American Society of Civil Engineers.)

Attachment II
Surface Water Run-Off

PARS ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED BY _____ DATE _____	CHECKED BY _____ DATE _____	PROJECT / PROPOSAL NUMBER

SUBJECT:

Surface Water Run-Off and Channel Peak Flows.

PURPOSE AND OBJECTIVE:

The following computations were performed to estimate the maximum run-off and resultant peak channel flows form the delineated watersheds of the proposed final cover grades. The computational procedures are derived from "Technical Release 55 – Urban Hydrology for Small Watersheds", SCS dated June 1986.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The final cover is constructed in conformance with the design grades and elevation.
2. Complete vegetation is established over the final cover in conformance with the design.
3. Existing perimeter channels will be utilized as much as possible. New channels will be constructed only as needed. Typically, the perimeter channels are to have a triangular cross section with 3:1 side slopes.

METHODOLOGY:

The methodology for the maximum surface water run-off is derived from "Technical Release 55 – Urban Hydrology for Small Watersheds", SCS dated June 1986.

$$Q = (P25 - Ia)^2 / (P25 - Ia + S)$$

Where,

Q = Direct run-off from the watershed (cfs)
P25 = The 25-year/24 hour storm event (inches)
Ia = initial abstraction (inches)
S = Potential maximum retention (inches)

Individual channel flow and velocity estimates are derived from Manning's equation for open channel flow:

$$V = (1.49/nc) * (Rh \wedge 0.667) * (S \wedge 0.5)$$

Where,

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PROJECT / PROPOSAL NAME	PREPARED BY: _____ DATE: _____	CHECKED BY _____ DATE _____	PROJECT / PROPOSAL NUMBER

V = Channel flow velocity (feet per second)
nc = Mannings' channel coefficient for a grass lined channel (dimensionless)
Rh = Hyraulic radius (feet)
Sc = Channel flow gradient (feet per feet)

MATERIAL CHARACTERISTICS:

The 25-year/24 hour storm event is 3.9 inches for southeast Michigan. The 2-year/24 hour storm event is 2.3 inches. The run-of curve number is C=79, equivalent to a moderate pasture or meadow with type C soils.

COMPUTATIONS:

See attached spreadsheets and associated documentation.

CONCLUSIONS:

Refer to attached design summary table. The maximum amount of flow discharging form the site at a point south of Site 9A is approximately 124 cfs. Note that this is a conservative estimate based on the direct addition of peak channel flows instead of the unit hydrographs for each channel.

The peak channel flow velocity, 4.4 feet per second, occurs in the downstream portion of channel 9A-2. This channel segment may require erosion control matting since the flow velocity exceeds 4.0 Feet per second.

Petro Environmental Technologies, Inc.
7851 Palace Drive
Cincinnati, Ohio 45249

Date: September 2000
Project: Macomb County Landfill
Channel: Design Summary
25-year/24-hour Rainfall

CHANNEL	TYPE	SURFACE RUN-OFF START ELEVATION (FEET)	SURFACE RUN-OFF END ELEVATION (FEET)	SURFACE RUN-OFF HORIZONTAL LENGTH (FEET)	AVERGE SURFACE RUN-OFF SLOPE (PER CENT)
Watershed 9-1	PERIMETER	632.0	630.0	200.0	1.0%
Watershed 9-2	PERIMETER	632.0	627.0	400.0	1.3%
Watershed 9-3	PERIMETER	627.0	617.0	250.0	4.2%
Watershed 9A-1	PERIMETER	625.0	619.0	300.0	2.0%
Watershed 9A-2	PERIMETER	623.0	615.0	300.0	2.7%
Watershed 9A-3	PERIMETER	625.0	614.0	500.0	2.2%
Watershed 9A-4	PERIMETER	625.0	617.0	300.0	2.7%

CHANNEL	INFLOW CHANNELS / STRUCTURES	CHANNEL WATERSHED AREA (ACRES)	CHANNEL PEAK DISCHARGE (CFS)	CHANNEL FLOW DEPTH (FEET)	CHANNEL FLOW VELOCITY (FPS)
Watershed 9-1		15.49	16.88	1.9	1.6
Watershed 9-2		5.89	5.48	1.4	0.9
Watershed 9-3	9-1,9a-1	22.48	58.28	2.3	3.6
Watershed 9A-1		14.42	8.51	3.2	0.3
Watershed 9A-2	9-3	30.85	93.51	2.6	4.4
Watershed 9A-3	9A-4	24.89	25.41	1.9	2.4
Watershed 9A-4		0.99	1.45	1.3	0.3

Petro Environmental Technologies, Inc.
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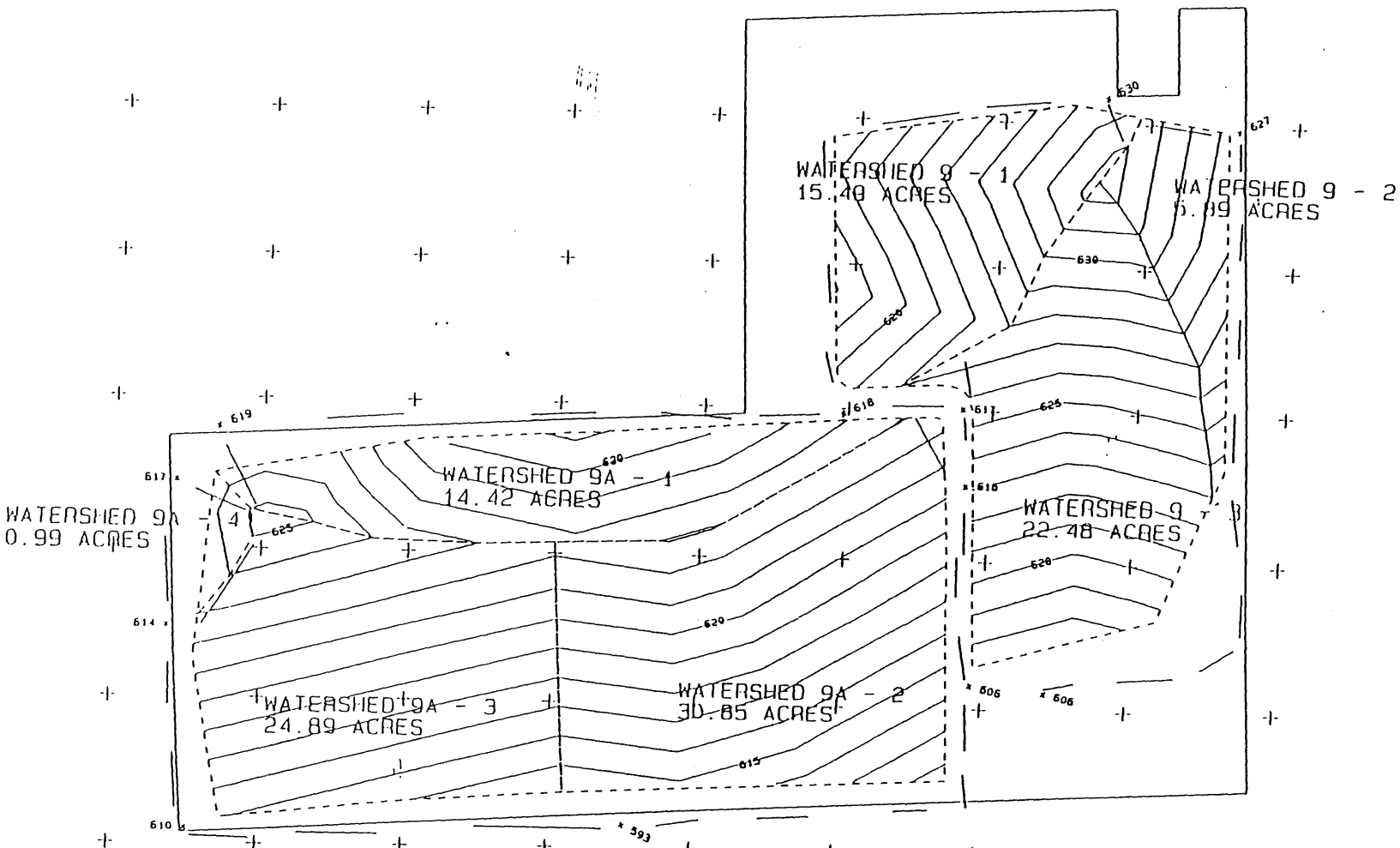
Cincinnati, Ohio 45249

Date: September 2000
Project: Macomb County Landfill
Channel: Design Summary
25-year/24-hour Rainfall

CHANNEL	CHANNEL START ELEVATION (FEET)	CHANNEL END ELEVATION (FEET)	CHANNEL FLOW LENGTH	CHANNEL FLOW GRADIENT (PER CENT)	CHANNEL LINING
Watershed 9-1	630.0	618.0	2000.0	0.6%	GRASS
Watershed 9-2	627.0	606.0	2400.0	0.9%	GRASS
Watershed 9-3	617.0	606.0	1250.0	0.9%	GRASS
Watershed 9A-1	619.0	618.0	2200.0	0.1%	GRASS
Watershed 9A-2	615.0	593.0	2300.0	0.9%	GRASS WITH EROSION MATTING
Watershed 9A-3	614.0	593.0	2300.0	0.9%	GRASS
Watershed 9A-4	617.0	614.0	500.0	0.6%	GRASS

CHANNEL	CHANNEL SIDE SLOPE Z1 (HOR/VER)	CHANNEL SIDE SLOPE Z2 (HOR/VER)	CHANNEL BOTTOM WIDTH (FEET)	CHANNEL TOP WIDTH (FEET)	CHANNEL DESIGN DEPTH (FEET)
Watershed 9-1	3.0	3.0	0.0	15.0	2.5
Watershed 9-2	3.0	3.0	0.0	12.0	2.0
Watershed 9-3	3.0	3.0	0.0	24.0	4.0
Watershed 9A-1	3.0	3.0	0.0	21.0	3.5
Watershed 9A-2	3.0	3.0	0.0	18.0	3.0
Watershed 9A-3	3.0	3.0	0.0	15.0	2.5
Watershed 9A-4	3.0	3.0	0.0	12.0	2.0


WATERSHED 9 - 1
15.40 ACRES
WATERSHED 9 - 2
5.89 ACRES
WATERSHED 9A - 1
14.42 ACRES
WATERSHED 9A - 4
0.99 ACRES
WATERSHED 9 - 3
22.48 ACRES
WATERSHED 9A - 3
24.89 ACRES
WATERSHED 9A - 2
30.85 ACRES

Petro Environmental Technologies, Inc.
7851 Palace Drive
Cincinnati, Ohio 45249
(* Values inputted manually)

Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9 1

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	632.000	ft
* C. Surface run-off end elevation, Es2 =	630.000	ft
* D. Surface run-off length, Ls =	200.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.010	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 *(Ss)^0.4)	0.443	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	630.000	ft
* B. Channel discharge elevation, Ec2 =	618.000	ft
* C. Channel length, Lc =	2000.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.006	ft/ft
E. Average channel velocity, Vc = 16.1345 * (Sc)^0.5	1.250	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.445	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tc = (Ts + Tc)	0.887	hrs
* B. Channel watershed area, Am =	674,744	sq ft
	15.490	acres
	0.024	sq.mi.
C. Surface run-off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^((C0 + (C1 * Log(Tc)) + (C2 * (Log(Tc))^2))	370.625	CSM/in
H. Channel Peak discharge, qp = (qp * Am * Q)	16.888	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.006	ft/ft
* E. Inflows from other channels, QI =	0.000	cfs
F. Channel flow, Qc = (Qc = qp + QI)	16.888	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	1.900	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	10.830	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	12.017	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.901	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	1.405	M/ps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.069	
G. Trial velocity, Va = (Qc/Ac)	1.559	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	1.561	fps

VII. Froude Number.

A. Channel free surface, W = (Z1*D) + B + (Z2*D)	11.400	ft
B. Hydraulic Depth, Dh = (Ac/W)	0.950	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.281	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	2.500	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	15.000	ft

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7851 Palace Drive
Cincinnati, Ohio 45249
(* Values inputted manually)

Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9-2

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	633.000	ft
* C. Surface run-off end elevation, Es2 =	627.000	ft
* D. Surface run-off length, Ls =	400.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.013	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 *(Ss)^0.4)	0.705	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	627.000	ft
* B. Channel discharge elevation, Ec2 =	606.000	ft
* C. Channel length, Lc =	2400.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.009	ft/ft
E. Average channel velocity, Vc = 16.1345 * (Sc)^0.5	1.509	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.442	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tc = (Ts + Tc)	1.146	hrs
* B. Channel watershed area, Am =	256.568	sq ft
	5.890	acres
	0.009	sq mi.
C. Surface run-off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tc)) + (C2 * (Log(Tc))^2))	316.329	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	5.481	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.009	ft/ft
* E. Inflows from other channels, Qi =	0.000	cfs
F. Channel flow, Qc = (Qc = qp + Qi)	5.481	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	1.430	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	6.135	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	9.044	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.678	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	0.606	sfps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.119	
G. Trial velocity, Va = (Qc/Ac)	0.893	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	0.501	fps

VII. Froude Number.

A. Channel free surface, H = (Z1*D) + B + (Z2*D)	8.580	ft
B. Hydraulic Depth, Dh = (Ac/H)	0.715	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.188	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	2.000	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	12.000	ft

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Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9-1

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	617.000	ft
* C. Surface run-off end elevation, Es2 =	617.000	ft
* D. Surface run-off length, Ls =	250.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.042	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 *(Ss)^0.4)	0.298	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	617.000	ft
* B. Channel discharge elevation, Ec2 =	606.000	ft
* C. Channel length, Lc =	1250.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.009	ft/ft
E. Average channel velocity, Vc = 16.1345 * (Sc)^0.5	1.514	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.229	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tt = (Ts + Tc)	0.527	hrs
* B. Channel watershed area, Am =	979,229 22.480 0.035	sq ft acres sq.mi.
C. Surface run off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tc)) + (C2 * (Log(Tc))^2))	497.248	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	12.882	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.009	ft/ft
* E. Inflows from other channels, QI = (Watersheds 9-1 and 9A-1)	25.395	cfs
F. Channel flow, Qc = (Qc = qp + QI)	58.277	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	2.330	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	16.147	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	14.673	ft
D. Hydraulic radius, Rh = (Ac/Pw)	1.100	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	3.972	sfps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.041	
G. Trial velocity, Va = (Qc/Ac)	3.609	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	3.619	fps

VII. Froude Number.

A. Channel free surface, W = (Z1*D) + B + (Z2*D)	13.920	ft
B. Hydraulic Depth, Dh = (Ac/W)	1.160	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.592	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	4.000	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	24.000	ft

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Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9A-1

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	625.000	ft
* C. Surface run-off end elevation, Es2 =	619.000	ft
* D. Surface run-off length, Ls =	300.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.020	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 * (Ss)^0.4)	0.464	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	619.000	ft
* B. Channel discharge elevation, Ec2 =	618.000	ft
* C. Channel length, Lc =	2200.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.00045	ft/ft
E. Average channel velocity, Vc = 16.1115 * (Sc)^0.5	0.344	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	1.777	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tc = (Ts + Tc)	2.240	hrs
* B. Channel watershed area, Am =	628,135	sq ft
	14.420	acres
	0.023	sq.mi.
C. Surface run-off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.51727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tc)) + (C2 * (Log(Tc))^2))	200.551	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	8.507	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.000	ft/ft
* E. Inflows from other channels, Qi =	0.000	cfs
F. Channel flow, Qc = (Qc = qp + Qi)	8.507	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	3.150	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	29.768	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	19.922	ft
D. Hydraulic radius, Rh = (Ac/Pw)	1.494	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	0.427	afps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.146	
G. Trial velocity, Va = (Qc/Ac)	0.286	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	0.284	fps

VII. Froude Number.

A. Channel free surface, W = (Z1*D) + B + (Z2*D)	18.900	ft
B. Hydraulic Depth, Dh = (Ac/W)	1.575	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.040	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	3.500	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	21.000	ft

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Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9A-2

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	623.000	ft
* C. Surface run-off end elevation, Es2 =	615.000	ft
* D. Surface run-off length, Ls =	300.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.027	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 * (Ss)^0.4)	0.413	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	615.000	ft
* B. Channel discharge elevation, Ec2 =	593.000	ft
* C. Channel length, Lc =	2300.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.00957	ft/ft
E. Average channel velocity, Vc = (6.1345 * (Sc)^0.5	1.578	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.405	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tc = (Ts + Tc)	0.818	hrs
* B. Channel watershed area, Am =	1,343,826	sq ft
	30.850	acres
	0.048	sq.mi.
C. Surface run-off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tc)) + (C2 * (Log(Tc))^2))	388.837	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	35.286	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	1.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	1.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.010	ft/ft
* E. Inflows from other channels, Qi = (Watershed 9-3)	58.227	cfs
F. Channel flow, Qc = (Qc = qp + Qi)	93.513	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	2.655	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	21.147	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	16.792	ft
D. Hydraulic radius, Rh = (Ac/Pw)	1.259	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	5.569	afps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.038	
G. Trial velocity, Va = (Qc/Ac)	4.422	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	4.422	fps

VII. Froude Number.

A. Channel free surface, H = (Z1*D) + B + (Z2*D)	15.930	ft
B. Hydraulic Depth, Dh = (Ac/H)	1.328	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.676	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	3.000	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	18.000	ft

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Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9A-3

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	625.000	ft
* C. Surface run-off end elevation, Es2 =	614.000	ft
* D. Surface run-off length, Ls =	500.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.022	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 *(Ss)^0.4)	0.672	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	614.000	ft
* B. Channel discharge elevation, Ec2 =	593.000	ft
* C. Channel length, Lc =	2300.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.00913	ft/ft
E. Average channel velocity, Vc = 16.1345 * (Sc)^0.5	1.542	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.414	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tt = (Ts + Tc)	1.086	hrs
* B. Channel watershed area, Am =	1,084,208	sq ft
	24.890	acres
	0.039	sq.mi.
C. Surface run off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15511	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tt)) + (C2 * (Log(Tt))^2))	327.264	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	21.961	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.009	ft/ft
* E. Inflows from other channels, QI = (Watershed 9A-4)	1.452	cfs
F. Channel flow, Qc = (Qc = qp + QI)	25.413	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	1.885	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	10.660	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	11.922	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.894	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	2.132	afps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.055	
G. Trial velocity, Va = (Qc/Ac)	2.384	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	2.384	fps

VII. Froude Number.

A. Channel free surface, W = (Z1*D) + B + (Z2*D)	11.310	ft
B. Hydraulic Depth, Dh = (Ac/W)	0.943	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.433	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	2.500	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	15.000	ft

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Date: September 2000
Project: Macomb County Landfill
Type: Perimeter Channel
Channel: Watershed 9A-4

I. Direct Run-off Estimate

* A. 25-year, 24 hour rainfall, P25 = (Macomb County, Michigan)	3.900	in
* B. Run-off Curve Number, CN = (fair pasture, type c soils)	79.000	
C. Potential maximum retention, S = (1000 / CN) - 10	2.658	in
D. Initial Abstraction, Ia = (0.2 * S)	0.532	in
E. Direct Run-off, Q = ((P25 - Ia)^2) / ((P25 - Ia) + S)	1.883	in

II. Slope Run-off Time of Concentration

* A. Surface run-off Manning's coeff, ns = (short grass prairie equivalent)	0.150	
* B. Surface run-off start elevation, Es1 =	625.000	ft
* C. Surface run-off end elevation, Es2 =	617.000	ft
* D. Surface run-off length, Ls =	300.000	ft
E. Surface run-off slope, Ss = ((Es1 - Es2) / Ls)	0.027	ft/ft
* F. 2-year, 24-hour rainfall, P2 = (Macomb County, Michigan)	2.300	in
G. Slope travel time, Ts = (0.007 * (ns * Ls)^0.8) / ((P2)^0.5 * (Ss)^0.4)	0.413	hrs

III. Average Channel Time of Concentration

A. Channel start elevation, Ec1 =	617.000	ft
* B. Channel discharge elevation, Ec2 =	614.000	ft
* C. Channel length, Lc =	500.000	ft
D. Average channel flow gradient, Sc = (Ec1 - Ec2) / Lc	0.00600	ft/ft
E. Average channel velocity, Vc = 16.1345 * (Sc)^0.5	1.250	fps
F. Channel travel time, Tc = Lc/(3600 * Vc)	0.111	hrs

IV. Total time of Concentration and Peak Discharge

A. Total time of concentration, Tt = (Ts + Tc)	0.525	hrs
* B. Channel watershed area, Am =	43,124	sq ft
	0.990	acres
	0.002	sq.mi.
C. Surface run-off ratio, Ia/P100 =	0.136	
D. Unit peak discharge coeff, C0 =	2.53727	
E. Unit peak discharge coeff, C1 =	-0.61647	
F. Unit peak discharge coeff, C2 =	-0.15541	
G. Unit peak discharge, qu = 10^(C0 + (C1 * Log(Tt)) + (C2 * (Log(Tt))^2))	498.650	CSM/in
H. Channel Peak discharge, qp = (qu * Am * Q)	1.452	cfs

V. Channel Geometry.

* A. Side slope, Z1 (hor/vert) =	3.000	ft/ft
* B. Side slope, Z2 (hor/vert) =	3.000	ft/ft
* C. Channel bottom width, B =	0.000	ft
D. Average channel flow gradient, Sc =	0.006	ft/ft
* E. Inflows from other channels, QI =	0.000	cfs
F. Channel flow, Qc = (Qc = qp + QI)	1.452	cfs

VI. Peak Flow Calculations.

* A. Trial flow depth, D = (trial and error until Va=Vb)	1.100	ft
B. Channel flow area, Ac = (.5*Z1*D^2) + (B*D) + (.5*Z2*D^2)	5.070	sq ft
C. Wetted Perimeter, Pw = (D*SQR(Z1^2+1)) + B + (D*SQR(Z2^2+1))	8.222	ft
D. Hydraulic radius, Rh = (Ac/Pw)	0.617	ft
E. Velocity and hydraulic radius, VR = (Va * Rh)	0.177	sfps
F. Channel flow Manning's coeff, nc = (from Type "C" vegetative retardance)	0.284	
G. Trial velocity, Va = (Qc/Ac)	0.286	fps
H. Resultant velocity, Vb = (1.49/nc) * (Rh^.667) * SQR(Sc)	0.294	fps

VII. Froude Number.

A. Channel free surface, H = (Z1*D) + B + (Z2*D)	7.800	ft
B. Hydraulic Depth, Dh = (Ac/H)	0.650	ft
C. Froude number, F = (V2/SQR(g*Dh))	0.064	

VIII. Channel Dimensions.

* A. Channel depth, Dc = (D + minimum 0.5 ft freeboard)	2.000	ft
B. Channel top width, Wt = (Z1*Dc) + B + (Z2*Dc)	12.000	ft

Table 2-2c.—Runoff curve numbers for other agricultural lands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing.[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element.[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	[4]30	48	65	73
Woods—grass combination (orchard or tree farm).[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods.[6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	[4]30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.

[3]*Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

[4]Actual curve number is less than 30; use CN = 30 for runoff computations.

[5]CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

[6]*Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

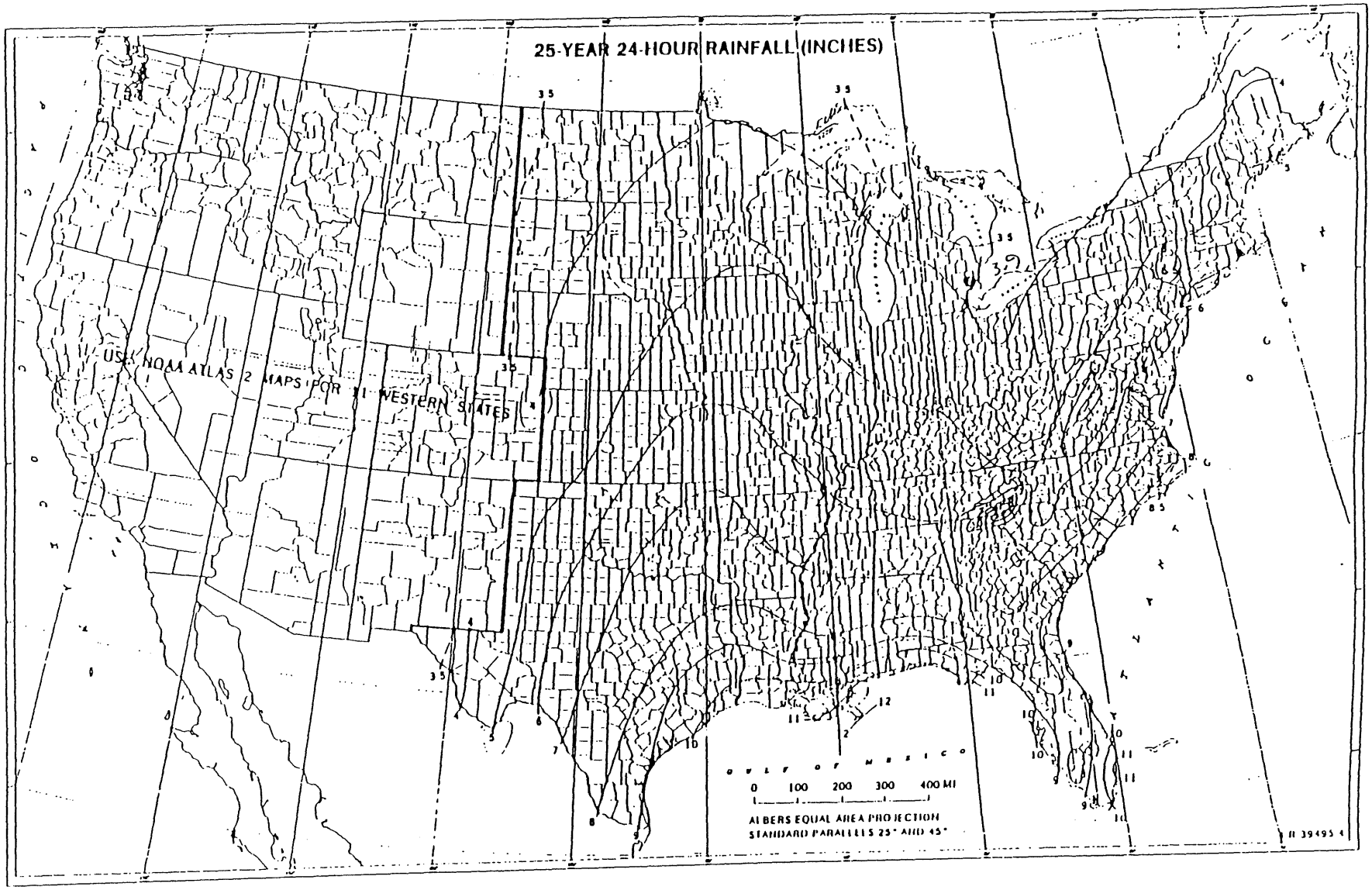

Figure B-6.—Twenty-five-year, 24-hour rainfall.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007\,(nL)^{0.8}}{(P_2)^{0.5}\,s^{0.4}} \qquad \text{[Eq. 3-3]}$$

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

where

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1),
L = flow length (ft),
P_2 = 2-year, 24-hour rainfall (in), and
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

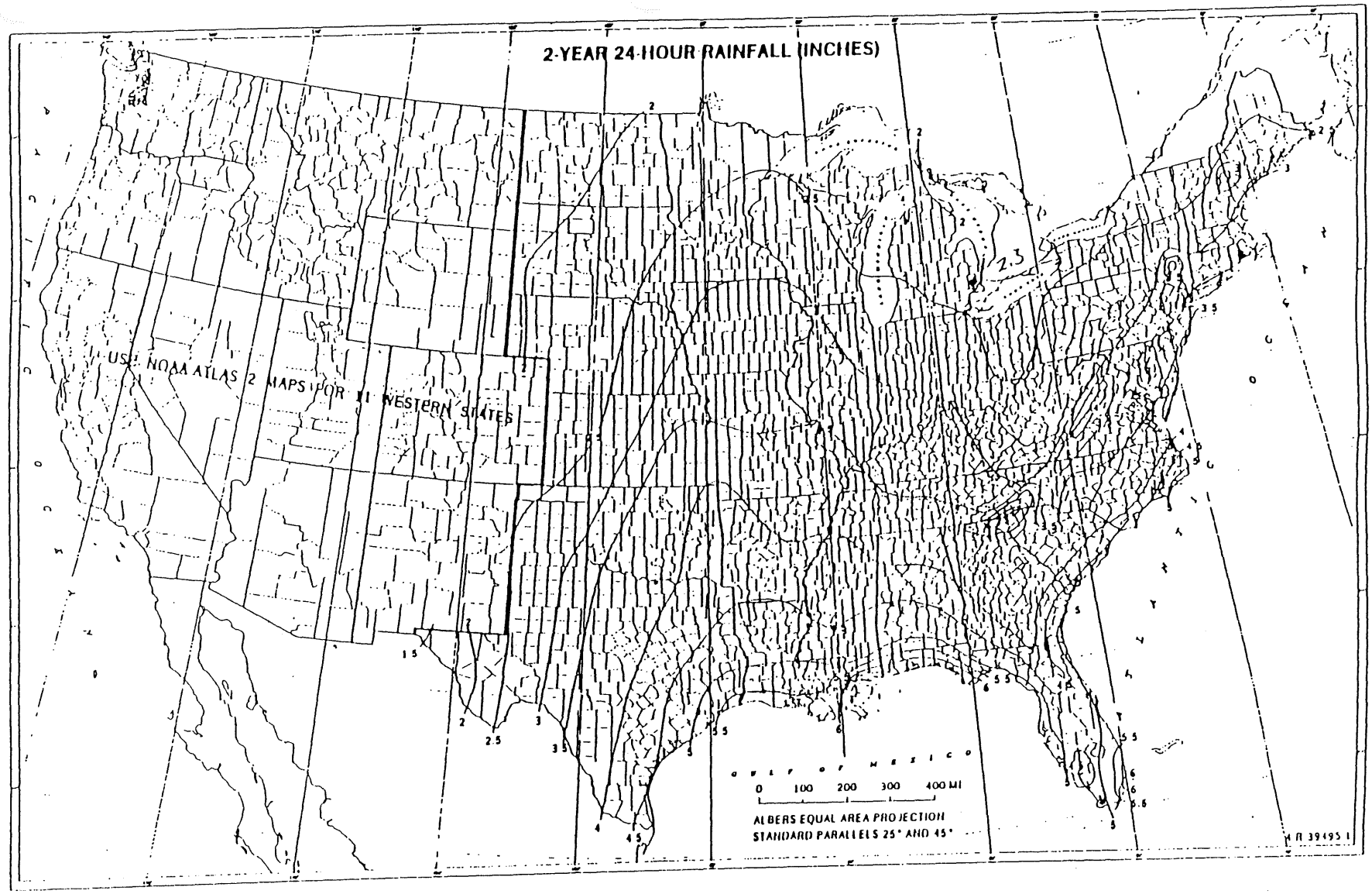

Figure II-3.—Two-year, 24-hour rainfall.

Attachment III
HELP Model - Leachate Generation Rates

PETRO ENVIRONMENTAL TECHNOLOGIES
ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513(489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

SUBJECT:

Results of the Hydraulic Evaluation of Landfill Performance (HELP) Model analyses performed for the landfill.

PURPOSE AND OBJECTIVE:

The following computations were performed to provide comparative analyses of potential leachate production rates for existing and proposed conditions for the landfill. The computations were performed using HELP Model Version 3.0 (U.S. Army Corps of Engineers, Vicksburg Station, September 1994).

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The bottom of waste grades and elevations for both Sites 9 and 9A conform to the surfaces interpolated from boring data provided by the Dragun Corporation ("Final report on Hydrogeological Investigation, South Macomb Disposal Authority, Landfill Site 9 an 9A", dated February 28, 1995).

2. Existing grades and elevations conform to recent aerial surveys performed at the site.

3. An existing cover thickness of 2 feet was assumed over the entire landfill. This represents a minimum thickness as determined by Petro Environmental field investigations.

4. The proposed final cover is constructed to the grades, elevations, and thickness as shown in the proposed design.

5. The proposed groundwater interceptor and leachate collection systems are constructed to the alignment and grades shown on the proposed design.

6. A synthetic weather database for Detroit, Michigan was utilized by the analyses.

METHODOLOGY:

The computations were performed using HELP Model Version 3.0 (see attached)

MATERIAL CHARACTERISTICS:

Both Sites 9 and 9A were analyzed for two conditions

Existing conditions with an assumed typical 24 inch existing cover. Site 9 was analyzed for a location that maximized waste thickness. This area is located in the north central region of the site with an existing top of cover elevation of 632.0 feet, a top of waste

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PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

elevation of 630.0 feet (inferred) and a bottom of waste elevation of 618.0 feet. Waste thickness was therefore 12 feet, or 144 inches. Below the waste a 5 feet, 60 inch, thick layer of natural clayey soils was modeled as a natural soil barrier. The default HELP Model soil type #12, sandy or silty clays, was chosen to represent this barrier layer as its permeability characteristics closely matched that described in the Dragun Corporation Hydrogeological Report. It is also assumed that this soil was excavated and subsequently utilized for existing final cover.

Site 9A was also analyzed for a location that maximized waste thickness. This area is located in the north central region of the site with an existing top of cover elevation of 621.0 feet, a top of waste elevation of 619.0 feet (inferred) and a bottom of waste elevation of 600.0 feet. Waste thickness was therefore 19 feet, or 228 inches.

Design conditions with an proposed 24 inch cover. Site 9 was analyzed for a location that maximized waste thickness. This area is located in the north central region of the site with an existing top of cover elevation of 632.0 feet, a top of waste elevation of 630.0 feet (inferred) and a bottom of waste elevation of 618.0 feet. Waste thickness was therefore 12 feet, or 144 inches. Below the waste a 5 feet, 60 inch, thick layer of natural clayey soils was modeled as a natural soil barrier. The default HELP Model soil type #12, sandy or silty clays, was chosen to represent this barrier layer as its permeability characteristics closely matched that described in the Dragun Corporation Hydrogeological Report. To meet the permeability requirements for a proposed final cover, the default HELP Model soil type #15, sandy clays, was chosen to represent the cover. The permeability of the final cover was set at both 1×10^{-6} and 1×10^{-5} cm/sec to provide a range of results.

Site 9A was also analyzed for a location that maximized waste thickness. This area is located in the north central region of the site with an existing top of cover elevation of 622.0 feet, a top of waste elevation of 620.0 feet (inferred) and a bottom of waste elevation of 599.0 feet. Waste thickness was therefore 21 feet, or 252 inches. The bottom 12 inches of the waste in Site 9A was also considered a lateral drainage layer for the purposes of modeling. The material characteristics of the final cover and bottom barrier layers conform to those for Site 9.

COMPUTATIONS:

Refer to attached HELP Model printouts.

PETRO ENVIRONMENTAL TECHNOLOGIES
ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

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PROJECT / PROPOSAL NAME	PREPARED BY: _____ DATE: _____	CHECKED BY: _____ DATE: _____	PROJECT / PROPOSAL NUMBER

CONCLUSIONS:

The following table summarizes the average annual results of the HELP Model analyses (all values are in inches):

	Precipitation	Run-off	Evapotrans-piration	Percolation Through Cover (1)	Percolation Below Waste
Site 9 Existing	32.34	3.81	22.19	6.35	6.41
Site 9 Proposed (10^{-5} Cover)	32.34	12.85	18.62	0.87	1.08
Site 9 Proposed (10^{-6} Cover)	32.34	22.73	9.60	0.01	0.0004
Site 9A Existing	32.34	3.81	22.18	6.35	6.41
Site 9A Proposed (10^{-5} Cover)	32.34	12.68	18.62	1.04	1.08
Site 9A Proposed (10^{-6} Cover)	32.34	22.73	9.60	0.01	0.0004

(1) Percolation through Cover = (Precipitation) – (Run-off) – (Evapotranspiration)

By improving the cover to a permeability of at least 1 x 10^{-5} cm/sec and by regarding the final cover to allow for unimpeded run-off, percolation through the final cover into the waste (and subsequent leachate formation) is reduced by 76%. Furthermore, percolation below the waste into the adjacent aquifer is reduced by 83%. Final cover permeabilities lower than 1 x 10^{-5} cm will result in even greater reduction efficiencies with permeabilities of 1 x 10^{-6} cm/sec effectively eliminating percolation.

Please note that the analyses of existing conditions indicate that more leachate is exiting the waste each year than is replenished by percolation through the cover. Since leachate levels remain significant in the landfills despite continuous leachate removal operations, it remains possible that groundwater inflow accounts for a significant portion of leachate generation.

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:  14:43     DATE:   4/ 5/2001


******************************************************************************

     TITLE:  MACOMB COUNTY LANDFILL SITE 9 (EXISTING CONDITIONS)

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  12
        THICKNESS                  =     24.00   INCHES
        POROSITY                   =      0.4710 VOL/VOL
        FIELD CAPACITY             =      0.3420 VOL/VOL
        WILTING POINT              =      0.2100 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.4109 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER  18
        THICKNESS                  =    144.00   INCHES
        POROSITY                   =      0.6710 VOL/VOL
        FIELD CAPACITY             =      0.2920 VOL/VOL
        WILTING POINT              =      0.0770 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                  LAYER  3
                                  --------

                     TYPE 3 - BARRIER SOIL LINER
                     MATERIAL TEXTURE NUMBER  12
        THICKNESS                  =     60.00   INCHES
        POROSITY                   =      0.4710 VOL/VOL
        FIELD CAPACITY             =      0.3420 VOL/VOL
        WILTING POINT              =      0.2100 VOL/VOL
        INITIAL SOIL WATER CONTENT =      0.4710 VOL/VOL
        EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

      NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

     SCS RUNOFF CURVE NUMBER              =     70.00
     FRACTION OF AREA ALLOWING RUNOFF     =     50.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
```

INITIAL WATER IN EVAPORATIVE ZONE	=	9.862	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.304	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	5.040	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	80.170	INCHES
TOTAL INITIAL WATER	=	80.170	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.42
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.80	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	0.609	0.611	1.052	0.195	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.294
EVAPOTRANSPIRATION	0.383	0.337	0.363	2.971	2.272	5.491
	2.885	2.399	3.323	1.461	0.680	0.284
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.0000	1.0114	2.4181	1.2252	0.0041
	0.0002	0.0002	0.0007	0.0000	0.0000	1.1619

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON OF LAYER 3	0.000	0.000	0.011	0.023	0.013	0.000
	0.000	0.000	0.000	0.000	0.000	0.013
STANDARD DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.014	0.016	0.018	0.000
	0.000	0.000	0.000	0.000	0.000	0.014

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	2.760	10019.824	8.78
POTRANSPIRATION	22.850	82945.430	72.70
RC./LEAKAGE THROUGH LAYER 3	5.821875	21133.406	18.52
AVG. HEAD ON TOP OF LAYER 3	0.0050		
CHANGE IN WATER STORAGE	-0.002	-7.755	-0.01
SOIL WATER AT START OF YEAR	80.169	291015.250	
SOIL WATER AT END OF YEAR	80.167	291007.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35	2.26	4.20	4.91	3.61	4.99
	0.65	6.15	1.40	0.76	4.72	2.02
RUNOFF	0.000	0.960	2.694	0.590	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.093
EVAPOTRANSPIRATION	0.450	0.529	0.453	3.192	4.033	5.687
	0.958	3.592	2.512	1.013	0.743	0.509
ATION/LEAKAGE THROUGH	0.0000	0.0000	1.1136	2.9628	2.8211	0.3458
ER 3	0.0000	0.8196	0.3689	0.0000	0.0000	1.0429

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.012	0.028	0.027	0.004
TOP OF LAYER 3	0.000	0.007	0.004	0.000	0.000	0.011
STD. DEVIATION OF DAILY	0.000	0.000	0.014	0.021	0.011	0.010
HEAD ON TOP OF LAYER 3	0.000	0.012	0.011	0.000	0.000	0.013

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	4.337	15744.463	11.41
EVAPOTRANSPIRATION	24.672	89558.906	64.89
PERC./LEAKAGE THROUGH LAYER 3	9.474739	34393.305	24.92
AVG. HEAD ON TOP OF LAYER 3	0.0077		
CHANGE IN WATER STORAGE	-0.471	-1710.646	-1.24
SOIL WATER AT START OF YEAR	80.167	291007.500	
SOIL WATER AT END OF YEAR	79.696	289296.875	
WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0073	26.577	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.186	0.202	1.130	1.809	0.019	0.000
	0.000	0.000	0.000	0.000	0.000	0.244
EVAPOTRANSPIRATION	0.493	0.413	0.392	1.850	5.018	6.172
	3.291	2.380	1.469	0.908	0.603	0.455
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0194	1.2376	3.4298	2.5612
LAYER 3	0.0003	0.0006	0.0006	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.013	0.036	0.027
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.001	0.015	0.022	0.017
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.03	123528.898	100.00
RUNOFF	3.591	13033.669	10.55
[illegible]OTRANSPIRATION	23.443	85099.695	68.89
[illegible]./LEAKAGE THROUGH LAYER 3	7.249610	26316.086	21.30
AVG. HEAD ON TOP OF LAYER 3	0.0064		
CHANGE IN WATER STORAGE	-0.254	-920.558	-0.75
SOIL WATER AT START OF YEAR	79.696	289296.875	
SOIL WATER AT END OF YEAR	78.304	284245.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	1.101	0.186	0.700	1.489	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.242
EVAPOTRANSPIRATION	0.527	0.384	0.398	1.030	3.944	4.143
	3.179	1.994	1.766	0.603	0.348	0.454
[illegible]TION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.7299	3.0764	0.0000
[illegible]ER 3	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.007	0.032	0.000

TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.013 0.000	0.016 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	4.718	17126.178	16.71
EVAPOTRANSPIRATION	18.770	68135.281	66.49
PERC./LEAKAGE THROUGH LAYER 3	3.806695	13818.301	13.48
AVG. HEAD ON TOP OF LAYER 3	0.0033		
CHANGE IN WATER STORAGE	0.930	3374.354	3.29
SOIL WATER AT START OF YEAR	78.304	284245.125	
SOIL WATER AT END OF YEAR	80.044	290561.125	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.819	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.92 2.66	2.33 2.38	0.71 2.00	4.60 1.57	4.27 1.52	4.24 2.78
RUNOFF	0.334 0.000	0.977 0.000	0.204 0.000	2.138 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.406 3.807	0.336 1.627	0.318 2.699	0.898 0.706	3.368 0.410	6.258 0.346
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000 0.0205	0.0000 0.0000	0.0767 0.0000	1.3430 0.0000	3.0443 0.0000	1.2245 0.0013

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.001 0.000	0.014 0.000	0.030 0.000	0.013 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000 0.002	0.000 0.000	0.003 0.000	0.017 0.000	0.016 0.000	0.013 0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	3.653	13260.419	12.18
TRANSPIRATION	21.179	76878.297	70.64
C./LEAKAGE THROUGH LAYER 3	5.710396	20728.738	19.05
AVG. HEAD ON TOP OF LAYER 3	0.0049		
CHANGE IN WATER STORAGE	-0.562	-2040.037	-1.87
SOIL WATER AT START OF YEAR	80.044	290561.125	
SOIL WATER AT END OF YEAR	79.810	289710.625	

SNOW WATER AT START OF YEAR	0.328	1189.533	1.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	0.446	0.587	1.156	1.244	0.004	0.000
	0.000	0.000	0.000	0.000	0.000	0.375
STD. DEVIATIONS	0.429	0.388	0.934	0.823	0.009	0.000
	0.000	0.000	0.000	0.000	0.000	0.499
EVAPOTRANSPIRATION						
TOTALS	0.452	0.400	0.385	1.988	3.727	5.750
	2.824	2.398	2.354	0.938	0.557	0.410
STD. DEVIATIONS	0.060	0.079	0.049	1.065	1.006	0.995
	1.095	0.739	0.744	0.334	0.172	0.092
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.4442	1.7383	2.7194	0.8271
	0.0043	0.1641	0.0741	0.0000	0.0000	0.4412
STD. DEVIATIONS	0.0000	0.0000	0.5663	0.9200	0.8632	1.0907
	0.0091	0.3664	0.1648	0.0000	0.0000	0.6050

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0047	0.0173	0.0276	0.0087
	0.0001	0.0014	0.0009	0.0000	0.0000	0.0046
STD. DEVIATIONS	0.0000	0.0000	0.0059	0.0083	0.0087	0.0113
	0.0002	0.0031	0.0019	0.0000	0.0000	0.0064

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	3.812	(0.7545)	13836.91	11.787
EVAPOTRANSPIRATION	22.183	(2.2850)	80523.52	68.597
PERCOLATION/LEAKAGE THROUGH LAYER 3	6.41266	(2.10417)	23277.969	19.83011
AVERAGE HEAD ON TOP OF LAYER 3	0.005	(0.002)		
CHANGE IN WATER STORAGE	-0.072	(0.6001)	-260.93	-0.222

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	1.163	4222.2534
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.207529	753.32996
AVERAGE HEAD ON TOP OF LAYER 3	0.065	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	9.5021	0.3959
2	42.0479	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:  15:15     DATE:   4/ 5/2001


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     TITLE:  MACOMB COUNTY LANDFILL SITE 9A (EXISTING CONDITIONS)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4109 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  4.63
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    228.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                  LAYER  3
                                  --------

                    TYPE 3 - BARRIER SOIL LINER
                    MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     60.00   INCHES
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

        NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

      SCS RUNOFF CURVE NUMBER              =     70.00
      FRACTION OF AREA ALLOWING RUNOFF     =     50.0     PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE   =      1.000   ACRES
      EVAPORATIVE ZONE DEPTH               =     24.0     INCHES
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INITIAL WATER IN EVAPORATIVE ZONE	=	9.862	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.304	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	5.040	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	104.698	INCHES
TOTAL INITIAL WATER	=	104.698	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.60	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	0.609	0.611	1.052	0.195	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.294
EVAPOTRANSPIRATION	0.383	0.337	0.363	2.971	2.272	5.491
	2.885	2.399	3.323	1.461	0.680	0.284
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	1.0114	1.9329	1.7104	0.0041
LAYER 3	0.0002	0.0002	0.0007	0.0000	0.0000	1.1619

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.011	0.018	0.018	0.000
OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.012
DEVIATION OF DAILY	0.000	0.000	0.014	0.013	0.018	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.014

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	2.760	10019.824	8.78
POTRANSPIRATION	22.850	82945.430	72.70
.C./LEAKAGE THROUGH LAYER 3	5.821877	21133.412	18.52
AVG. HEAD ON TOP OF LAYER 3	0.0049		
CHANGE IN WATER STORAGE	-0.002	-7.755	-0.01
SOIL WATER AT START OF YEAR	104.697	380051.906	
SOIL WATER AT END OF YEAR	104.695	380044.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35	2.26	4.20	4.91	3.61	4.99
	0.65	6.15	1.40	0.76	4.72	2.02
RUNOFF	0.000	0.960	2.694	0.590	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.093
EVAPOTRANSPIRATION	0.450	0.529	0.453	3.192	4.033	6.687
	0.958	3.592	2.512	1.013	0.743	0.509
ATION/LEAKAGE THROUGH	0.0000	0.0000	1.0358	2.2724	2.7466	1.1886
ER 3	0.0000	0.7122	0.4762	0.0000	0.0000	1.0429

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.011	0.022	0.027	0.013
TOP OF LAYER 3	0.000	0.007	0.005	0.000	0.000	0.010
STD. DEVIATION OF DAILY	0.000	0.000	0.015	0.018	0.012	0.016
HEAD ON TOP OF LAYER 3	0.000	0.012	0.012	0.000	0.000	0.013

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	4.337	15744.463	11.41
EVAPOTRANSPIRATION	24.672	89558.906	64.89
PERC./LEAKAGE THROUGH LAYER 3	9.474738	34393.301	24.92
AVG. HEAD ON TOP OF LAYER 3	0.0079		
CHANGE IN WATER STORAGE	-0.471	-1710.646	-1.24
SOIL WATER AT START OF YEAR	104.695	380044.156	
SOIL WATER AT END OF YEAR	104.224	378333.500	
WATER AT START OF YEAR	0.000	0.000	0.00
NOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0073	26.580	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.186	0.202	1.130	1.809	0.019	0.000
	0.000	0.000	0.000	0.000	0.000	0.244
EVAPOTRANSPIRATION	0.493	0.413	0.392	1.850	5.018	6.172
	3.291	2.380	1.469	0.908	0.603	0.455
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0190	1.0274	2.8337	3.2679
LAYER 3	0.1004	0.0006	0.0006	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.011	0.030	0.035
TOP OF LAYER 3	0.001	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.001	0.014	0.018	0.009
HEAD ON TOP OF LAYER 3	0.006	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.03	123528.898	100.00
RUNOFF	3.591	13033.669	10.55
EVAPOTRANSPIRATION	23.443	85099.695	68.89
PERC./LEAKAGE THROUGH LAYER 3	7.249610	26316.084	21.30
AVG. HEAD ON TOP OF LAYER 3	0.0065		
CHANGE IN WATER STORAGE	-0.254	-920.558	-0.75
SOIL WATER AT START OF YEAR	104.224	378333.500	
SOIL WATER AT END OF YEAR	102.832	373281.781	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	1.101	0.186	0.700	1.489	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	1.242
EVAPOTRANSPIRATION	0.527	0.384	0.398	1.030	3.944	4.143
	3.179	1.994	1.766	0.603	0.348	0.454
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.7193	3.0430	0.0441
LAYER 3	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.007	0.032	0.001

TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.013	0.011	0.003
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	4.718	17126.178	16.71
EVAPOTRANSPIRATION	18.770	68135.281	66.49
PERC./LEAKAGE THROUGH LAYER 3	3.806694	13818.299	13.48
AVG. HEAD ON TOP OF LAYER 3	0.0033		
CHANGE IN WATER STORAGE	0.930	3374.354	3.29
SOIL WATER AT START OF YEAR	102.832	373281.781	
SOIL WATER AT END OF YEAR	104.572	379597.781	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.822	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.92	2.33	0.71	4.60	4.27	4.24
	2.66	2.38	2.00	1.57	1.52	2.78
RUNOFF	0.334	0.977	0.204	2.138	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.406	0.336	0.318	0.898	3.368	6.258
	3.807	1.627	2.699	0.706	0.410	0.346
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0767	1.2756	2.5338	1.8021
LAYER 3	0.0207	0.0000	0.0000	0.0000	0.0000	0.0013

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.001	0.014	0.024	0.019
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.003	0.016	0.015	0.014
HEAD ON TOP OF LAYER 3	0.002	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	3.653	13260.419	12.18
EVAPOTRANSPIRATION	21.179	76878.297	70.64
PERC./LEAKAGE THROUGH LAYER 3	5.710395	20728.734	19.05
AVG. HEAD ON TOP OF LAYER 3	0.0048		
CHANGE IN WATER STORAGE	-0.562	-2040.037	-1.87
SOIL WATER AT START OF YEAR	104.572	379597.781	
SOIL WATER AT END OF YEAR	104.338	378747.250	

SNOW WATER AT START OF YEAR	0.328	1189.533	1.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	0.446	0.587	1.156	1.244	0.004	0.000
	0.000	0.000	0.000	0.000	0.000	0.375
STD. DEVIATIONS	0.429	0.388	0.934	0.823	0.009	0.000
	0.000	0.000	0.000	0.000	0.000	0.499
EVAPOTRANSPIRATION						
TOTALS	0.452	0.400	0.385	1.988	3.727	5.750
	2.824	2.398	2.354	0.938	0.557	0.410
STD. DEVIATIONS	0.060	0.079	0.049	1.065	1.006	0.995
	1.095	0.739	0.744	0.334	0.172	0.092
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.4286	1.4455	2.5735	1.2613
	0.0244	0.1426	0.0955	0.0000	0.0000	0.4412
STD. DEVIATIONS	0.0000	0.0000	0.5440	0.6427	0.5159	1.3589
	0.0435	0.3184	0.2128	0.0000	0.0000	0.6050

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0047	0.0145	0.0262	0.0133
	0.0003	0.0015	0.0011	0.0000	0.0000	0.0044
STD. DEVIATIONS	0.0000	0.0000	0.0058	0.0056	0.0053	0.0144
	0.0005	0.0033	0.0024	0.0000	0.0000	0.0061

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	3.812	(0.7545)	13836.91	11.787
EVAPOTRANSPIRATION	22.183	(2.2850)	80523.52	68.597
PERCOLATION/LEAKAGE THROUGH LAYER 3	6.41266	(2.10417)	23277.965	19.83011
AVERAGE HEAD ON TOP OF LAYER 3	0.006	(0.002)		
CHANGE IN WATER STORAGE	-0.072	(0.6001)	-260.93	-0.222

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	1.163	4222.2534
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.172878	627.54681
AVERAGE HEAD ON TOP OF LAYER 3	0.052	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4710
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2100

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	9.5021	0.3959
2	66.5759	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:  15: 9     DATE:   4/ 5/2001


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     TITLE:  MACOMB COUNTY LANDFILL SITE 9 (PROPOSED DESIGN)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =     24.00   INCHES
        POROSITY                     =      0.4750 VOL/VOL
        FIELD CAPACITY               =      0.3780 VOL/VOL
        WILTING POINT                =      0.2650 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.4115 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC


                                LAYER  2
                                --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                       MATERIAL TEXTURE NUMBER  18
        THICKNESS                    =    144.00   INCHES
        POROSITY                     =      0.6710 VOL/VOL
        FIELD CAPACITY               =      0.2920 VOL/VOL
        WILTING POINT                =      0.0770 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                LAYER  3
                                --------

                   TYPE 3 - BARRIER SOIL LINER
                   MATERIAL TEXTURE NUMBER  12
        THICKNESS                    =     60.00   INCHES
        POROSITY                     =      0.4710 VOL/VOL
        FIELD CAPACITY               =      0.3420 VOL/VOL
        WILTING POINT                =      0.2100 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC


                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                 ----------------------------------------

       NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

      SCS RUNOFF CURVE NUMBER              =     79.00
      FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
      AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
      EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
      INITIAL WATER IN EVAPORATIVE ZONE    =      9.876  INCHES
      UPPER LIMIT OF EVAPORATIVE STORAGE   =     11.400  INCHES
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LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.360	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	80.184	INCHES
TOTAL INITIAL WATER	=	80.184	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.80	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	1.123	1.025	1.834	0.691	0.136	0.220
	0.415	1.519	0.798	0.063	0.716	2.025
EVAPOTRANSPIRATION	0.404	0.375	0.425	2.382	2.060	5.784
	2.540	1.761	1.889	1.045	0.655	0.265
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.9148	0.2778	0.0115
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.008	0.003	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD DEVIATION OF DAILY	0.000	0.000	0.000	0.010	0.002	0.001
ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	10.566	38353.707	33.62
EVAPOTRANSPIRATION	19.585	71091.930	62.31
PERC./LEAKAGE THROUGH LAYER 3	1.204148	4371.056	3.83
AVG. HEAD ON TOP OF LAYER 3	0.0009		
CHANGE IN WATER STORAGE	0.076	274.233	0.24
SOIL WATER AT START OF YEAR	80.184	291067.125	
SOIL WATER AT END OF YEAR	80.259	291341.344	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35	2.26	4.20	4.91	3.61	4.99
	0.65	6.15	1.40	0.76	4.72	2.02
RUNOFF	0.000	1.837	4.674	1.704	1.008	2.231
	0.000	3.075	0.000	0.000	1.163	0.398
EVAPOTRANSPIRATION	0.454	0.529	0.685	2.400	3.050	5.329
	0.650	2.595	1.620	0.841	0.749	0.459
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.8359	1.0872	0.0864
LAYER 3	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.009	0.010	0.001
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.009	0.009	0.002
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	16.090	58405.496	42.32
EVAPOTRANSPIRATION	19.361	70279.328	50.92
PERC./LEAKAGE THROUGH LAYER 3	2.009663	7295.078	5.29
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.553	2006.149	1.45
SOIL WATER AT START OF YEAR	80.259	291341.344	
SOIL WATER AT END OF YEAR	80.812	293347.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0073	26.550	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.565	0.476	2.203	3.687	2.502	1.234
	1.205	0.267	0.118	0.061	0.489	1.130
EVAPOTRANSPIRATION	0.504	0.428	0.415	1.761	4.406	4.966
	2.732	1.458	1.341	0.864	0.552	0.454
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0402	1.5273	0.0144
LAYER 3	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.013	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.001	0.012	0.001
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.03	123528.898	100.00
RUNOFF	13.938	50593.785	40.96
EVAPOTRANSPIRATION	19.881	72168.164	58.42
C./LEAKAGE THROUGH LAYER 3	1.582182	5743.320	4.65
.. HEAD ON TOP OF LAYER 3	0.0011		
CHANGE IN WATER STORAGE	-1.371	-4976.336	-4.03
SOIL WATER AT START OF YEAR	80.812	293347.500	
SOIL WATER AT END OF YEAR	78.303	284239.969	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	-0.038	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	2.855	0.065	0.793	2.177	0.455	0.421
	0.723	0.461	0.000	0.000	0.754	3.185
EVAPOTRANSPIRATION	0.525	0.382	0.396	1.025	3.366	3.888
	2.456	1.919	1.347	0.619	0.342	0.453
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0403	0.0000
R 3	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.001	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	11.888	43154.859	42.11
EVAPOTRANSPIRATION	16.718	60686.070	59.22
PERC./LEAKAGE THROUGH LAYER 3	0.040610	147.416	0.14
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.423	-1534.255	-1.50
SOIL WATER AT START OF YEAR	78.303	284239.969	
SOIL WATER AT END OF YEAR	78.691	285647.375	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.843	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PITATION	0.92	2.33	0.71	4.60	4.27	4.24
	2.66	2.38	2.00	1.57	1.52	2.78
RUNOFF	0.280	1.725	0.168	3.221	0.751	1.355
	1.393	0.333	0.508	0.057	0.130	1.021
EVAPOTRANSPIRATION	0.402	0.335	0.313	0.889	3.478	5.502
	1.704	1.297	2.177	0.726	0.409	0.346
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.4711	0.0941
LAYER 3	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.004	0.001
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.003	0.002
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	10.941	39716.137	36.49
EVAPOTRANSPIRATION	17.578	63808.324	58.63
C./LEAKAGE THROUGH LAYER 3	0.565229	2051.781	1.89
G. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	0.896	3251.174	2.99
SOIL WATER AT START OF YEAR	78.691	285647.375	
SOIL WATER AT END OF YEAR	79.914	290088.062	
SNOW WATER AT START OF YEAR	0.328	1189.533	1.09

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	0.965	1.025	1.934	2.296	0.971	1.092
	0.747	1.131	0.285	0.036	0.650	1.552
STD. DEVIATIONS	1.135	0.770	1.733	1.197	0.916	0.806
	0.569	1.200	0.355	0.033	0.379	1.082
EVAPOTRANSPIRATION						
TOTALS	0.458	0.410	0.447	1.691	3.272	5.094
	2.016	1.806	1.675	0.819	0.541	0.395
STD. DEVIATIONS	0.056	0.074	0.140	0.720	0.845	0.736
	0.858	0.504	0.360	0.160	0.168	0.087
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.3582	0.6807	0.0413
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.4732	0.6120	0.0451
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0000	0.0035	0.0059	0.0005
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0046	0.0051	0.0004
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	12.685	(2.3091)	46044.80	39.225
EVAPOTRANSPIRATION	18.624	(1.3940)	67606.77	57.593
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.08037	(0.78695)	3921.730	3.34086
AVERAGE HEAD ON TOP OF LAYER 3	0.001	(0.001)		
CHANGE IN WATER STORAGE	-0.054	(0.8884)	-195.81	-0.167

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	3.169	11503.2656
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.123499	448.29968
AVERAGE HEAD ON TOP OF LAYER 3	0.032	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4631
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	9.6061	0.4003
2	42.0479	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04    (13 MARCH 1995)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:  15:19     DATE:   4/ 5/2001


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     TITLE:  MACOMB COUNTY LANDFILL SITE 9A (PROPOSED DESIGN)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
          THICKNESS                  =     24.00   INCHES
          POROSITY                   =      0.4750 VOL/VOL
          FIELD CAPACITY             =      0.3780 VOL/VOL
          WILTING POINT              =      0.2650 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.4115 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.999999975000E-05 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                  =    252.00   INCHES
          POROSITY                   =      0.6710 VOL/VOL
          FIELD CAPACITY             =      0.2920 VOL/VOL
          WILTING POINT              =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2920 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.100000005000E-02 CM/SEC


                                  LAYER  3
                                  --------

                 TYPE 3 - BARRIER SOIL LINER
                     MATERIAL TEXTURE NUMBER  12
          THICKNESS                  =     60.00   INCHES
          POROSITY                   =      0.4710 VOL/VOL
          FIELD CAPACITY             =      0.3420 VOL/VOL
          WILTING POINT              =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.4710 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.419999997000E-04 CM/SEC


                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                 ----------------------------------------

          NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

          SCS RUNOFF CURVE NUMBER            =     79.00
          FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
          AREA PROJECTED ON HORIZONTAL PLANE =      1.000  ACRES
          EVAPORATIVE ZONE DEPTH             =     24.0    INCHES
          INITIAL WATER IN EVAPORATIVE ZONE  =      9.876  INCHES
          UPPER LIMIT OF EVAPORATIVE STORAGE =     11.400  INCHES
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LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.360	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	111.720	INCHES
TOTAL INITIAL WATER	=	111.720	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.80	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	1.123	1.025	1.834	0.691	0.136	0.220
	0.415	1.519	0.798	0.063	0.716	2.025
EVAPOTRANSPIRATION	0.404	0.375	0.425	2.382	2.060	5.784
	2.540	1.761	1.889	1.045	0.655	0.265
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.9148	0.2778	0.0115
LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.008	0.003	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.010	0.002	0.001
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	10.566	38353.707	33.62
EVAPOTRANSPIRATION	19.585	71091.930	62.31
PERC./LEAKAGE THROUGH LAYER 3	1.204148	4371.056	3.83
AVG. HEAD ON TOP OF LAYER 3	0.0009		
CHANGE IN WATER STORAGE	0.076	274.233	0.24
SOIL WATER AT START OF YEAR	111.720	405542.781	
SOIL WATER AT END OF YEAR	111.795	405817.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35	2.26	4.20	4.91	3.61	4.99
	0.65	6.15	1.40	0.76	4.72	2.02
RUNOFF	0.000	1.837	4.674	1.704	1.008	2.231
	0.000	3.075	0.000	0.000	1.163	0.398
EVAPOTRANSPIRATION	0.454	0.529	0.685	2.400	3.050	5.329
	0.650	2.595	1.620	0.841	0.749	0.459
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.0000	0.0000	0.8345	1.0886	0.0864
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.009	0.009	0.001
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.009	0.008	0.002
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	16.090	58405.496	42.32
EVAPOTRANSPIRATION	19.361	70279.328	50.92
PERC./LEAKAGE THROUGH LAYER 3	2.009663	7295.078	5.29
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.553	2006.149	1.45
SOIL WATER AT START OF YEAR	111.795	405817.000	
SOIL WATER AT END OF YEAR	112.348	407823.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0073	26.550	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.565	0.476	2.203	3.687	2.502	1.234
	1.205	0.267	0.118	0.061	0.489	1.130
EVAPOTRANSPIRATION	0.504	0.428	0.415	1.761	4.406	4.966
	2.732	1.458	1.341	0.864	0.552	0.454
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0318	1.5357	0.0144
LAYER 3	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.012	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.001	0.011	0.001
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.03	123528.898	100.00
RUNOFF	13.938	50593.785	40.96
EVAPOTRANSPIRATION	19.881	72168.164	58.42
[illegible]./LEAKAGE THROUGH LAYER 3	1.582182	5743.319	4.65
[illegible] HEAD ON TOP OF LAYER 3	0.0010		
CHANGE IN WATER STORAGE	-1.371	-4976.336	-4.03
SOIL WATER AT START OF YEAR	112.348	407823.156	
SOIL WATER AT END OF YEAR	109.839	398715.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	-0.037	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	2.855	0.065	0.793	2.177	0.455	0.421
	0.723	0.461	0.000	0.000	0.754	3.185
EVAPOTRANSPIRATION	0.525	0.382	0.396	1.025	3.366	3.888
	2.456	1.919	1.347	0.619	0.342	0.453
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0403	0.0000
[illegible]R 3	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.001 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	11.888	43154.859	42.11
EVAPOTRANSPIRATION	16.718	60686.070	59.22
PERC./LEAKAGE THROUGH LAYER 3	0.040610	147.416	0.14
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.423	-1534.255	-1.50
SOIL WATER AT START OF YEAR	109.839	398715.656	
SOIL WATER AT END OF YEAR	110.227	400123.031	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.843	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
ETATION	0.92 2.66	2.33 2.38	0.71 2.00	4.60 1.57	4.27 1.52	4.24 2.78
RUNOFF	0.280 1.393	1.725 0.333	0.168 0.508	3.221 0.057	0.751 0.130	1.355 1.021
EVAPOTRANSPIRATION	0.402 1.704	0.335 1.297	0.313 2.177	0.889 0.726	3.478 0.409	5.502 0.346
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000 0.0000	0.0000 0.0000	0.0000 0.0001	0.0000 0.0000	0.4711 0.0000	0.0941 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.004 0.000	0.001 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.003 0.000	0.002 0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	10.941	39716.137	36.49
EVAPOTRANSPIRATION	17.578	63808.324	58.63
./LEAKAGE THROUGH LAYER 3	0.565229	2051.781	1.89
. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	0.896	3251.202	2.99
SOIL WATER AT START OF YEAR	110.227	400123.031	
SOIL WATER AT END OF YEAR	111.450	404563.781	
SNOW WATER AT START OF YEAR	0.328	1189.533	1.09

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.019	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	0.965	1.025	1.934	2.296	0.971	1.092
	0.747	1.131	0.285	0.036	0.650	1.552
STD. DEVIATIONS	1.135	0.770	1.733	1.197	0.916	0.806
	0.569	1.200	0.355	0.033	0.379	1.082
EVAPOTRANSPIRATION						
TOTALS	0 458	0.410	0.447	1.691	3.272	5.094
	2.016	1.806	1.675	0.819	0.541	0.395
STD. DEVIATIONS	0.056	0.074	0.140	0.720	0.845	0.736
	0.858	0.504	0.360	0.160	0.168	0.087
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.3562	0.6827	0.0413
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.4743	0.6152	0.0451
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0000	0.0035	0.0057	0.0005
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0046	0.0048	0.0004
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	12.685	(2.3091)	46044.80	39.225
EVAPOTRANSPIRATION	18.624	(1.3940)	67606.77	57.593
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.08037	(0.78695)	3921.730	3.34086
AVERAGE HEAD ON TOP OF LAYER 3	0.001	(0.001)		
CHANGE IN WATER STORAGE	-0.054	(0.8884)	-195.80	-0.167

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	3.169	11503.2656
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.115699	419.98883
AVERAGE HEAD ON TOP OF LAYER 3	0.029	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4631
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	9.6061	0.4003
2	73.5839	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:  15:50     DATE:   4/ 5/2001


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     TITLE:  MACOMB COUNTY LANDFILL SITE 9A (PROPOSED DESIGN)

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
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                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4750 VOL/VOL
          FIELD CAPACITY               =      0.3780 VOL/VOL
          WILTING POINT                =      0.2650 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2954 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.999999997000E-06 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER  18
          THICKNESS                    =    252.00   INCHES
          POROSITY                     =      0.6710 VOL/VOL
          FIELD CAPACITY               =      0.2920 VOL/VOL
          WILTING POINT                =      0.0770 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                  LAYER  3
                                  --------

                 TYPE 3 - BARRIER SOIL LINER
                     MATERIAL TEXTURE NUMBER  12
          THICKNESS                    =     60.00   INCHES
          POROSITY                     =      0.4710 VOL/VOL
          FIELD CAPACITY               =      0.3420 VOL/VOL
          WILTING POINT                =      0.2100 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
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     NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

     SCS RUNOFF CURVE NUMBER              =     79.00
     FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE    =      7.089  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE   =     11.400  INCHES
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LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.360	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	108.933	INCHES
TOTAL INITIAL WATER	=	108.933	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.80	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	1.508	1.278	2.013	1.581	0.993	2.649
	1.577	2.309	2.109	0.291	2.373	3.307
EVAPOTRANSPIRATION	0.375	0.337	0.376	1.494	0.832	1.677
	1.262	0.810	1.070	0.393	0.523	0.269
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
LAYER 3	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
D ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	21.987	79814.562	69.96
EVAPOTRANSPIRATION	9.419	34190.781	29.97
RC./LEAKAGE THROUGH LAYER 3	0.000333	1.207	0.00
G. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.023	84.358	0.07
SOIL WATER AT START OF YEAR	108.933	395425.719	
SOIL WATER AT END OF YEAR	108.956	395510.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35	2.26	4.20	4.91	3.61	4.99
	0.65	6.15	1.40	0.76	4.72	2.02
RUNOFF	0.000	2.163	5.130	3.391	2.328	3.733
	0.287	4.745	0.687	0.432	3.583	1.207
EVAPOTRANSPIRATION	0.449	0.529	0.524	1.937	1.435	1.401
	0.374	1.424	0.598	0.456	0.622	0.452
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001
ER 3	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	27.786	100861.992	73.08
EVAPOTRANSPIRATION	10.202	37033.496	26.83
PERC./LEAKAGE THROUGH LAYER 3	0.000486	1.763	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.024	88.845	0.06
SOIL WATER AT START OF YEAR	108.956	395510.094	
SOIL WATER AT END OF YEAR	108.980	395598.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
WATER AT END OF YEAR	0.000	0.000	0.00
NUAL WATER BUDGET BALANCE	0.0073	26.503	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.830	0.554	2.370	4.422	4.419	2.817
	2.768	0.938	0.732	0.351	1.633	1.236
EVAPOTRANSPIRATION	0.500	0.436	0.440	1.214	1.993	1.283
	1.467	0.727	0.645	0.486	0.486	0.443
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
LAYER 3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.03	123528.898	100.00
RUNOFF	23.071	83748.750	67.30
EVAPOTRANSPIRATION	10.122	36741.992	29.74
./LEAKAGE THROUGH LAYER 3	0.000366	1.329	0.00
HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.837	3036.793	2.46
SOIL WATER AT START OF YEAR	108.980	395598.937	
SOIL WATER AT END OF YEAR	108.679	394504.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	2.946	0.488	1.455	2.884	1.692	1.285
	1.778	2.020	0.045	0.394	1.690	3.434
EVAPOTRANSPIRATION	0.519	0.375	0.389	0.746	1.367	1.050
	1.377	1.185	0.498	0.469	0.416	0.441
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
R 3	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	20.113	73010.602	71.25
EVAPOTRANSPIRATION	8.832	32060.332	31.29
PERC./LEAKAGE THROUGH LAYER 3	0.000427	1.549	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.721	-2618.392	-2.56
SOIL WATER AT START OF YEAR	108.679	394504.562	
SOIL WATER AT END OF YEAR	108.768	394827.812	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.842	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
[illegible]ITATION	0.92	2.33	0.71	4.60	4.27	4.24
	2.66	2.38	2.00	1.57	1.52	2.78
RUNOFF	0.360	1.981	0.344	3.954	2.445	2.857
	1.957	1.321	1.128	0.924	0.861	2.077
EVAPOTRANSPIRATION	0.388	0.332	0.297	0.772	2.155	1.405
	0.870	0.905	0.898	0.519	0.472	0.398
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
LAYER 3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	20.708	75170.750	69.07
EVAPOTRANSPIRATION	9.413	34167.527	31.40
[illegible]/LEAKAGE THROUGH LAYER 3	0.000390	1.417	0.00
[illegible] HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.141	-512.342	-0.47
SOIL WATER AT START OF YEAR	108.768	394827.812	
SOIL WATER AT END OF YEAR	108.955	395505.000	
SNOW WATER AT START OF YEAR	0.328	1189.533	1.09

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.068	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	1.229	1.293	2.262	3.246	2.375	2.668
	1.673	2.267	0.940	0.478	2.028	2.272
STD. DEVIATIONS	1.099	0.778	1.777	1.096	1.280	0.881
	0.897	1.488	0.760	0.254	1.021	1.056
EVAPOTRANSPIRATION						
TOTALS	0.446	0.402	0.405	1.233	1.357	1.363
	1.070	1.010	0.742	0.465	0.504	0.401
STD. DEVIATIONS	0.065	0.082	0.084	0.503	0.530	0.327
	0.451	0.288	0.235	0.046	0.076	0.076
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	22.733	(3.0481)	82521.34	70.299
EVAPOTRANSPIRATION	9.597	(0.5684)	34838.83	29.679
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00040	(0.00006)	1.453	0.00124
AVERAGE HEAD ON TOP OF LAYER 3	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.004	(0.5570)	15.85	0.014

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	3.198	11609.4238
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000146	0.53169
AVERAGE HEAD ON TOP OF LAYER 3	0.000	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2994
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	7.1106	0.2963
2	73.5839	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.04   (13 MARCH 1995)                 **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:     C:\HELP3\MCPREC.D4
TEMPERATURE DATA FILE:       C:\HELP3\MCTEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\MCSOLR.D13
EVAPOTRANSPIRATION DATA:     c:\HELP3\MCEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\MCSOIL.D10
OUTPUT DATA FILE:            C:\HELP3\MCOUTP.OUT


TIME:   8:43     DATE:   4/ 6/2001


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    TITLE:  MACOMB COUNTY LANDFILL SITE 9 (PROPOSED DESIGN)

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER  1
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER   0
        THICKNESS                    =     24.00   INCHES
        POROSITY                     =      0.4750 VOL/VOL
        FIELD CAPACITY               =      0.3780 VOL/VOL
        WILTING POINT                =      0.2650 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.2954 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.999999997000E-06 CM/SEC


                                LAYER  2
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER  18
        THICKNESS                    =    144.00   INCHES
        POROSITY                     =      0.6710 VOL/VOL
        FIELD CAPACITY               =      0.2920 VOL/VOL
        WILTING POINT                =      0.0770 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.2920 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.100000005000E-02 CM/SEC


                                LAYER  3
                                --------

                TYPE 3 - BARRIER SOIL LINER
                MATERIAL TEXTURE NUMBER  12
        THICKNESS                    =     60.00   INCHES
        POROSITY                     =      0.4710 VOL/VOL
        FIELD CAPACITY               =      0.3420 VOL/VOL
        WILTING POINT                =      0.2100 VOL/VOL
        INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
        EFFECTIVE SAT. HYD. COND.    =  0.419999997000E-04 CM/SEC


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

      NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

     SCS RUNOFF CURVE NUMBER              =     79.00
     FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
     AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
     EVAPORATIVE ZONE DEPTH               =     24.0    INCHES
     INITIAL WATER IN EVAPORATIVE ZONE    =      7.089  INCHES
     UPPER LIMIT OF EVAPORATIVE STORAGE   =     11.400  INCHES
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LOWER LIMIT OF EVAPORATIVE STORAGE	=	6.360	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	77.397	INCHES
TOTAL INITIAL WATER	=	77.397	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
DETROIT MICHIGAN

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	3.50	
START OF GROWING SEASON (JULIAN DATE)	=	121	
END OF GROWING SEASON (JULIAN DATE)	=	286	
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.20	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	75.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.86	1.69	2.54	3.15	2.77	3.43
3.10	3.21	2.25	2.12	2.33	2.52

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
23.40	25.80	35.00	47.40	58.10	67.70
71.90	70.50	63.30	51.90	39.50	28.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR DETROIT MICHIGAN
AND STATION LATITUDE = 42.40 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.91	1.64	2.40	2.37	1.78	4.49
	2.78	3.11	3.12	0.61	3.38	3.84
RUNOFF	1.508	1.278	2.013	1.581	0.993	2.649
	1.577	2.309	2.109	0.291	2.373	3.307
EVAPOTRANSPIRATION	0.375	0.337	0.376	1.494	0.832	1.677
	1.262	0.810	1.070	0.393	0.523	0.269
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.43	114090.922	100.00
RUNOFF	21.987	79814.562	69.96
EVAPOTRANSPIRATION	9.419	34190.781	29.97
PERC./LEAKAGE THROUGH LAYER 3	0.000333	1.207	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.023	84.358	0.07
SOIL WATER AT START OF YEAR	77.397	280950.062	
SOIL WATER AT END OF YEAR	77.420	281034.437	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.35 0.65	2.26 6.15	4.20 1.40	4.91 0.76	3.61 4.72	4.99 2.02
RUNOFF	0.000 0.287	2.163 4.745	5.130 0.687	3.391 0.432	2.328 3.583	3.733 1.307
EVAPOTRANSPIRATION	0.449 0.374	0.529 1.424	0.524 0.598	1.937 0.456	1.435 0.622	1.401 0.452
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000 0.0000	0.0000 0.0002	0.0000 0.0000	0.0001 0.0000	0.0001 0.0000	0.0001 0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	38.02	138012.609	100.00
RUNOFF	27.786	100861.992	73.08
EVAPOTRANSPIRATION	10.202	37033.496	26.83
PERC./LEAKAGE THROUGH LAYER 3	0.000486	1.763	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.024	88.817	0.06
SOIL WATER AT START OF YEAR	77.420	281034.437	
SOIL WATER AT END OF YEAR	77.444	281123.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0073	26.531	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PITATION	1.33	0.99	2.81	5.25	6.05	4.20
	4.25	1.69	1.32	0.82	2.48	2.84
RUNOFF	0.830	0.554	2.370	4.422	4.419	2.817
	2.768	0.938	0.732	0.351	1.633	1.236
EVAPOTRANSPIRATION	0.500	0.436	0.440	1.214	1.993	1.283
	1.467	0.727	0.645	0.486	0.486	0.443
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
LAYER 3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.03	123528.898	100.00
RUNOFF	23.071	83748.750	67.80
EVAPOTRANSPIRATION	10.122	36741.992	29.74
PC./LEAKAGE THROUGH LAYER 3	0.000366	1.329	0.00
HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	0.837	3036.821	2.46
SOIL WATER AT START OF YEAR	77.444	281123.250	
SOIL WATER AT END OF YEAR	77.143	280028.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.138	4131.177	3.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	2.37	0.99	1.82	3.35	2.82	2.27
	3.18	3.15	0.64	0.97	2.28	4.39
RUNOFF	2.946	0.488	1.455	2.884	1.692	1.285
	1.778	2.020	0.045	0.394	1.690	3.434
EVAPOTRANSPIRATION	0.519	0.375	0.389	0.746	1.367	1.050
	1.377	1.185	0.498	0.469	0.416	0.441
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
ER 3	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.23	102474.930	100.00
RUNOFF	20.113	73010.602	71.25
EVAPOTRANSPIRATION	8.832	32060.332	31.29
PERC./LEAKAGE THROUGH LAYER 3	0.000427	1.549	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.721	-2618.392	-2.56
SOIL WATER AT START OF YEAR	77.143	280028.875	
SOIL WATER AT END OF YEAR	77.232	280352.125	
SNOW WATER AT START OF YEAR	1.138	4131.177	4.03
SNOW WATER AT END OF YEAR	0.328	1189.533	1.16
ANNUAL WATER BUDGET BALANCE	0.0057	20.842	0.02

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.92	2.33	0.71	4.60	4.27	4.24
	2.66	2.38	2.00	1.57	1.52	2.78
RUNOFF	0.860	1.981	0.344	3.954	2.445	2.857
	1.957	1.321	1.128	0.924	0.861	2.077
EVAPOTRANSPIRATION	0.388	0.332	0.297	0.772	2.155	1.405
	0.870	0.905	0.898	0.519	0.472	0.398
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 3	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.98	108827.430	100.00
RUNOFF	20.708	75170.750	69.07
EVAPOTRANSPIRATION	9.413	34167.527	31.40
PERC./LEAKAGE THROUGH LAYER 3	0.000390	1.417	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
CHANGE IN WATER STORAGE	-0.141	-512.342	-0.47
SOIL WATER AT START OF YEAR	77.232	280352.125	
SOIL WATER AT END OF YEAR	77.419	281029.344	
SNOW WATER AT START OF YEAR	0.328	1189.533	1.09

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.068	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.78	1.64	2.39	4.10	3.71	4.04
	2.70	3.30	1.70	0.95	2.88	3.17
STD. DEVIATIONS	0.64	0.65	1.28	1.20	1.61	1.04
	1.31	1.70	0.93	0.37	1.23	0.94
RUNOFF						
TOTALS	1.229	1.293	2.262	3.246	2.375	2.668
	1.673	2.267	0.940	0.478	2.028	2.272
STD. DEVIATIONS	1.099	0.778	1.777	1.096	1.280	0.881
	0.897	1.488	0.760	0.251	1.021	1.056
EVAPOTRANSPIRATION						
TOTALS	0.446	0.402	0.405	1.233	1.557	1.363
	1.070	1.010	0.742	0.465	0.504	0.401
STD. DEVIATIONS	0.065	0.082	0.084	0.503	0.530	0.227
	0.451	0.288	0.235	0.046	0.076	0.076
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3						
AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.34	(3.821)	117387.0	100.00
RUNOFF	22.733	(3.0481)	82521.34	70.299
EVAPOTRANSPIRATION	9.597	(0.5684)	34838.83	29.679
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00040	(0.00006)	1.453	0.00124
AVERAGE HEAD ON TOP OF LAYER 3	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.004	(0.5570)	15.85	0.014

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	2.56	9292.800
RUNOFF	3.198	11609.4238
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000146	0.53169
AVERAGE HEAD ON TOP OF LAYER 3	0.000	
SNOW WATER	3.10	11265.5547

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2994
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2650

****

****

FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	7.1106	0.2963
2	42.0479	0.2920
3	28.2600	0.4710
SNOW WATER	0.000	

****
****

Attachment IV
Leachate Collectors and Groundwater Interceptors
Flow Capacity

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6799 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

SUBJECT:

High Density Polyethylene (HDPE) Leachate Collection Pipe and Groundwater Interceptor Pipe Flow Capacity.

PURPOSE AND OBJECTIVE:

The following computations are performed to determine the maximum flow capacity of the proposed leachate collection and groundwater interceptor pipes. This maximum capacity is compared to the estimated leachate flows or groundwater inflows. An estimate of the necessary amount of clogging needed to reduce the pipe flow capacity below this estimated leachate rate is also provided.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. For non-pressure flow conditions, the maximum flow depth in a pipe is equal to 95% of the pipe's interior diameter. Flow depths greater than this enter pressure flow regimes.

2. At 95% flow depth, ratio of flow cross-sectional area to the square of the pipe's interior diameter is 0.771 ($Af = 0.771 * D^2$).

3. At 95% flow depth, the ratio of the wetted perimeter to the pipe's interior diameter is 2.691 ($Wp = 2.691 * D$).

4. At 95 % flow depth, the ratio of the hydraulic radius to the pipe's interior diameter is 0.286 ($Rh = 0.286 * D$).

5. The minimum flow gradient of the pipe is 0.28% (0.0028 ft/ft). It occurs along the leachate collector pipe located adjacent to the southern limits of Site 9A (5 feet elevation difference over a length of 1,800 feet)

METHODOLOGY:

The flow velocity is estimated using Manning's equation for open channel flows:

$$Vp = (1.49 / np) * (Rh^{2/3}) * (S^{1/2})$$

where,

Vp = Pipe Flow Velocity (ft / sec)

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

np = Manning's Roughness Coefficient (dimensionless)
Rh = Hydraulic Radius (ft)
S = Pipe Flow Gradient (ft / ft)

The flow capacity is derived from the following:

$$Qp = Vp * Af$$

where,

Qp = Pipe Flow Capacity (cubic feet / sec)
Vp = Pipe Flow Velocity (ft / sec)
Af = Flow Cross-Sectional Area (sq ft)

MATERIAL CHARACTERISTICS:

The collection pipes will be perforated, 6 inch diameter, SDR 11 HDPE pipes having an interior diameter of 5.421 inches and a Manning's roughness coefficient of 0.047. The perforations do not significantly alter the pipe's flow characteristics.

COMPUTATIONS:

The following table performs the computations to estimate the pipe flow capacity:

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7351 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-4739 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

Table 1 - Pipe Flow Capacity

Pipe Interior Diameter, D =	0.452 feet
(6in dia SDR-11 HDPE)	
Manning's Roughness Coefficient, np =	0.047
(High Density Polyethylene)	
Pipe Flow Area, Af =	0.157 sq ft
(0.771 * D^2)	
Wetted Perimeter, Wp =	1.216 feet
(2.691 * D)	
Hydraulic Radius, Rh =	0.129 feet
(0.286 * D)	
Pipe Flow Gradient, S =	0.0028 ft/ft
Pipe Flow Velocity, Vp =	0.428 ft/sec
(1.49/np) * (Rh^0.667) * (S ^0.5)	
Pipe Flow Capacity, Qp =	0.067 cf/sec
(Vp * Af)	
Pipe Flow Capacity, Qp =	30.254 gpm

CONCLUSIONS:

The minimum peak flow capacity of the leachate collection pipes/ groundwater collector pipes is 0.067 cubic feet per second or 30 gpm. According to the groundwater and leachate flow model results previously performed by CRA ("Conceptual Design for Remedial Action", Table 4.1), the maximum leachate groundwater extraction rate for all of Site 9A is 78 gpm. The pipe's minimum peak flow capacity is approximately 40% of the predicted rate for the entire site. It therefore represents a flow capacity greatly in excess of anticipated requirements. Only the most severe clogging will significantly impact the pipe's flow capacity.

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513(489-7208

SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

SUBJECT:

Polyvinyl Chloride (PVC) Leachate Collection Pipe and Groundwater Interceptor Pipe Flow Capacity.

PURPOSE AND OBJECTIVE:

The following computations are performed to determine the maximum flow capacity of the proposed leachate collection and groundwater interceptor pipes. This maximum capacity is compared to the estimated leachate flows or groundwater. An estimate of the necessary amount of clogging needed to reduce the pipe flow capacity below this estimated leachate rate is also provided.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. For non-pressure flow conditions, the maximum flow depth in a pipe is equal to 95% of the pipe's interior diameter. Flow depths greater than this enter pressure flow regimes.

2. At 95% flow depth, ratio of flow cross-sectional area to the square of the pipe's interior diameter is 0.771 ($Af = 0.771 * D^2$).

3. At 95% flow depth, the ratio of the wetted perimeter to the pipe's interior diameter is 2.691 ($Wp = 2.691 * D$).

4. At 95 % flow depth, the ratio of the hydraulic radius to the pipe's interior diameter is 0.286 ($Rh = 0.286 * D$).

5. The minimum flow gradient of the pipe is 0.28% (0.0028 ft/ft). It occurs along the leachate collector pipe located adjacent to the southern limits of Site 9A (5 feet elevation difference over a length of 1,800 feet)

METHODOLOGY:

The flow velocity is estimated using Manning's equation for open channel flows:

$$Vp = (1.49 / np) * (Rh^{2/3}) * (S^{1/2})$$

where,

Vp = Pipe Flow Velocity (ft / sec)

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

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SHEET _____ OF _____

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____ DATE: _____	BY: _____ DATE: _____	

np = Manning's Roughness Coefficient (dimensionless)
Rh = Hydraulic Radius (ft)
S = Pipe Flow Gradient (ft / ft)

The flow capacity is derived from the following:

$$Qp = Vp * Af$$

where,

Qp = Pipe Flow Capacity (cubic feet / sec)
Vp = Pipe Flow Velocity (ft / sec)
Af = Flow Cross-Sectional Area (sq ft)

MATERIAL CHARACTERISTICS:

The collection pipes will be perforated, 6 inch diameter, Schedule 80 PVC pipes having an interior diameter of 5.761 inches and a Manning's roughness coefficient of 0.009. The perforations do not significantly alter the pipe's flow characteristics.

COMPUTATIONS:

The following table performs the computations to estimate the pipe flow capacity:

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7851 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513(489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

Table 1 - Pipe Flow Capacity

Pipe Interior Diameter, D =	0.480	feet
(6in dia SCH 80 PVC)		
Manning's Roughness Coefficient, np =	0.009	
(Polyvinyl Chloride)		
Pipe Flow Area, Af =	0.178	sq ft
(0.771 * D^2)		
Wetted Perimeter, Wp =	1.292	feet
(2.691 * D)		
Hydraulic Radius, Rh =	0.137	feet
(0.286 * D)		
Pipe Flow Gradient, S =	0.0028	ft/ft
Pipe Flow Velocity, Vp =	2.330	ft/sec
(1.49/np) * (Rh^0.667) * (S ^0.5)		
Pipe Flow Capacity, Qp =	0.414	cf/sec
(Vp * Af)		
Pipe Flow Capacity, Qp =	185.822	gpm

CONCLUSIONS:

The minimum peak flow capacity of the leachate collection pipes/ groundwater collector pipes is 0.414 cubic feet per second or 186 gpm. According to the groundwater and leachate flow model results previously performed by CRA ("Conceptual Design for Remedial Action", Table 4.1), the maximum leachate groundwater extraction rate for all of Site 9A is 78 gpm. The pipe's minimum peak flow capacity is 2.37 times greater than this predicted rate for the entire site. It therefore represents a flow capacity greatly in excess of anticipated requirements. Only the most severe clogging will significantly impact the pipe's flow capacity.

HDPE pipe is to be used due to potentially unstable sidewall conditions in the trench excavation.

PETRO
environmental
technologies

August 30, 2001

Mr. David Kline
Michigan Department of Environmental Quality
KNAPPS Office Center
P.O. Box 30426
Lansing, Michigan 48909-7926

Letter #018

RE: Remedial Action Plan
Macomb County Landfill Sites 9 and 9A
Revised Leachate and Groundwater Collection Pipe

Dear Mr. Kline,

Attached for your review is information concerning the 6" diameter, perforated ADS N-12 pipe Petro Environmental intends to use for its leachate and groundwater collection system at the Macomb County Landfill Sites 9 and 9A.

Given that pipe trenching in municipal solid waste in a potentially unsafe operation due to unstable excavation side walls and the accumulation of methane gas in the exposed trench, Petro Environmental has chosen a safer pipe product to be installed for the leachate and groundwater collection system. ADS pipe segments can be mechanically joined outside the trench and are flexible enough to allow the assembled pipeline to be lowered into the trench, without the need for workers to be in the trench and exposed to potentially dangerous conditions.

As far as performance characteristics, please note that the ADS pipe is stable against a loading three times greater than anticipated in the high-density polyethylene pipe RAP design calculations (60 feet of overburden vs. 19 feet). Also the ADS pipe has a flow capacity significantly greater than that estimated in the RAP design calculations (0.27 cfs at a flow gradient of 0.002 ft/ft vs. 0.07 cfs at a flow gradient of 0.003 ft/ft). In all performance aspects, ADS N-12 pipe exceeds the requirements of the RAP design calculations.

Please call us at (513) 489-6789 if you have any questions or comments. We are at your convenience and look forward to your response.

Respectfully yours,
Petro Environmental Technologies, Inc.

Daniel P. Duffy, PE

7851 Palace Drive • Cincinnati, Ohio 45249 • 513.489.6789 • Fax 489.7208
8200 Seville Road • Lodi, Ohio 44254 • 330.948.1494 • Fax 948.1933

Cc: Mark S. Mather
Mr. Ted Wahby (SMDA)
Mr. Roger Timm (Dykema-Gosset)
Mr. John Brennan (Macomb Township)
Mr. Lawrence Dloski (Seibert and Dloski)
Mr. David Lakin (Spalding-DeDecker Assoc.)
File

Attachments ADS N-12 Pipe Information Sheet
ADS N-12 Pipe Specifications
ADS Pipe Strength Calculations
ADS Pipe Flow Calculations

CONTACT ADS

Phone, Fax or E-mail Contact Us with product questions or comments about our new website.

SALES INFORMATION

Get ADS Sales/Pricing Information

RELATED INFORMATION

See related Pipe Technical Data

See more Pipe Products

Product-related questions? See our Product/Technical FAQs

N-12®Pipe

N-12 has built an impressive service record in storm water and other drainage applications where hydraulics are important and durability is critical.

It is designed for use under both H25 and E80 live loads, or with fill heights of 50 feet or more. In fact, field research shows the pipe performing well at depths exceeding 100 feet. With its superior abrasion and corrosion resistance, it has become an excellent alternative to concrete and metal pipe.

N-12's light weight leads to a number of job site economies: more pipe per delivery truck, easier handling, smaller crews, less heavy equipment, less pipe damage, and better safety. The pipe cuts easily and requires no beveling for joining.

N-12 Pipe Product Information	
Diameters Available:	4"-48"
Lengths Available:	20'
Joint Performance:	Soil-tight Water-tight
Joining System:	Bell and Spigot Split Coupler
Specifications:	Product Note 3.107
Applications:	Storm Sewers Sanitary Sewers Waste Management Highway

Back to top

SEARCH

Ho
Pipe
N-12

"From n
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3300 Riverside Drive, Columbus OH 43221 Tel: 1-800-821-6710 Fax: 1-614-538-5204

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Product Notes

Product Note 3.107

Re: Specification for Smooth Interior Corrugated Polyethylene Pipe

Date: November 2000

This specification applies to high density polyethylene corrugated pipe with an integrally formed smooth waterway. Nominal sizes for which this specification is acceptable are 100 – 1500 mm (4 - 60 inch) diameters. Sizes 100 – 1500 mm (4 - 60 inch) shall be either AASHTO Type 'S' or Type 'D' as follows. Sizes 100 – 1050 mm (4 - 42 inch) designated as AASHTO Type 'S' (N-12) shall have a full circular cross-section, with an outer corrugated pipe wall and an essentially smooth inner wall (waterway). Corrugations for Type 'S' sizes 100 – 1050 mm (4 - 42 inch) shall be annular (N-12). Sizes 1050 – 1500 mm (42 thru 60 inch) designated as AASHTO Type 'D' (N-12HC) shall consist of an essentially smooth waterway braced circumferentially with circular ribs which are formed simultaneously with an essentially smooth outer wall. The 1050 – 1500 mm (42 thru 60 inch) (N-12HC) sizes shall conform to AASHTO Type 'D' (which describes dual wall pipe with a smooth waterway).

Pipe manufactured for this specification shall comply with the requirements for test methods, dimensions and markings found in AASHTO Designations M252, M294 and MP7. Pipe and fittings shall be made from virgin PE compounds which conform with the applicable current edition of the AASHTO Material Specifications for cell classification as defined and described in ASTM D3350.

The minimum parallel plate stiffness values when tested in accordance with ASTM D2412 shall be as follows:

Diameter (nominal)	Pipe Stiffness (minimum)	Diameter (nominal)	Pipe Stiffness (minimum)
100 mm (4″)	340 kN/m² (50 pii)	600 mm (24″)	235 kN/m² (34 pii)
150 mm (6″)	340 kN/m² (50 pii)	750 mm (30″)	195 kN/m² (28 pii)
200 mm (8″)	340 kN/m² (50 pii)	900 mm (36″)	150 kN/m² (22 pii)
250 mm (10″)	340 kN/m² (50 pii)	1050 mm (42″)	140 kN/m² (20 pii)
300 mm (12″)	345 kN/m² (50 pii)	1200 mm (48″)	125 kN/m² (18 pii)
375 mm (15″)	290 kN/m² (42 pii)	1500 mm (60″)	95 kN/m² (14 pii)
450 mm (18″)	275 kN/m² (40 pii)		

The fittings shall not reduce or impair the overall integrity or function of the pipeline. Fittings may be either molded or fabricated. Common corrugated fittings include in-line joint fittings, such as couplers and reducers, and branch or complementary assembly fittings such as tees, wyes and end caps. These fittings may be installed by various methods such as snap-on, bell and spigot, bell – bell and wrap around couplers. Couplers shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings supplied or recommended by the manufacturer shall be used. Where designated on the plans or project specifications, an elastomeric gasket meeting the requirements of ASTM F477 shall be supplied.

Installation of the pipe specified above shall be in accordance with either AASHTO Section 30 or ASTM Recommended Practice D2321 as described elsewhere in these specifications and as recommended by the manufacturer.

ADS N-12 PRODUCT INFORMATION SHEET

NOMINAL DIAMETER	INSIDE DIAMETER, AVERAGE	OUTSIDE DIAMETER, AVERAGE	INNER LINER THICKNESS, MINIMUM	MINIMUM PIPE STIFFNESS @ 5% DEFLECTION	WEIGHT kg./6m (lbs./20 ft.)	AREA mm²/mm	"I" cm⁴/cm	"C" mm
100 mm (4")	104 mm (4.10")	120 mm (4.78")	0.5 mm (0.020")	340 kN/m² 50 psi	4.08 kg (9.00 lbs)	1.59 (0.063 in²/in)	0.010 (0.0006 in⁴/in)	3.06 (0.12 in)
150 mm (6")	152 mm (6.00")	176 mm (6.92")	0.5 mm (0.020")	340 kN/m² 50 psi	7.71 kg (17.00 lbs)	2.18 (0.085 in²/in)	0.025 (0.002 in⁴/in)	4.24 (0.19 in)
200 mm (8")	200 mm (7.90")	233 mm (9.11")	0.6 mm (0.024")	340 kN/m² 50 psi	13.97 kg (30.80 lbs)	2.75 (0.108 in²/in)	0.078 (0.005 in⁴/in)	6.36 (0.25 in)
250 mm (10")	251 mm (9.90")	287 mm (11.36")	0.6 mm (0.024")	340 kN/m² 50 psi	20.96 kg (46.20 lbs)	3.43 (0.137 in²/in)	0.131 (0.008 in⁴/in)	7.58 (0.30 in)
300 mm (12")	308 mm (12.15")	367 mm (14.45")	0.9 mm (0.035")	345 kN/m² 50 psi	28.96 kg (63.80 lbs)	5.50 (0.217 in²/in)	0.574 (0.035 in⁴/in)	10.92 (0.43 in)
375 mm (15")	380 mm (14.98")	448 mm (17.67")	1.0 mm (0.039")	290 kN/m² 42 psi	42.00 kg (92.50 lbs)	6.91 (0.272 in²/in)	0.961 (0.058 in⁴/in)	13.24 (0.52 in)
450 mm (18")	459 mm (18.07")	536 mm (21.20")	1.3 mm (0.051")	275 kN/m² 40 psi	58.38 kg (128.60 lbs)	6.93 (0.273 in²/in)	1.327 (0.081 in⁴/in)	14.48 (0.57 in)
600 mm (24")	612 mm (24.08")	719 mm (27.80")	1.5 mm (0.058")	235 kN/m² 34 psi	99.93 kg (220.30 lbs)	8.23 (0.324 in²/in)	2.245 (0.137 in⁴/in)	18.80 (0.74 in)
750 mm (30")	762 mm (30.00")	892 mm (35.10")	1.5 mm (0.059")	195 kN/m² 28 psi	145.83 kg (321.50 lbs)	9.60 (0.378 in²/in)	4.539 (0.277 in⁴/in)	21.84 (0.86 in)
900 mm (36")	914 mm (36.00")	1059 mm (41.70")	1.7 mm (0.067")	150 kN/m² 22 psi	191.85 kg (422.8 lbs)	10.19 (0.401 in²/in)	6.355 (0.400 in⁴/in)	25.40 (1.00 in)
1050 mm (42") Type S	1054 mm (41.40")	1212 mm (47.70")	2.54 mm (0.100")	140 kN/m² 20 psi	239.77 kg (528.60 lbs)	11.64 (0.458 in²/in)	9.373 (0.572 in⁴/in)	30.73 (1.21 in)
1050 mm (42") Type D	1054 mm (41.50")	1137 mm (46.75")	1.8 mm (0.070")	140 kN/m² 20 psi	269.76 kg (594.70 lbs)	14.86 (0.585 in²/in)	9.685 (0.591 in⁴/in)	35.31 (1.39 in)
1200 mm (48") Type D	1208 mm (47.55")	1339 mm (52.70")	1.8 mm (0.070")	125 kN/m² 18 psi	309.72 kg (682.80 lbs)	14.76 (0.581 in²/in)	10.090 (0.616 in⁴/in)	33.02 (1.30 in)
1500 mm (60") Type D	1514 mm (59.6")	1664 mm (65.5")	3.30 mm (0.130")	95 kN/m² 14 psi	509.68 kg (1122.30 lbs)	17.18 (0.675 in²/in)	13.306 (0.812 in⁴/in)	36.32 (1.43 in)

Date: November 2000

PIPE PARAMETERS - AASHTO M294, Type S

effective radius (in), R =3.25
outside diameter (in), D =6.92
thickness (in), t = 0.46
unit area of wall (in^2/in), A = 0.107
unit moment of inertia (in^4/in), I = 0.0036
flexural modulus (psi), E_f = 110,000
ring compression modulus (psi), E_{rc} = 110,000
flexural stiffness (psi), $K_f = 6E_fI/R^3$ = 69
ring compression stiffness (psi), $K_{rc} = E_{rc}A/R$ = 3,622
distance from inner wall to n.a. (in), c =0.25

SOIL PARAMETERS - good granular soil

mod of soil reaction at 5' of cover (psi), E_5' = 1600
modulus of soil reaction (psi), E' =3,364
Poisson's ratio, u = 0.30
constr mod (psi), M*=E*(1-u)/((1+u)(1-2u))=4527.97
lateral stress ratio = K = u/(1-u) =0.429
sym lateral stress ratio = B = (1/2)(1+K) =0.714
antisym lat stress ratio = C = (1/2)(1-K) =0.286

SOIL/STRUCTURE PARAMETERS (full slippage)

ring flexibility ratio, UF =(1+K)M*/K_{rc} = 1.79
bending flexibility ratio, VF = (1-K)M*/K_f= 37.4

STRESS FUNCTION COEFFICIENTS

constant term, a_0* = 0.183
cos(2*theta), a_2** = 0.964
sin(2*theta), b_2** = 0.946

LOAD PARAMETERS

unit weight of soil (lb/ft^3) = 120
height of fill above crown (ft) = 60.0
surcharge pressure (psi), P =50.0

RESPONSE OF PIPE WALL

deg c.c.w. from horiz	radial soil press P_r(psi)	radial defl w(in)	tang defl v(in)	circum wall thrust N(#/in)	wall bend mom(M) (#-lb/in)	ring comp stress (psi)	inner bend stress (psi)	outer bend stress (psi)	total stress inner (psi)	total stress outer (psi)
0	27.6	-0.022	0.000	96	6	-901	-444	373	-1346	-528
10	27.7	-0.019	0.008	96	6	-900	-422	354	-1322	-546
20	28.0	-0.011	0.016	96	5	-898	-356	299	-1254	-598
30	28.4	0.002	0.021	96	4	-894	-256	215	-1150	-678
40	28.9	0.018	0.024	95	2	-889	-133	112	-1022	-776
50	29.4	0.035	0.024	94	0	-883	-3	2	-886	-881
60	29.9	0.050	0.021	94	-2	-878	120	-101	-758	-979
70	30.3	0.063	0.016	94	-3	-874	220	-185	-654	-1059
80	30.6	0.071	0.008	93	-4	-871	285	-240	-586	-1111
90	30.7	0.074	0.000	93	-4	-870	308	-259	-562	-1129
100	30.6	0.071	-0.008	93	-4	-871	285	-240	-586	-1111
110	30.3	0.063	-0.016	94	-3	-874	220	-185	-654	-1059
120	29.9	0.050	-0.021	94	-2	-878	120	-101	-758	-979
130	29.4	0.035	-0.024	94	0	-883	-3	2	-886	-881
140	28.9	0.018	-0.024	95	2	-889	-133	112	-1022	-776
150	28.4	0.002	-0.021	96	4	-894	-256	215	-1150	-678
160	28.0	-0.011	-0.016	96	5	-898	-356	299	-1254	-598
170	27.7	-0.019	-0.008	96	6	-900	-422	354	-1322	-546
180	27.6	-0.022	0.000	96	6	-901	-444	373	-1346	-528

CALCULATION OF RING SHORTENING

deg c.c.w. from horiz	ring comp stress (psi)	ring comp strain (in/in)	ring shortening (in)
0	-901	-0.008195	-0.0046
10	-900	-0.0082	-0.0046
20	-898	-0.008161	-0.0046
30	-894	-0.008124	-0.0046
40	-889	-0.008077	-0.0046
50	-883	-0.008028	-0.0046
60	-878	-0.007982	-0.0045
70	-874	-0.007944	-0.0045
80	-871	-0.00792	-0.0045
90	-870	-0.007911	-0.0045
100	-871	-0.00792	-0.0045
110	-874	-0.007944	-0.0045
120	-878	-0.007982	-0.0045
130	-883	-0.008028	-0.0046
140	-889	-0.008077	-0.0046
150	-894	-0.008124	-0.0046
160	-898	-0.008161	-0.0046
170	-900	-0.0082	-0.0046
180	-901	-0.008195	-0.0046
		SUM (1/2 circle) =	-0.0869

COMMENTS

1. *This is 6" diameter ADS N-12*
2. *Flexural and compressive modulus are taken as 110,000 psi.*
3. *Typical E'_5 values (in psi) for various soils are listed in the table below:*

Type of soil	Standard AASHTO Relative Compaction 85%	90%	95%
Fine-grained soils with less than 25% sand (CL, ML, DL-ML)	500	700	1000
Coarse-grained soils with fines (SM, SC)	600	1000	1200
Coarse-grained soils with little or no fines (SP, SW, GP, GW)	700	1000	1600

MISC CALCS

Vertical deflection (%) = 2.29
Horizontal deflection (%) = -1.35
Critical Buckling Pressure (psi), P_{cr}= 184.7
Radial Soil Pressure at Crown (psi), P_{sd}= 30.7
Arc length of each sector (in) = 0.5672

CIRCUMFERENCE SHORTENS= -0.17 inches

Max. Compressive Stress: -1345.9 OK (< -3000)
Max. Tensile Stress: -528.05 OK (< 1000)
Circumfence Shortening % (2% Max): -0.0079 OK

Calculations by: _____
Title

Table 3

CIRCULAR PIPE FLOW CAPACITY

Full Flow (cubic feet per second) *Conv. Factor = $(1.486 x R^{2/3} x A)/n$ (English)

Full Flow (cubic meters per second) *Conv. Factor = $(1.0 x R^{2/3} x A)/n$ (Metric)

Manning's "n" = 0.012

Diameter (in.)	Diameter (mm.)	*Conv Factor	(% Slope) ft/100ft, m/100m 0.02	0.05	0.10	0.20	0.35	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	5.00	10.00	20.00
4		2.04	0.0289	0.0457	0.0647	0.0914	0.1210	0.1446	0.1771	0.2045	0.2286	0.2504	0.2705	0.2892	0.3233	0.4572	0.6466	0.9144
	100	0.06	0.0008	0.0012	0.0017	0.0025	0.0033	0.0039	0.0048	0.0055	0.0062	0.0068	0.0073	0.0078	0.0087	0.0124	0.0175	0.0247
6		6.04	0.0854	0.1350	0.1909	0.2700	0.3571	0.4269	0.5228	0.6037	0.6749	0.7393	0.7986	0.8537	0.9545	1.3498	1.9090	2.6997
	150	0.16	0.0023	0.0036	0.0052	0.0073	0.0097	0.0115	0.0141	0.0163	0.0182	0.0200	0.0216	0.0231	0.0258	0.0365	0.0516	0.0730
8		13.01	0.1840	0.2910	0.4115	0.5820	0.7699	0.9202	1.1270	1.3013	1.4549	1.5938	1.7215	1.8403	2.0576	2.9098	4.1151	5.8197
	200	0.35	0.0050	0.0079	0.0111	0.0157	0.0208	0.0249	0.0305	0.0352	0.0393	0.0431	0.0465	0.0498	0.0556	0.0787	0.1112	0.1573
10		23.61	0.3339	0.5280	0.7467	1.0560	1.3969	1.6696	2.0449	2.3612	2.6399	2.8919	3.1236	3.3392	3.7334	5.2798	7.4668	10.5596
	250	0.64	0.0090	0.0143	0.0202	0.0285	0.0378	0.0451	0.0553	0.0638	0.0714	0.0782	0.0844	0.0903	0.1009	0.1427	0.2018	0.2855
12		38.42	0.5433	0.8591	1.2149	1.7182	2.2729	2.7166	3.3272	3.8419	4.2954	4.7054	5.0824	5.4333	6.0746	8.5908	12.1492	17.1815
	300	1.04	0.0147	0.0232	0.0328	0.0464	0.0614	0.0734	0.0899	0.1039	0.1161	0.1272	0.1374	0.1469	0.1642	0.2322	0.3284	0.4645
15		69.71	0.986	1.559	2.204	3.118	4.124	4.929	6.037	6.971	7.794	8.538	9.222	9.859	11.022	15.588	22.044	31.175
	375	1.88	0.027	0.042	0.060	0.084	0.111	0.133	0.163	0.188	0.211	0.231	0.249	0.267	0.298	0.421	0.596	0.843
18		113.43	1.604	2.536	3.587	5.073	6.710	8.020	9.823	11.343	12.681	13.892	15.005	16.041	17.934	25.363	35.868	50.725
	450	3.07	0.043	0.069	0.097	0.137	0.181	0.217	0.266	0.307	0.343	0.376	0.406	0.434	0.485	0.686	0.970	1.371
21		171.18	2.421	3.828	5.413	7.656	10.127	12.104	14.825	17.118	19.139	20.965	22.645	24.209	27.066	38.278	54.133	76.555
	530	4.75	0.067	0.106	0.150	0.212	0.281	0.336	0.411	0.475	0.531	0.581	0.628	0.671	0.750	1.061	1.501	2.123
24		244.51	3.458	5.467	7.732	10.935	14.465	17.289	21.175	24.451	27.337	29.946	32.346	34.579	38.660	54.674	77.321	109.348
	600	6.61	0.093	0.148	0.209	0.296	0.391	0.467	0.572	0.661	0.739	0.810	0.874	0.935	1.045	1.478	2.090	2.956
27		334.87	4.736	7.488	10.589	14.976	19.811	23.679	29.000	33.487	37.439	41.013	44.299	47.358	52.947	74.879	105.895	149.758
	680	9.23	0.131	0.206	0.292	0.413	0.546	0.653	0.800	0.923	1.032	1.131	1.221	1.306	1.460	2.064	2.920	4.129
30		443.66	6.27	9.92	14.03	19.84	26.25	31.37	38.42	44.37	49.60	54.34	58.69	62.74	70.15	99.20	140.30	198.41
	760	12.43	0.18	0.28	0.39	0.56	0.74	0.88	1.08	1.24	1.39	1.52	1.64	1.76	1.96	2.78	3.93	5.56
36		721.87	10.21	16.14	22.83	32.28	42.71	51.04	62.52	72.19	80.71	88.41	95.49	102.09	114.14	161.42	228.28	322.83
	900	19.51	0.28	0.44	0.62	0.87	1.15	1.38	1.69	1.95	2.18	2.39	2.58	2.76	3.09	4.36	6.17	8.73
42		1089.45	15.41	24.36	34.45	48.72	64.45	77.04	94.35	108.95	121.80	133.43	144.12	154.07	172.26	243.61	344.52	487.22
	1050	29.45	0.42	0.66	0.93	1.32	1.74	2.08	2.55	2.95	3.29	3.61	3.90	4.17	4.66	6.59	9.31	13.17
48		1556.14	22.01	34.80	49.21	69.59	92.06	110.04	134.77	155.61	173.98	190.59	205.86	220.07	246.05	347.96	492.09	695.92
	1200	42.07	0.59	0.94	1.33	1.88	2.49	2.97	3.64	4.21	4.70	5.15	5.56	5.95	6.65	9.41	13.30	18.81
60		2823.56	39.93	63.14	89.29	126.27	167.04	199.66	244.53	282.36	315.68	345.81	373.52	399.31	446.44	631.37	892.89	1262.73
	1500	76.33	1.08	1.71	2.41	3.41	4.52	5.40	6.61	7.63	8.53	9.35	10.10	10.79	12.07	17.07	24.14	34.14

Attachment V
Leachate Collectors and Groundwater Interceptors Stability

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

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PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

SUBJECT:

The Effects of Static Loadings on the Structural Integrity of High Density Polyethylene (HDPE) Leachate Collection Pipes and Groundwater Interceptor Pipes.

PURPOSE AND OBJECTIVE:

The following computations were performed to estimate the maximum potential deflection of the HDPE leachate collection pipes/groundwater interceptor pies while subject to anticipated static loadings from deposited waste and/or soil overburden.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The leachate collection pipes/groundwater interceptor pipes are installed according to the design alignment, grade and elevation.

2. The "arching" of overburden over laying the leachate collection pipes/groundwater interceptor pipes is conservatively ignored so that the load from the total depth of overburden can be applied to the pipe.

3. As a non-rigid, non-pressurized pipe, the stability of the HDPE pipe should be considered as part of a soil/pipe system.

4. The total design period for the HDPE leachate collection pipes/groundwater interceptor pipes is 30 years (conforming to a typical 30-year post-closure care period).

5. Since the leachate collection pipes/groundwater interceptor pipes may be placed outside of waste in structural fill or natural soil, the soil's higher density will be conservatively used for this analysis instead of waste.

METHODOLOGY:

The external soil/waste pressure on the pipe is estimated as follows:

$$Pt = (Dw * H) * (1\,ft^2 / 144\,in^2)$$

where,

Pt = External Soil Pressure (psi)
Dw = In-Place Density of the Overburden (lbs per cubic foot)

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	DATE: _____	DATE: _____	

H = Total Overburden Fill Height (feet)

The potential for wall crushing failure of the HDPE pipe is dependent upon the actual compressive stress:

$$Sa = ((SDR - 1) * Pt) / 2$$

where,

Sa = Actual Compressive Stress (psi)
SDR = Standard Dimension Ratio (dimensionless, 11)
Pt = External Soil Pressure (psi)

The factor of safety against wall crushing is detemined by dividing the pipe's compressive yield strength by the actual compressive stress:

$$FSc = Ys / Sa$$

where,

Fsc = Factor of Safety Against Wall Crushing (dimensionless)
Ys = Compressive Yield Strength (psi)
Sa = Actual Compressive Stress (psi)

The potential for long-term wall buckling pipe failure is dependent upon the pipe/soil system's critical buckling pressure:

$$Pcb = 0.8 * (E' * Pc)^{1/2}$$

where,

Pcb = Critical Buckling Soil Pressure at the Top of the Pipe (psi)
E' = Soil Modulus (calculated as the ratio of soil pressure ot vertical soil strain at a specified density, for soil pressure greater than 4,000 psi and a compaction of 90% of Standard Density, the soil strain is 2% and E' = Pt /2%)
Pc = Hydrostatic, Critical Collapse Differential Pressure (psi)

The hydrostatic, critical collapse differential pressure is is calculated as follows:

$$Pc = (2.32 * E) / (SDR^3)$$

where,

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E = The HDPE Stress and Time Dependent Tensile Modulus of Elasticity (28,000 psi after 50 years for an actual compressive stress of Sa = 200 psi)
SDR = Standard Dimension Ratio (dimensionless, 11)

The factor of safety against wall buckling is determined as follows:

$$Fsb = Pcb / Pt$$

where,

Fsb = Factor of Safety Against Wall Buckling (dimensionless)
Pcb = Critical Buckling Soil Pressure at the Top of the Pipe (psi)
Pt = External Soil Pressure (psi)

The percentage of ring deflection is based upon strain for a given SDR and is calculated as follows:

$$Y\% = dY / OD$$

or

$$Y\% = 0.25 * e * SDR$$

where,

Y% = Percentage of Ring Deflection (percent)
dY = Vertical Deflection (inches)
OD = Outside Diameter of the Pipe (6.25 inches for 6 inch SDR-11 HDPE)
e = Tangential Strain in the Surface of the Pipe Ring (dimensionless, conservatively estimated at 0.01)
SDR = Standard Dimension Ratio (dimensionless, 11)

The factor of safety against ring deflection failure is determined as follows:

$$FSr = Y\% / es$$

where,

Fsr = Factor of Safety Against Ring Deflection Failure (dimensionless)
Y% = Percentage of Ring Deflection (percent)
es = Adjacent Soil Strain (for soil pressure greater than 4,000 psi and a compaction of 90% of Standard Density, the soil strain is 2%)

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MATERIAL CHARACTERISTICS:

The leachate collection pipes/groundwater interceptor pipes are 6 inch nominal diameter SDR-11 HDPE having an inside diameter of 5.421 inches and an outside diameter of 6.250 inches. Pipe wall thickness is therefore 0.415 inches. Pipe perforations are 0.375 inches in diameter and spaced in a double row with 6 inch spacing between perforations. The number of perforations per foot of pipe length is 4 each. The modulus of elasticity after the 50 year design time is 28,000 psi.

The maximum height of overburden over laying a leachate collection pipe or groundwater interceptor is 19 feet and occurs at the north center boundary of Site 9A adjacent to the groundwater collection sump. The average in-place density of the overburden is approximately 130 lbs per cubic foot (1.75 tons per cubic yard). The thicknesses of the aggregate bedding layer is insignificant compared to the thickness of the overburden and are ignored for the purposes of computation. Any portion of the proposed final cover system overlaying the pipe will be assumed to have the same density as the rest of the overburden.

The bedding soil adjacent to the pipe consists of highly compacted (as a result of the weight of the overburden) coarse grained soils having a modulus of reaction of 3,000 lbs per square inch.

COMPUTATIONS:

The following table calculates the factor of safety against wall crushing failure:

Table 1 - Wall Crushing Failure

Pipe Standard Dimension Ratio, SDR =	11.000	
In-Place Density of Overburden, Dw =	130.000	lbs / cf
Total Overburden Fill Depth, H =	19.000	feet
External Soil Pressure, Pt =	17.153	psi
(Dw * H * (1/144))		
Actual Compressive Stress, Sa =	85.764	psi
((SDR -1) * Pt) / 2		
Compressive Yield Strength, Ys =	15,000.000	psi
Factor of Safety Against Wall Crushing, FSc =	174.899	
(Ys / Sa)		

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The following table calculates the factor of safety against wall buckling failure:

Table 2 - Wall Buckling Failure

Pipe Standard Dimension Ratio, SDR =	11.000	
HDPE Modulus of Elasticity, E =	28,000.000	psi
(30 year design time)		
Hydrostatic Critical Collapse Differential Pressure, Pc =	48.805	psi
(2.32 * E) / (SDR^3)		
External Soil Pressure, Pt =	17.153	psi
(from table above)		
Soil Modulus, E' =	857.650	psi
(Pt / 2%)		
Critical Buckling Soil Pressure, Pcb =	163.674	psi
(0.8 * (E' * Pc)^0.5)		
Factor of Safety Against Wall Buckling, FSb =	9.542	
(Pcb / Pt)		

The following table calculates the factor of safety against ring deflection failure:

Table 3 - Ring Deflection Failure

Pipe Standard Dimension Ratio, SDR =	11.000
Tangential Strain on the Pipe Ring Surface, e =	0.010
Percent of Ring Deflection, Y% =	2.75%
(0.25 * e * SDR)	
Adjacent Soil Strain, es =	2.00%
Factor of Safety Against Ring Deflection Failure, FSr =	1.375
(Y% / es)	

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CONCLUSIONS:

The 6 inch diameter SDR-11 HDPE leachate collection pipe is stable under anticipated loadings.

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PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

SUBJECT:

The Effects of Static Loadings on the Structural Integrity of Polyvinyl Chloride (PVC) Leachate Collection Pipes and Groundwater Interceptor Pipes.

PURPOSE AND OBJECTIVE:

The following computations were performed to estimate the maximum potential deflection of the PVC leachate collection pipes/groundwater interceptor pipes while subject to anticipated static loadings from deposited waste and/or soil overburden.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The leachate collection pipes/groundwater interceptor pipes are installed according to the design alignment, grade and elevation.

2. The "arching" of waste or soil over laying the leachate collection pipes/groundwater interceptor pipes is conservatively ignored so that the load from the total depth of waste and soil can be applied to the pipe.

3. A depth of overburden greater than the maximum of 50 feet typically allowed by the Modified Iowa formula is allowed for this analysis.

4. A percent of horizontal deflection equal to 7% provides a factor of safety against inverse pipe curvature (pipe failure) of 4.

5. Since the leachate collection pipes/groundwater interceptor pipes may be placed outside of waste in structural fill or natural soil, the soil's higher density will be conservatively used for this analysis instead of waste.

METHODOLOGY:

The vertical stress on the pipe as the result of waste overburden is estimated by the following:

$$W = (Dw * H * OD) * (1\ ft^2 / 144\ in^2)$$

where,

W = Vertical Stress on the Pipe (lbs per inch of pipe length)
Dw = In-Place Density of the Waste or Soil (lbs per cubic foot)

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PROJECT / PROPOSAL NAME	PREPARED BY _____ DATE: _____	CHECKED BY: _____ DATE: _____	PROJECT / PROPOSAL NUMBER

H = Total waste or soil Fill Height (feet)
OD = Outside Diameter of the Leachate Collection Pipe (inches)

The estimated vertical stress is modified by the collection pipe perforations:

$$Wp = (W * 12) / (12 - (D * N))$$

where,

Wp = Modified Vertical Stress on the Pipe (lbs per inch of pipe length)
W = Vertical Stress on the Pipe (lbs per inch of pipe length)
D = Diameter of the Pipe Perforation (inches)
N = Number of Pipe Holes (each per foot of pipe length)

The pipe wall thickness is determined as follows:

$$Tp = (OD - ID) / 2$$

where,

Tp = Pipe Wall Thickness (inches)
OD = Outside Diameter of the Leachate Collection Pipe (inches)
ID = Inside Diameter of the Leachate Collection Pipe (inches)

Given the pipe wall thickness, the pipe wall's moment of inertia can be determined:

$$I = (Tp^3 / 12)$$

where,

I = Pipe Wall Moment of Inertia (inches^4 per inch)
Tp = Pipe Wall Thickness (inches)

The pipe's mean radius is determined as follows:

$$r = 0.5 * ((OD + ID) / 2)$$

where,

r = Pipe Mean Radius (inches)
OD = Outside Diameter of the Leachate Collection Pipe (inches)
ID = Inside Diameter of the Leachate Collection Pipe (inches)

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	BY: _____	BY: _____	
	DATE. _____	DATE. _____	

The potential horizontal deflection of the pipe is determined by the Modified Iowa formula:

$$X = (Dl * K * Wp * r^3) / ((Ep * I) + (0.061 * Es * r^3))$$

where,

X = Horizontal Deflection (inches)
Dl = Deflection Lag Factor (dimensionless, 1.25 to 1.50)
K = Pipe Bedding Constant (dimensionless, typically 0.1)
Wp = Modified Vertical Stress on the Pipe (lbs per inch of pipe length)
r = Pipe Mean Radius (inches)
Ep = PVC Pipe Modulus of Elasticity (lbs per square inch)
I = Pipe Wall Moment of Inertia (inches^4 per inch)
Es = Bedding Soil Modulus of Reaction (lbs per square inch)

The percentage of horizontal deflection is determined as follows:

$$X\% = X / (2 * r)$$

where,

X% = Percentage of Horizontal Deflection (percent)
X = Horizontal Deflection (inches)
r = Pipe Mean Radius (inches)

MATERIAL CHARACTERISTICS:

The leachate collection pipe/groundwater interceptor is 6 inch nominal diameter Schedule 80 PVC having an inside diameter of 5.761 inches and an outside diameter of 6.625 inches. Pipe wall thickness is therefore 0.432 inches. Pipe perforations are 0.375 inches in diameter and spaced in a double row with 6 inch spacing between perforations. The number of perforations per foot of pipe length is 4 each. The modulus of elasticity of PVC is 420,000 psi.

The maximum height of overburden over laying a leachate collection pipe or groundwater interceptor is 19 feet and occurs at the north center boundary of Site 9A adjacent to the groundwater collection sump. The average in-place density of the overburden is approximately 130 lbs per cubic foot (1.75 tons per cubic yard). The thicknesses of the aggregate bedding layer is insignificant compared to the thickness of the overburden and are ignored for the purposes of computation. Any portion of the proposed final cover system overlaying the pipe will be assumed to have the same density as the rest of the overburden.

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	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

The bedding soil adjacent to the pipe consists of highly compacted (as a result of the weight of the overburden) coarse-grained soils having a modulus of reaction of 3,000 lbs per square inch.

COMPUTATIONS:

The following table estimates the modified vertical stress on the pipe:

Table 1 - Modified Vertical Stress on the Leachate Collection Pipe

In Place Density of Overburden, Dw =	130.000 lbs / cf
(1.75 tons per cubic yard)	
Total Overburden Fill Depth, H =	19.000 feet
Outside Diameter of Pipe, OD =	6.625 inch
(6 inch SCH 80 PVC)	
Inside Diameter of Pipe, ID =	5.761 inch
(6 inch SCH 80 PVC)	
Pipe Wall Thickness, Tp =	0.432 inch
(OD - ID) / 2	
Mean Pipe Radius, r =	3.097 inch
(1/2) * ((OD + ID) / 2)	
Pipe Wall Moment of Inertis, I =	0.007 inch^4 / inch
(Tp^3 / 12)	
Vertical Stress on Pipe, W =	113.637 lbs / inch
(Dw * H * OD) * (1 / 144)	
Diameter of Perforations, D =	0.375 inch
Number of Perforations per Foot, N =	4.000 each
Modified Vertical Stress on Pipe, Wp =	129.871 lbs / inch
(W * 12) / (12 -(D * N))	

The following table estimates the maximum horizontal deflection of the pipe resulting from the Modified Iowa Formula:

7351 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6739 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY: _____	
	DATE: _____	DATE: _____	

Table 2 - Maximum Horizontal Deflection

Deflection Lag Factor, DI =	1.500
(1.25 to 1.50)	
Bedding Constant, K	0.100
Mean Pipe Radius, r =	3.097 inch
(from table above)	
Modulus of Soil Reaction, Es =	3,000.000 psi
(highly compacted, coarse grained soils)	
PVC Pipe Modulus of Elasticity, Ep =	420,000.000 psi
(Polyvinyl Chloride)	
Pipe Wall Moment of Inertia, I =	0.007 inch^4 / inch
(from table above)	
Modified Vertical Stress on Pipe, Wp =	129.871 lbs / inch
(from table above)	
Horizontal Deflection, X =	0.069 inch
(DI * K * Wp * r^3) / ((Ep * I) + (0.061 * Es * r^3))	
Percent Horizontal Deflection, X% =	1.12%
(X / (2 * r))	

CONCLUSIONS:

The estimated percent of horizontal deflection of 1.22% is significantly less than the 7% which provides a factor of safety against pipe failure of 4. The leachate collection pipes/groundwater interceptor pipes are stable under anticipated loadings.

PETRO
environmental
technologies

August 30, 2001

Mr. David Kline
Michigan Department of Environmental Quality
KNAPPS Office Center
P.O. Box 30426
Lansing, Michigan 48909-7926

Letter #018

RE: Remedial Action Plan
Macomb County Landfill Sites 9 and 9A
Revised Leachate and Groundwater Collection Pipe

Dear Mr. Kline,

Attached for your review is information concerning the 6" diameter, perforated ADS N-12 pipe Petro Environmental intends to use for its leachate and groundwater collection system at the Macomb County Landfill Sites 9 and 9A.

Given that pipe trenching in municipal solid waste in a potentially unsafe operation due to unstable excavation side walls and the accumulation of methane gas in the exposed trench, Petro Environmental has chosen a safer pipe product to be installed for the leachate and groundwater collection system. ADS pipe segments can be mechanically joined outside the trench and are flexible enough to allow the assembled pipeline to be lowered into the trench, without the need for workers to be in the trench and exposed to potentially dangerous conditions.

As far as performance characteristics, please note that the ADS pipe is stable against a loading three times greater than anticipated in the high-density polyethylene pipe RAP design calculations (60 feet of overburden vs. 19 feet). Also the ADS pipe has a flow capacity significantly greater than that estimated in the RAP design calculations (0.27 cfs at a flow gradient of 0.002 ft/ft vs. 0.07 cfs at a flow gradient of 0.003 ft/ft). In all performance aspects, ADS N-12 pipe exceeds the requirements of the RAP design calculations.

Please call us at (513) 489-6789 if you have any questions or comments. We are at your convenience and look forward to your response.

Respectfully yours,
Petro Environmental Technologies, Inc.

Daniel P. Duffy, PE

7851 Palace Drive • Cincinnati, Ohio 45249 • 513.489.6789 • Fax 489.7208
8200 Seville Road • Lodi, Ohio 44254 • 330.948.1494 • Fax 948.1933

Cc: Mark S. Mather
Mr. Ted Wahby (SMDA)
Mr. Roger Timm (Dykema-Gosset)
Mr. John Brennan (Macomb Township)
Mr. Lawrence Dloski (Seibert and Dloski)
Mr. David Lakin (Spalding-DeDecker Assoc.)
File

Attachments ADS N-12 Pipe Information Sheet
ADS N-12 Pipe Specifications
ADS Pipe Strength Calculations
ADS Pipe Flow Calculations

CONTACT ADS

Phone, Fax or E-mail Contact Us with product questions or comments about our new website.

SALES INFORMATION

Get ADS Sales/Pricing Information

RELATED INFORMATION

See related Pipe Technical Data

See more Pipe Products

Product-related questions? See our Product/Technical FAQs

N-12®Pipe

N-12 has built an impressive service record in storm water and other drainage applications where hydraulics are important and durability is critical.

It is designed for use under both H25 and E80 live loads, or with fill heights of 50 feet or more. In fact, field research shows the pipe performing well at depths exceeding 100 feet. With its superior abrasion and corrosion resistance, it has become an excellent alternative to concrete and metal pipe.

N-12's light weight leads to a number of job site economies: more pipe per delivery truck, easier handling, smaller crews, less heavy equipment, less pipe damage, and better safety. The pipe cuts easily and requires no beveling for joining.

N-12 Pipe Product Information	
Diameters Available:	4"-48"
Lengths Available:	20'
Joint Performance:	Soil-tight Water-tight
Joining System:	Bell and Spigot Split Coupler
Specifications:	Product Note 3.107
Applications:	Storm Sewers Sanitary Sewers Waste Management Highway

Back to top

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3300 Riverside Drive, Columbus OH 43221 Tel: 1-800-821-6710 Fax: 1-614-538-5204

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SEARCH

Ho
Pipe
N-12

"From n
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to save
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importe
gravel,

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Product Notes

Product Note 3.107

Re: Specification for Smooth Interior Corrugated Polyethylene Pipe

Date: November 2000

This specification applies to high density polyethylene corrugated pipe with an integrally formed smooth waterway. Nominal sizes for which this specification is acceptable are 100 – 1500 mm (4 - 60 inch) diameters. Sizes 100 – 1500 mm (4 - 60 inch) shall be either AASHTO Type 'S' or Type 'D' as follows. Sizes 100 – 1050 mm (4 - 42 inch) designated as AASHTO Type 'S' (N-12) shall have a full circular cross-section, with an outer corrugated pipe wall and an essentially smooth inner wall (waterway). Corrugations for Type 'S' sizes 100 – 1050 mm (4 - 42 inch) shall be annular (N-12). Sizes 1050 – 1500 mm (42 thru 60 inch) designated as AASHTO Type 'D' (N-12HC) shall consist of an essentially smooth waterway braced circumferentially with circular ribs which are formed simultaneously with an essentially smooth outer wall. The 1050 – 1500 mm (42 thru 60 inch) (N-12HC) sizes shall conform to AASHTO Type 'D' (which describes dual wall pipe with a smooth waterway).

Pipe manufactured for this specification shall comply with the requirements for test methods, dimensions and markings found in AASHTO Designations M252, M294 and MP7. Pipe and fittings shall be made from virgin PE compounds which conform with the applicable current edition of the AASHTO Material Specifications for cell classification as defined and described in ASTM D3350.

The minimum parallel plate stiffness values when tested in accordance with ASTM D2412 shall be as follows:

Diameter (nominal)	Pipe Stiffness (minimum)	Diameter (nominal)	Pipe Stiffness (minimum)
100 mm (4")	340 kN/m² (50 pii)	600 mm (24")	235 kN/m² (34 pii)
150 mm (6")	340 kN/m² (50 pii)	750 mm (30")	195 kN/m² (28 pii)
200 mm (8")	340 kN/m² (50 pii)	900 mm (36")	150 kN/m² (22 pii)
250 mm (10")	340 kN/m² (50 pii)	1050 mm (42")	140 kN/m² (20 pii)
300 mm (12")	345 kN/m² (50 pii)	1200 mm (48")	125 kN/m² (18 pii)
375 mm (15")	290 kN/m² (42 pii)	1500 mm (60")	95 kN/m² (14 pii)
450 mm (18")	275 kN/m² (40 pii)		

The fittings shall not reduce or impair the overall integrity or function of the pipeline. Fittings may be either molded or fabricated. Common corrugated fittings include in-line joint fittings, such as couplers and reducers, and branch or complementary assembly fittings such as tees, wyes and end caps. These fittings may be installed by various methods such as snap-on, bell and spigot, bell – bell and wrap around couplers. Couplers shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Only fittings supplied or recommended by the manufacturer shall be used. Where designated on the plans or project specifications, an elastomeric gasket meeting the requirements of ASTM F477 shall be supplied.

Installation of the pipe specified above shall be in accordance with either AASHTO Section 30 or ASTM Recommended Practice D2321 as described elsewhere in these specifications and as recommended by the manufacturer.

3300 RIVERSIDE DRIVE COLUMBUS, OH 43221 (614) 457-3051 http://www.ADS-pipe.com

ADS N-12 PRODUCT INFORMATION SHEET

NOMINAL DIAMETER	INSIDE DIAMETER, AVERAGE	OUTSIDE DIAMETER, AVERAGE	INNER LINER THICKNESS, MINIMUM	MINIMUM PIPE STIFFNESS @ 5% DEFLECTION	WEIGHT kg./6m (lbs./20 ft.)	AREA mm²/mm	"I" cm⁴/cm	"C" mm
100 mm (4")	104 mm (4.10")	120 mm (4.78")	0.5 mm (0.020")	340 kN/m² 50 psi	4.08 kg (9.00 lbs)	1.59 (0.063 in²/in)	0.010 (0.0006 in⁴/in)	3.06 (0.12 in)
150 mm (6")	154 mm (6.00")	183 mm (7.20")	0.5 mm (0.020")	340 kN/m² 50 psi	6.12 kg (13.50 lbs)	2.36 (0.093 in²/in)	0.032 (0.0020 in⁴/in)	4.57 (0.18 in)
200 mm (8")	200 mm (7.90")	233 mm (9.11")	0.6 mm (0.024")	340 kN/m² 50 psi	13.97 kg (30.80 lbs)	2.75 (0.108 in²/in)	0.078 (0.005 in⁴/in)	6.36 (0.25 in)
250 mm (10")	255 mm (9.90")	297 mm (11.66")	0.8 mm (0.031")	340 kN/m² 50 psi	20.41 kg (45.00 lbs)	3.14 (0.123 in²/in)	0.164 (0.010 in⁴/in)	7.62 (0.30 in)
300 mm (12")	308 mm (12.15")	367 mm (14.45")	0.9 mm (0.035")	345 kN/m² 50 psi	28.96 kg (63.80 lbs)	5.50 (0.217 in²/in)	0.574 (0.035 in⁴/in)	10.92 (0.43 in)
375 mm (15")	386 mm (15.20")	456 mm (17.95")	1.0 mm (0.039")	290 kN/m² 42 psi	42.06 kg (92.50 lbs)	6.65 (0.262 in²/in)	1.064 (0.064 in⁴/in)	13.97 (0.55 in)
450 mm (18")	459 mm (18.07")	536 mm (21.20")	1.3 mm (0.051")	275 kN/m² 40 psi	58.38 kg (128.60 lbs)	6.93 (0.273 in²/in)	1.327 (0.081 in⁴/in)	14.48 (0.57 in)
600 mm (24")	612 mm (24.08")	708 mm (27.80")	1.5 mm (0.059")	235 kN/m² 34 psi	95.93 kg (211.00 lbs)	8.26 (0.325 in²/in)	2.345 (0.141 in⁴/in)	16.76 (0.66 in)
750 mm (30")	762 mm (30.00")	892 mm (35.10")	1.5 mm (0.059")	195 kN/m² 28 psi	145.83 kg (321.50 lbs)	9.60 (0.378 in²/in)	4.539 (0.277 in⁴/in)	21.84 (0.86 in)
900 mm (36")	914 mm (36.00")	1059 mm (41.70")	2.0 mm (0.079")	150 kN/m² 22 psi	210.98 kg (465.00 lbs)	10.99 (0.433 in²/in)	7.855 (0.480 in⁴/in)	24.13 (0.95 in)
1050 mm (42") Type S	1054 mm (41.40")	1212 mm (47.70")	2.54 mm (0.100")	140 kN/m² 20 psi	239.77 kg (528.60 lbs)	11.64 (0.458 in²/in)	9.373 (0.572 in⁴/in)	30.73 (1.21 in)
1050 mm (42") Type D	1054 mm (41.40")	1212 mm (47.70")	1.8 mm (0.070")	140 kN/m² 20 psi	289.76 kg (638.80 lbs)	11.64 (0.458 in²/in)	9.373 (0.572 in⁴/in)	30.73 (1.21 in)
1200 mm (48") Type D	1208 mm (47.55")	1339 mm (52.70")	1.8 mm (0.070")	125 kN/m² 18 psi	309.72 kg (682.80 lbs)	14.76 (0.581 in²/in)	10.090 (0.616 in⁴/in)	33.02 (1.30 in)
1500 mm (60") Type D	1514 mm (59.60")	1664 mm (65.50")	2.0 mm (0.079")	110 kN/m² 16 psi	389.54 kg (858.80 lbs)	18.61 (0.732 in²/in)	15.306 (0.934 in⁴/in)	40.64 (1.60 in)

Date: November 2000

PIPE PARAMETERS - AASHTO M294, Type S

effective radius (in), R =3.25
outside diameter (in), D =6.92
thickness (in), t = 0.46
unit area of wall (in^2/in), A = 0.107
unit moment of inertia (in^4/in), I = 0.0036
flexural modulus (psi), E_f = 110,000
ring compression modulus (psi), E_{rc} = 110,000
flexural stiffness (psi), $K_f = 6E_fI/R^3$ = 69
ring compression stiffness (psi), $K_{rc} = E_{rc}A/R$ = 3,622
distance from inner wall to n.a. (in), c =0.25

SOIL PARAMETERS - good granular soil

mod of soil reaction at 5' of cover (psi), E_s' = 1600
modulus of soil reaction (psi), E' =3,364
Poisson's ratio, u = 0.30
constr mod (psi), M*=E*(1-u)/((1+u)(1-2u))=4527.97
lateral stress ratio = K = u/(1-u) =0.429
sym lateral stress ratio = B = (1/2)(1+K) =0.714
antisym lat stress ratio = C = (1/2)(1-K) =0.286

SOIL/STRUCTURE PARAMETERS (full slippage)

ring flexibility ratio, UF =(1+K)M*/K_c = 1.79
bending flexibility ratio, VF = (1-K)M*/K_f = 37.4

STRESS FUNCTION COEFFICIENTS

constant term, a_0* = 0.183
cos(2*theta), a_2** = 0.964
sin(2*theta), b_2** = 0.946

LOAD PARAMETERS

unit weight of soil (lb/ft^3) = 120
height of fill above crown (ft) = 60.0
surcharge pressure (psi), P =50.0

RESPONSE OF PIPE WALL

deg c.c.w. from horiz	radial soil press P_r(psi)	radial defl w(in)	tang defl v(in)	circum wall thrust N(#/in)	wall bend mom(M) (#-lb/in)	ring comp stress (psi)	inner bend stress (psi)	outer bend stress (psi)	total stress inner (psi)	total stress outer (psi)
0	27.6	-0.022	0.000	96	6	-901	-444	373	-1346	-528
10	27.7	-0.019	0.008	96	6	-900	-422	354	-1322	-546
20	28.0	-0.011	0.016	96	5	-898	-356	299	-1254	-598
30	28.4	0.002	0.021	96	4	-894	-256	215	-1150	-678
40	28.9	0.018	0.024	95	2	-889	-133	112	-1022	-776
50	29.4	0.035	0.024	94	0	-883	-3	2	-886	-881
60	29.9	0.050	0.021	94	-2	-878	120	-101	-758	-979
70	30.3	0.063	0.016	94	-3	-874	220	-185	-654	-1059
80	30.6	0.071	0.008	93	-4	-871	285	-240	-586	-1111
90	30.7	0.074	0.000	93	-4	-870	308	-259	-562	-1129
100	30.6	0.071	-0.008	93	-4	-871	285	-240	-586	-1111
110	30.3	0.063	-0.016	94	-3	-874	220	-185	-654	-1059
120	29.9	0.050	-0.021	94	-2	-878	120	-101	-758	-979
130	29.4	0.035	-0.024	94	0	-883	-3	2	-886	-881
140	28.9	0.018	-0.024	95	2	-889	-133	112	-1022	-776
150	28.4	0.002	-0.021	96	4	-894	-256	215	-1150	-678
160	28.0	-0.011	-0.016	96	5	-898	-356	299	-1254	-598
170	27.7	-0.019	-0.008	96	6	-900	-422	354	-1322	-546
180	27.6	-0.022	0.000	96	6	-901	-444	373	-1346	-528

CALCULATION OF RING SHORTENING

deg c.c.w. from horiz	ring comp stress (psi)	ring comp strain (in/in)	ring shortening (in)
0	-901	-0.008195	-0.0046
10	-900	-0.0082	-0.0046
20	-898	-0.008161	-0.0046
30	-894	-0.008124	-0.0046
40	-889	-0.008077	-0.0046
50	-883	-0.008028	-0.0046
60	-878	-0.007982	-0.0045
70	-874	-0.007944	-0.0045
80	-871	-0.00792	-0.0045
90	-870	-0.007911	-0.0045
100	-871	-0.00792	-0.0045
110	-874	-0.007944	-0.0045
120	-878	-0.007982	-0.0045
130	-883	-0.008028	-0.0046
140	-889	-0.008077	-0.0046
150	-894	-0.008124	-0.0046
160	-898	-0.008161	-0.0046
170	-900	-0.0082	-0.0046
180	-901	-0.008195	-0.0046
		SUM (I/2 circle) =	-0.0869

COMMENTS

1. *This is 6" diameter ADS N-12*
2. *Flexural and compressive modulus are taken as 110,000 psi.*
3. *Typical E'_5 values (in psi) for various soils are listed in the table below:*

Type of soil	Standard AASHTO Relative Compaction 85%	90%	95%
Fine-grained soils with less than 25% sand (CL, ML, DL-ML)	500	700	1000
Coarse-grained soils with fines (SM, SC)	600	1000	1200
Coarse-grained soils with little or no fines (SP, SW, GP, GW)	700	1000	1600

MISC CALCS

Vertical deflection (%) = 2.29
Horizontal deflection (%) = -1.35
Critical Buckling Pressure (psi), P_{cr}= 184.7
Radial Soil Pressure at Crown (psi), P_{scl}= 30.7
Arc length of each sector (in) = 0.5672

CIRCUMFERENCE SHORTENS= -0.17 inches

Max. Compressive Stress: -1345.9 OK (< -3000)
Max. Tensile Stress: -528.05 OK (< 1000)
Circumfence Shortening % (2% Max): -0.0079 OK

Calculations by: _____
Title

Table 3

CIRCULAR PIPE FLOW CAPACITY

Full Flow (cubic feet per second) *Conv. Factor = $(1.486 \times R^{2/3} \times A)/n$ (English)

Full Flow (cubic meters per second) *Conv. Factor = $(1.0 \times R^{2/3} \times A)/n$ (Metric)

Manning's "n" =		0.012																
Diameter		*Conv	(% Slope) ft/100ft, m/100m															
(in.)	(mm.)	Factor	0.02	0.05	0.10	0.20	0.35	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	5.00	10.00	20.00
4		2.04	0.0289	0.0457	0.0647	0.0914	0.1210	0.1446	0.1771	0.2045	0.2286	0.2504	0.2705	0.2892	0.3233	0.4572	0.6466	0.9144
	100	0.06	0.0008	0.0012	0.0017	0.0025	0.0033	0.0039	0.0048	0.0055	0.0062	0.0068	0.0073	0.0078	0.0087	0.0124	0.0175	0.0247
6		6.04	0.0854	0.1350	0.1909	0.2700	0.3571	0.4269	0.5228	0.6037	0.6749	0.7393	0.7986	0.8537	0.9545	1.3498	1.9090	2.6997
	150	0.16	0.0023	0.0036	0.0052	0.0073	0.0097	0.0115	0.0141	0.0163	0.0182	0.0200	0.0216	0.0231	0.0258	0.0365	0.0516	0.0730
8		13.01	0.1840	0.2910	0.4115	0.5820	0.7699	0.9202	1.1270	1.3013	1.4549	1.5938	1.7215	1.8403	2.0576	2.9098	4.1151	5.8197
	200	0.35	0.0050	0.0079	0.0111	0.0157	0.0208	0.0249	0.0305	0.0352	0.0393	0.0431	0.0465	0.0498	0.0556	0.0787	0.1112	0.1573
10		23.61	0.3339	0.5280	0.7467	1.0560	1.3969	1.6696	2.0449	2.3612	2.6399	2.8919	3.1236	3.3392	3.7334	5.2798	7.4668	10.5596
	250	0.64	0.0090	0.0143	0.0202	0.0285	0.0378	0.0451	0.0553	0.0638	0.0714	0.0782	0.0844	0.0903	0.1009	0.1427	0.2018	0.2855
12		38.42	0.5433	0.8591	1.2149	1.7182	2.2729	2.7166	3.3272	3.8419	4.2954	4.7054	5.0824	5.4333	6.0746	8.5908	12.1492	17.1815
	300	1.04	0.0147	0.0232	0.0328	0.0464	0.0614	0.0734	0.0899	0.1039	0.1161	0.1272	0.1374	0.1469	0.1642	0.2322	0.3284	0.4645
15		69.71	0.986	1.559	2.204	3.118	4.124	4.929	6.037	6.971	7.794	8.538	9.222	9.859	11.022	15.588	22.044	31.175
	375	1.88	0.027	0.042	0.060	0.084	0.111	0.133	0.163	0.188	0.211	0.231	0.249	0.267	0.298	0.421	0.596	0.843
18		113.43	1.604	2.536	3.587	5.073	6.710	8.020	9.823	11.343	12.681	13.892	15.005	16.041	17.934	25.363	35.868	50.725
	450	3.07	0.043	0.069	0.097	0.137	0.181	0.217	0.266	0.307	0.343	0.376	0.406	0.434	0.485	0.686	0.970	1.371
21		171.18	2.421	3.828	5.413	7.656	10.127	12.104	14.825	17.118	19.139	20.965	22.645	24.209	27.066	38.278	54.133	76.555
	530	4.75	0.067	0.106	0.150	0.212	0.281	0.336	0.411	0.475	0.531	0.581	0.628	0.671	0.750	1.061	1.501	2.123
24		244.51	3.458	5.467	7.732	10.935	14.465	17.289	21.175	24.451	27.337	29.946	32.346	34.579	38.660	54.674	77.321	109.348
	600	6.61	0.093	0.148	0.209	0.296	0.391	0.467	0.572	0.661	0.739	0.810	0.874	0.935	1.045	1.478	2.090	2.956
27		334.87	4.736	7.488	10.589	14.976	19.811	23.679	29.000	33.487	37.439	41.013	44.299	47.358	52.947	74.879	105.895	149.758
	680	9.23	0.131	0.206	0.292	0.413	0.546	0.653	0.800	0.923	1.032	1.131	1.221	1.306	1.460	2.064	2.920	4.129
30		443.66	6.27	9.92	14.03	19.84	26.25	31.37	38.42	44.37	49.60	54.34	58.69	62.74	70.15	99.20	140.30	198.41
	760	12.43	0.18	0.28	0.39	0.56	0.74	0.88	1.08	1.24	1.39	1.52	1.64	1.76	1.96	2.78	3.93	5.56
36		721.87	10.21	16.14	22.83	32.28	42.71	51.04	62.52	72.19	80.71	88.41	95.49	102.09	114.14	161.42	228.28	322.83
	900	19.51	0.28	0.44	0.62	0.87	1.15	1.38	1.69	1.95	2.18	2.39	2.58	2.76	3.09	4.36	6.17	8.73
42		1089.45	15.41	24.36	34.45	48.72	64.45	77.04	94.35	108.95	121.80	133.43	144.12	154.07	172.26	243.61	344.52	487.22
	1050	29.45	0.42	0.66	0.93	1.32	1.74	2.08	2.55	2.95	3.29	3.61	3.90	4.17	4.66	6.59	9.31	13.17
48		1556.14	22.01	34.80	49.21	69.59	92.06	110.04	134.77	155.61	173.98	190.59	205.86	220.07	246.05	347.96	492.09	695.92
	1200	42.07	0.59	0.94	1.33	1.88	2.49	2.97	3.64	4.21	4.70	5.15	5.56	5.95	6.65	9.41	13.30	18.81
60		2823.56	39.93	63.14	89.29	126.27	167.04	199.66	244.53	282.36	315.68	345.81	373.52	399.31	446.44	631.37	892.89	1262.73
	1500	76.33	1.08	1.71	2.41	3.41	4.52	5.40	6.61	7.63	8.53	9.35	10.10	10.79	12.07	17.07	24.14	34.14

Attachment VI
Cut and Fill Volumes

PETRO ENVIRONMENTAL TECHNOLOGIES

ENGINEERING COMPUTATION SHEET

SHEET _____ OF _____

7351 Palace Drive, Cincinnati, Ohio 45249 Phone (513)489-6789 Fax (513)489-7208

PROJECT / PROPOSAL NAME	PREPARED	CHECKED	PROJECT / PROPOSAL NUMBER
	BY: _____	BY _____	
	DATE: _____	DATE: _____	

SUBJECT:

Volumes Estimates for the Regrading the Final Covers of Sites 9 and 9A.

PURPOSE AND OBJECTIVE:

The following computations were preformed to estimate the amount of cut and fill required to reconfigure the existing landfill cover to the thickness, grades and elevations described in the proposed site design.

DESIGN ASSUMPTIONS AND CONDITIONS:

1. The final cover is constructed in conformance with the design grades and elevations.
2. There is no significant swell factor experienced when excavating the existing final cover for reuse, and there is no significant compaction in-place of the proposed final cover.

METHODOLOGY:

The cut and fill volume computations were preformed using Terramodel Release 9.6 by Spectra Precision.

MATERIAL CHARACTERISTICS:

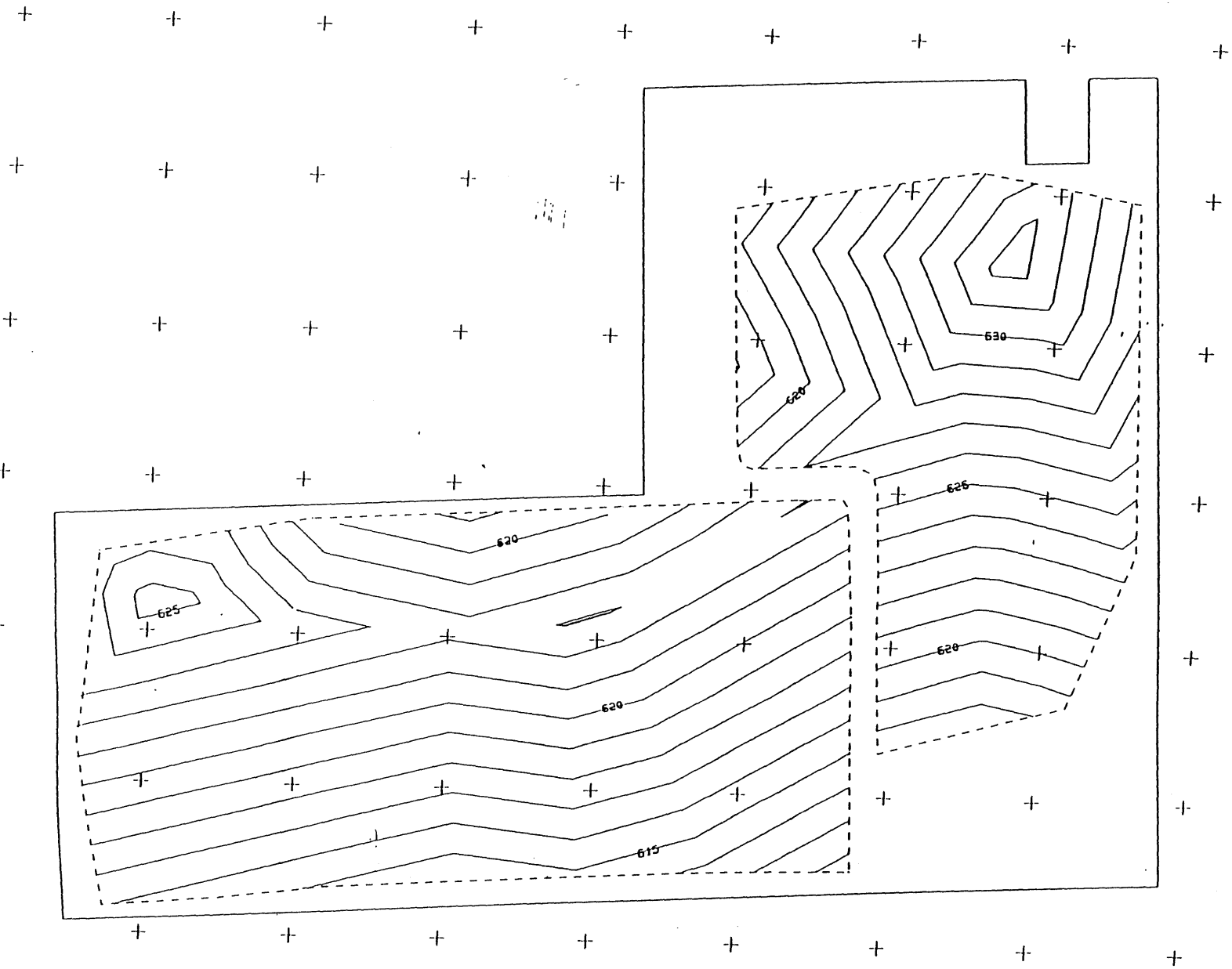
Existing cover soils, as far as possible, will be excavated and reused for the proposed final cover.

COMPUTATIONS:

Refer to attached printouts.

CONCLUSIONS:

To reconfigure the final cover of Site 9 will require approximately 37,000 cubic yards of cut and 33,000 cubic yards of fill. Site 9A will require approximately 48,000 cubic yards of cut and 51,000 cubic yards of fill. Over all the proposed final grades provide a balance between cut and fill.


630
620
625
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615

Spectra Precision Software, Inc.
5901 Peachtree-Dunwoody Rd., Suite A-300
Atlanta, GA 30328-5548
800-235-4972
Wed Aug 30 15:21:29 2000

PROJECT: F:\CHRONO\DPD\Macomb\Design\macomb.proposed.pro

DTM TO DTM VOLUME

Cut and Fill Volumes

Volume limited to boundary record 794
Area within boundary: 1911648.353 SQ FT
Total triangulated area: 1789832.245 SQ FT

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
Z-EXISTING	20,926	Z-PROP	224

Cut Volume (yd3)	Cumulative Cut Volume	Fill Volume (yd3)	Cumulative Fill Volume
37,202.8	37,202.8	33,361.6	33,361.6

Net Difference: 3841.2 yd3 WASTE
Cumulative Net Difference: 3841.2 yd3 WASTE

Spectra Precision Software, Inc.
5901 Peachtree-Dunwoody Rd., Suite A-300
Atlanta, GA 30328-5548
800-235-4972
Wed Aug 30 15:20:26 2000

PROJECT: F:\CHRONO\DPD\Macomb\Design\macomb.proposed.pro

DTM TO DTM VOLUME

Cut and Fill Volumes

Volume limited to boundary record 793
Area within boundary: 3094031.346 SQ FT
Total triangulated area: 2879512.704 SQ FT

Shrinkage/swell factors: Cut 1.0000 Fill 1.0000

Original DTM Layer Name	# of Points	Final DTM Layer Name	# of Points
Z-EXISTING	20,926	Z-PROP	224

Cut Volume (yd3)	Cumulative Cut Volume	Fill Volume (yd3)	Cumulative Fill Volume
47,761.1	47,761.1	50,853.4	50,853.4

Net Difference: 3092.3 yd3 BORROW
Cumulative Net Difference: 3092.3 yd3 BORROW

Attachment VII
The Schedule

THE SCHEDULE

* Major submission/milestones of the schedule where stipulated penalties will apply for failure to meet the schedule, pursuant to Paragraph 5.6, Paragraph 12.2 and Section XVIII of the consent decree of July 11, 2001.

SUBMISSION/MILESTONE	DUE DATE
* Implement Remedial Action Plan	Thirty (30) days from entry of Consent Decree
Leachate and Groundwater Management Plan	March 31, 2002
Landfill Gas Vent and Probe Installation Plan	March 31, 2002
* QAPP/Field Sampling Plan	March 31, 2002
* Start Groundwater Sampling Program	March 31, 2002
Propose Locations of Background Wells	December 30, 2001
Install Background Wells	Within 3 months of MDEQ approval of background well locations
Install Six Transducers	Within sixty (60) days of MDEQ approval
* Additional Design Plans for Treatment and/or Disposal Systems	Prior to starting construction of these elements
* Provision of Mitigation Measures for any Aesthetically Impacted Residential Wells	March 31, 2002/ or within forty-five (45) days of discovery for any wells impacted after March 31, 2002.
Monitoring Well Installation Plan	March 31, 2002
Piezometer Installation Plan	March 31, 2002
*Complete Installation of Piezometers and Monitoring Wells	July 9, 2002
* Startup of Leachate and Collection Systems	September 7, 2002
* Record Restrictive Covenants	Twenty-one (21) days after completion of construction of the initial leachate collection/treatment system

SUBMISSION/MILESTONE	DUE DATE
* Complete Cap Improvements (Including Permanent Marker Installation)	October 15, 2002
* Complete Gas Vent Installation	November 26, 2002
Initial Well Abandonment Plan	December 30, 2002
Submit Background Data	October 15, 2003
Extraction Well Design Plan	May 31, 2003
* Start Pumping Groundwater Extraction Wells	Within 15 Months After Startup of the Leachate Collection System
* Demonstrate "Capture" of Contaminant Plumes	Four (4) years from start date of leachate collection
* Operation and Maintenance Plan Updates	Every 5 years and upon completion of design, construction and significant modifications
Final Well Abandonment Plan	Sixty (60) days after completion of long-term monitoring

Appendix A
Site Specific Health and Safety Plan

SITE-SPECIFIC HEALTH AND SAFETY PLAN

for

REMEDIAL ACTION PLAN
SOUTH MACOMB DISPOSAL AUTHORITY
LANDFILLS 9 AND 9A

Submitted by:

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 Palace Drive
Cincinnati, Ohio 45249
(513) 489-6789

January 2002

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Attachment II - ..... Respirator Program

1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been prepared for remediation of the Macomb County Landfill. The project involves remediation of the landfill and associated activities in which personnel are not expected to come in contact with potentially hazardous materials. Major work items include the following activities:

i) Installation of a groundwater interceptor and sumps
ii) Construction of leachate collectors and sumps;
iii) Construction of gas vents;
iv) Construction of leachate management system
v) Clearing and grubbing
vi) Regrading of final cover
vii) Construction of the final cover soil layer and seeding, mulching and fertilizing.

This HASP is designed to ensure:

i) That personnel working on Site are not exposed to hazardous materials which could adversely affect their health and safety;
ii) That the health and safety of the general public and the environment is not compromised by on-Site activities; and
iii) Compliance with applicable governmental and non-governmental (American Conference of Governmental Industrial Hygienists (ACGIH) regulations and guidelines.

All site operations will be conducted in accordance with the provisions of the HASP.

2.0 BASIS

The Occupational Safety and Health Administration (OSHA) Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926) will provide the basis for this HASP. The plan also reflects the position of the United States Environmental Protection Agency (USEPA) and National Institute for Occupational Safety and Health (NIOSH) regarding procedures required to ensure safe operations at sites containing hazardous or toxic materials.

3.0 SITE CHARACTERIZATION

The Macomb County landfill consists of two sites, 9 and 9A. Site 9 is approximately 43 acres and contains approximately 680,000 cubic yards of waste. Site 9A is approximately 71 acres and contains approximately 1,200,000 cubic yards of waste. Both sites are closed.

Implementation of work activities at the Macomb County Landfill are not expected to expose workers to chemical health and safety hazards as the Macomb County Landfill has been classified as a Type II municipal solid waste landfill and the landfill has been covered with a clean soil barrier layer. A physical hazard analysis for construction activities is presented in Table 1.2.

Table 1.1

IDENTIFIED CONTAMINANTS
MACOMB COUNTY LANDFILL
MACOMB COUNTY, MICHIGAN

(See attached spreadsheet summarizing groundwater and leachate sampling results performed at the site)

WELLS LOCATED WITHIN THE LANDFILL

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
Sump #1	108	SM-MW-108	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	108	SM-MW-108S	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	110	SW-MW-110S	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	110	SM-MW-110	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	205	SM-MW-205	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	205	SM-MW-205 DUP	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	218	SM-MW-218	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	403	SM-MW-403	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	529	529-2-1	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	529	529-2-2	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	529	529-3-1	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	530	SM-MW-530-2-1	2/29/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	530	SM-MW-530-2-2	2/29/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	530	SM-MW-530-2-3	2/29/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	530	SM-MW-530-3-1	2/29/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	548	SM-MW-548	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	554	SM-MW-554	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	556	SM-MW-556-23	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	558	558-22	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	563	SM-MW-563	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	565	SM-MW-565	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	565	SM-MW-565-23	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	567	SM-MW-567-50	3/4/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	567	SM-MW-567-8	3/4/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	571	SM-MW-571-68	3/1/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	575	SM-MW-575	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	578	SM-MW-578-26	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	578	SM-MW-578-26 DUP	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	578	SM-MW-578-36	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	578	SM-MW-578-68	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	578	SM-MW-578-70	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	579	SM-MW-579-21	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	579	SM-MW-579-62	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	219	219	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	558	558	3/5/96	Dragun	Monitoring			0.0000	0.0000
Sump #1	8832	8832	3/5/96	Dragun	Monitoring			0.0000	0.0000

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
SM-MW-108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-108S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SW-MW-110S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-218	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-403	0.0000	0.0000	0.0000	0.0054	0.0000	0.0000	0.0000	0.0000
529-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-548	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-554	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-556-23	0.0000	0.0000	0.0000	0.0000	39.0000	0.6600	0.0000	10.0000
558-22	0.0000	0.0000	0.0000	0.0054	12.0000	0.4800	0.1100	1.0000
SM-MW-563	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-565	0.0000	0.0000	0.0000	0.0110	21.0000	0.5300	0.1300	9.0000
SM-MW-565-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-567-50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-567-8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-571-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-26 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-36	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-7D	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-579-21	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-579-62	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
219	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
558	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8832	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
SM-MW-108	0.0100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-108S	0.0140	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SW-MW-110S	0.0042	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-218	0.0064	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-403	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-2	0.0130	0.0000	0.0000	0.0000	0.0023	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-548	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-554	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-556-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
558-22	0.0170	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-563	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-565	0.0210	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-565-23	0.0000	0.0000	0.0000	0.0000	0.0089	0.0000	0.0000	0.0000	0.0000
SM-MW-567-50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-567-8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-571-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-26	0.0097	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-26 DUP	0.0095	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-36	0.0042	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-70	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-579-21	0.0100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.0000
SM-MW-579-62	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
219	0.0010	0.0000	0.0000	0.0000	0.0058	0.0000	0.0140	0.0000	0.0000
558	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8832	0.0000	0.0000	0.0000	0.0000	0.0220	0.0000	0.0000	0.0000	0.0000

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochlorormethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
SM-MW-108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-108S	0.0000	0.0000	0.0000	0.0043	0.0000	0.0000	0.0000	0.0000
SW-MW-110S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-205 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000
SM-MW-218	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-403	0.0000	0.0000	0.0000	0.0200	0.0000	0.0000	0.0000	0.1800
529-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
529-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-2	0.0000	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	0.0000
SM-MW-530-2-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-530-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-548	0.0000	0.0000	0.0000	0.0100	0.0000	0.0000	0.0000	0.0000
SM-MW-554	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-556-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6200
558-22	0.0000	0.0000	0.0000	0.0040	0.3400	0.0000	0.0000	5.8000
SM-MW-563	0.0000	0.0000	0.0000	0.0250	0.0000	0.0000	0.0000	0.0000
SM-MW-565	0.0000	0.0000	0.0000	0.0250	1.3000	0.0000	0.0000	0.3000
SM-MW-565-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-567-50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-567-8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-571-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0014
SM-MW-578-26 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013
SM-MW-578-36	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-578-7D	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-579-21	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-579-62	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
219	0.0000	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000
558	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
8832	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichloroethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
SM-MW-108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0023
SM-MW-108S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0018
SW-MW-110S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1100	0.0022
SM-MW-110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1000	0.0026
SM-MW-205	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000
SM-MW-205 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2100	0.0014
SM-MW-218	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000
SM-MW-403	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.2000	0.0039
529-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0049
529-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0027
529-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0900	1.0000
SM-MW-530-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0022
SM-MW-530-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0161	50.0000	0.0029
SM-MW-530-2-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0010
SM-MW-530-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0016
SM-MW-548	0.0000	0.0000	0.0000	0.0000	0.0000	0.0170	0.1300	0.0014
SM-MW-554	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.4400	0.0016
SM-MW-556-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.1000	0.0011
558-22	0.0000	0.0000	0.0000	0.0000	0.0000	0.0120	50.0000	0.0070
SM-MW-563	0.0000	0.0000	0.0000	0.0000	0.0000	0.0440	0.2900	0.0034
SM-MW-565	0.0000	0.0450	0.1200	0.0000	0.0000	0.0400	1.6000	0.0020
SM-MW-565-23	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.8000	0.0010
SM-MW-567-50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0016
SM-MW-567-8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0019
SM-MW-571-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1600	0.0046
SM-MW-575	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0600	0.0013
SM-MW-578-26	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0600	1.0000
SM-MW-578-26 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0020
SM-MW-578-36	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1480	1.0000
SM-MW-578-68	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1100	1.0000
SM-MW-578-70	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000
SM-MW-579-21	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1800	0.0024
SM-MW-579-62	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0031
219	0.0000	0.0000	0.0000	0.0000	0.0000	0.0096	50.0000	0.0060
558	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0019
8832	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0064

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
SM-MW-108			0.0004	0.0048	20.0000	50.0000	0.0990		0.6900	124.0000		12.7000
SM-MW-108S			0.2000	0.0035	20.0000	50.0000	0.0700		0.4300	236.0000		32.5000
SW-MW-110S	0.0860		0.0003	0.0030	20.0000	50.0000	0.0830		0.3800	105.0000		13.0000
SM-MW-110	0.0290		0.0012	0.0110	20.0000	0.0560	0.1700		1.0660	20.1000		2.3700
SM-MW-205	1.0000		0.0003	0.0016	20.0000	50.0000	50.0000		0.1300	0.0231		100.0000
SM-MW-205 DUP			0.2000	1.0000	20.0000	50.0000	50.0000		0.1280	22.6000		100.0000
SM-MW-218	0.2400		0.2000	0.0029	20.0000	50.0000	0.0770		0.7800	84.6000		10.0000
SM-MW-403			0.0160	0.0420	44.0000	0.3900	0.1700		0.5600	91.8000		27.0000
529-2-1	0.0018		0.2000	0.0037	20.0000	50.0000	50.0000		0.5500	125.0000		8.9000
529-2-2	0.0015		0.2000	0.0068	20.0000	50.0000	50.0000		1.0270	105.0000		5.5300
529-3-1	0.0018		0.0002	1.0000	20.0000	50.0000	50.0000		0.0570	23.0000		0.1220
SM-MW-530-2-1	0.0036		0.3000	1.0000	20.0000	50.0000	50.0000		0.0025	160.0000		1.6000
SM-MW-530-2-2	0.1300		0.2000	0.0044	20.0000	50.0000	50.0000		0.2000	157.0000		23.2000
SM-MW-530-2-3			0.2000		20.0000	50.0000	50.0000		2.1000	211.0000		13.0000
SM-MW-530-3-1			0.2000	1.0000	20.0000	50.0000	50.0000		0.0024	9.6000		100.0000
SM-MW-548	0.1100		0.2000	0.0038	20.0000	50.0000	50.0000		1.6000	106.0000		37.0000
SM-MW-554	0.0094		0.2000	1.0000	20.0000	50.0000	50.0000		0.0670	33.7000		0.6000
SM-MW-556-23	5.0000		1.0000	0.0020	20.0000	50.0000	50.0000		0.7200	1,750.0000		666.0000
558-22	0.0100		0.0004	0.0078	20.0000	50.0000	50.0000		0.1400	448.0000		67.0000
SM-MW-563			0.0010	0.0075	20.0000	0.1300	0.1000		0.2400	111.0000		66.0000
SM-MW-565	5.0000		0.0002	0.0066	20.0000	50.0000	50.0000		2.3000	2,250.0000		1,014.0000
SM-MW-565-23	0.0180		0.2000	0.0015	20.0000	50.0000	50.0000		0.3000	153.0000		7.4000
SM-MW-567-50			0.2000	0.0024	20.0000	50.0000	50.0000		0.3800	131.0000		4.1000
SM-MW-567-8	0.0800		1.0000	0.0057	20.0000	50.0000	50.0000		0.6100	167.0000		15.0000
SM-MW-571-68			0.2000	1.0000	20.0000	50.0000	50.0000		0.0170	42.7000		100.0000
SM-MW-575			0.2000	1.0000	20.0000	50.0000	50.0000		0.0960	95.0000		3.1000
SM-MW-578-26	0.2500		0.2000	0.0030	20.0000	50.0000	0.0700		0.3250	125.0000		23.4000
SM-MW-578-26 DUP	0.2400		0.2000	0.0028	20.0000	50.0000	0.0690		0.3150	125.0000		22.6000
SM-MW-578-36	0.2000		0.2000	0.0032	20.0000	50.0000	0.0670		1.0860	102.0000		9.2000
SM-MW-578-68			0.2000	1.0000	20.0000	50.0000	50.0000		0.1150	89.8000		1.0600
SM-MW-578-7D	0.3100		0.2000	0.0037	20.0000	50.0000	0.1200		1.7400	129.0000		8.1600
SM-MW-579-21	0.1500		0.2000	0.0030	20.0000	50.0000	50.0000		0.1800	121.0000		26.2000
SM-MW-579-62			0.2000	1.0000	20.0000	50.0000	50.0000		0.0560	25.7000		100.0000
219	0.0018		0.2000	0.0019	20.0000	50.0000	50.0000		0.2300	129.0000		3.9000
558	0.0080		0.2000	1.0000	20.0000	50.0000	50.0000		0.0660	26.4000		100.0000
8832	1.0000		0.2000	1.0000	20.0000	50.0000	50.0000		0.2520	86.9000		0.6500

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
SM-MW-108	152.0000	0.0240	199.0000	334.0000		0.3400			
SM-MW-108S	57.0000	0.4500	70.0000	118.0000		0.3000			
SW-MW-110S	112.0000	0.2900	222.0000	238.0000		0.4200			
SM-MW-110	174.0000	20.0000	670.0000	520.0000		0.8300			
SM-MW-205	2.8000	20.0000	44.6000	138.0000		50.0000			
SM-MW-205 DUP	2.8000	20.0000	41.0000	144.0000		50.0000			
SM-MW-218	87.0000	0.0280	121.0000	163.0000		50.0000			
SM-MW-403	143.0000	0.1900	820.0000	373.0000		1.6000			
529-2-1	116.0000	0.0360	172.0000	118.0000		50.0000			
529-2-2	193.0000	20.0000	317.0000	198.0000		50.0000			
529-3-1	12.0000	20.0000	16.5000	12.2000		50.0000			
SM-MW-530-2-1	23.3000	1.7280	1.1200	2.9000		50.0000			
SM-MW-530-2-2	53.0000	0.0560	128.0000	58.3000		50.0000			
SM-MW-530-2-3	210.0000	0.0270	59.0000	652.0000		50.0000			
SM-MW-530-3-1	8.0000	20.0000	10.3000	19.2000		50.0000			
SM-MW-548	111.0000	0.2500	156.0000	150.0000		50.0000			
SM-MW-554	17.5000	0.0350	5.0000	68.0000		50.0000			
SM-MW-556-23	400.0000	11.3000	710.0000	504.0000		0.1100			
558-22	184.0000	0.3370	35.4000	186.0000		50.0000			
SM-MW-563	187.0000	0.1400	174.0000	538.0000		0.1400			
SM-MW-565	450.0000	8.9000	307.0000	6,437.0000		0.3600			
SM-MW-565-23	90.0000	0.1500	3.4400	23.8000		50.0000			
SM-MW-567-50	72.0000	0.0500	4.9000	105.0000		0.0700			
SM-MW-567-8	152.0000	0.1800	75.0000	546.0000		50.0000			
SM-MW-571-68	1,000.0000	20.0000	5.1000	34.3000		50.0000			
SM-MW-575	31.1000	1.4000	54.0000	66.1000		50.0000			
SM-MW-578-26	53.0000	0.0620	134.0000	49.9000		0.0780			
SM-MW-578-26 DUP	50.0000	0.0600	134.0000	48.8000		50.0000			
SM-MW-578-36	82.0000	0.0970	192.0000	110.0000		50.0000			
SM-MW-578-68	33.6000	0.0740	3.1200	26.9000		50.0000			
SM-MW-578-7D	165.0000	0.0220	187.0000	306.0000		0.6700			
SM-MW-579-21	55.0000	0.0650	123.0000	47.7000		50.0000			
SM-MW-579-62	10.3000	0.0280	6.4000	30.8000		50.0000			
219	79.0000	0.0770	80.0000	71.4000		50.0000			
558	11.7000	0.0280	3.7400	44.6000		50.0000			
8832	37.8000	0.0710	10.9000	32.6000		0.8930			

POTENTIALLY IMPACTED WELLS (NORTH AND WEST OF THE LANDFILLS)

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
Sump #2 & #3	3	MW-3.1	7/25/83	CH2M-Hill	Monitoring				
Sump #2 & #3	3	MW-3.2	9/21/83	CH2M-Hill	Monitoring				
Sump #2 & #3	3	MW-3.3	3/30/84	CH2M-Hill	Monitoring		7.1		
Sump #2 & #3	3	MW-3.4	3/20/86	CH2M-Hill	Monitoring		7.6		
Sump #2 & #3	3	MW-3.5	6/16/86	CH2M-Hill	Monitoring		7.3		
Sump #2 & #3	3	MW-3.6	3/3/87	CH2M-Hill	Monitoring		7.7		
Sump #2 & #3	3	MW-3.7	3/3/87	CH2M-Hill	Monitoring		8.0		
Sump #2 & #3	3	BK-MW-3	2/3/00	CRA	Background			0.0000	0.0000
Sump #2 & #3	6	MW-6.1	7/25/83	CH2M-Hill	Monitoring				
Sump #2 & #3	6	MW-6.2	9/21/83	CH2M-Hill	Monitoring				
Sump #2 & #3	6	MW-6.3	3/30/84	CH2M-Hill	Monitoring		7.7		
Sump #2 & #3	6	MW-6.4	3/20/86	CH2M-Hill	Monitoring		7.3		
Sump #2 & #3	6	MW-6.5	6/16/86	CH2M-Hill	Monitoring		6.8		
Sump #2 & #3	6	MW-6.6	3/3/87	CH2M-Hill	Monitoring		7.2		
Sump #2 & #3	6	MW-6.7	3/3/87	CH2M-Hill	Monitoring		7.1		
Sump #2 & #3	8	MW-8.1	7/25/83	CH2M-Hill	Monitoring				
Sump #2 & #3	8	MW-8.2	9/21/83	CH2M-Hill	Monitoring				
Sump #2 & #3	8	MW-8.3	3/30/84	CH2M-Hill	Monitoring		7.0		
Sump #2 & #3	8	MW-8.4	3/20/86	CH2M-Hill	Monitoring		6.7		
Sump #2 & #3	8	MW-8.5	6/16/86	CH2M-Hill	Monitoring		6.6		
Sump #2 & #3	8	MW-8.6	3/3/87	CH2M-Hill	Monitoring		6.7		
Sump #2 & #3	8	MW-8.7	3/3/87	CH2M-Hill	Monitoring		6.8		
Sump #2 & #3	9	MW-9.1	7/25/83	CH2M-Hill	Monitoring				
Sump #2 & #3	9	MW-9.2	9/21/83	CH2M-Hill	Monitoring				
Sump #2 & #3	9	MW-9.3	3/30/84	CH2M-Hill	Monitoring		6.6		
Sump #2 & #3	9	MW-9.4	3/20/86	CH2M-Hill	Monitoring		6.4		
Sump #2 & #3	9	MW-9.5	6/16/86	CH2M-Hill	Monitoring		6.3		
Sump #2 & #3	9	MW-9.6	3/3/87	CH2M-Hill	Monitoring		6.7		
Sump #2 & #3	9	MW-9.7	3/3/87	CH2M-Hill	Monitoring		6.5		
Sump #2 & #3	103	SM-MW-103	3/1/96	Dragun	Monitoring			0.0000	0.0000
Sump #2 & #3	104	SM-MW-104	3/6/96	Dragun	Monitoring			0.0000	0.0000
Sump #2 & #3	9705	9705.1	10/18/99	CRA	VAS	27		0.0000	0.0000
Sump #2 & #3	9705	9705.2	10/18/99	CRA	VAS	22		0.0000	0.0000
Sump #2 & #3	9705	9705.3	10/18/99	CRA	VAS	17		0.0000	0.0000
Sump #2 & #3	9705	9705.4	10/18/99	CRA	VAS	12		0.0000	0.0000
Sump #2 & #3	9705	MW9705	1/7/00	CRA	Monitoring			0.0000	0.0000

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
MW-3.1		0.0200						
MW-3.2		0.0210						
MW-3.3		0.0180	0.0250					
MW-3.4								
MW-3.5		0.0150	0.0033					
MW-3.6		0.0000	0.0000					
MW-3.7			0.0018					
BK-MW-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.1								
MW-6.2								
MW-6.3								
MW-6.4								
MW-6.5								
MW-6.6								
MW-6.7								
MW-8.1								
MW-8.2								
MW-8.3								
MW-8.4								
MW-8.5								
MW-8.6								
MW-8.7								
MW-9.1								
MW-9.2								
MW-9.3								
MW-9.4								
MW-9.5								
MW-9.6								
MW-9.7								
SM-MW-103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
MW-3.1									
MW-3.2	0.0100								
MW-3.3	0.0000								
MW-3.4									
MW-3.5	0.0000								
MW-3.6	0.0050								
MW-3.7	0.0066								
BK-MW-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.1									
MW-6.2									
MW-6.3	0.0000						0.0000		
MW-6.4	0.0000						0.0000		
MW-6.5	0.0000						0.0000		
MW-6.6	0.0000						0.0260		
MW-6.7									
MW-8.1									
MW-8.2									
MW-8.3									
MW-8.4	0.0040								
MW-8.5									
MW-8.6									
MW-8.7									
MW-9.1							0.0500		
MW-9.2	0.0100		0.0000				0.0330		
MW-9.3	0.0075		0.0000				0.0000		
MW-9.4	0.0060		0.0000				0.0380		
MW-9.5	0.0000		0.0057				0.0290		
MW-9.6	0.0000		0.0000			0.0000	0.0000		
MW-9.7	0.0070		0.0000			0.0000	0.0350		
SM-MW-103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0260	0.0000	0.0000
9705.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochlorormethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
MW-3.1						0.0000	0.0000	
MW-3.2					0.0000	0.0000	0.0000	0.0000
MW-3.3					0.1300	0.0000	0.0000	0.0000
MW-3.4						0.0000	0.0000	
MW-3.5					0.0000	0.0000	0.0000	0.0160
MW-3.6						0.0000	0.0000	0.0000
MW-3.7						0.0000	0.0000	
BK-MW-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.1					0.0000	0.0000	0.0000	0.0000
MW-6.2					0.0000	0.0000	0.0000	0.0000
MW-6.3				0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.4				0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.5				0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.6				0.0430	0.0000	0.0000	0.0000	0.0000
MW-6.7					0.0000	0.0000	0.0000	0.0000
MW-8.1	0.0500							
MW-8.2								
MW-8.3								
MW-8.4								
MW-8.5								
MW-8.6	0.0000							
MW-8.7								
MW-9.1	0.0500							
MW-9.2	0.0000				0.0380			0.0190
MW-9.3					0.0800			0.0000
MW-9.4	0.0000				0.0530			0.0000
MW-9.5					0.0530			0.0000
MW-9.6	0.0000				0.0000			0.0000
MW-9.7					0.0070			
SM-MW-103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-104	0.0000	0.0000	0.0000	0.0270	0.0000	0.0000	0.0000	0.0000
9705.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9705.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichloroethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
MW-3.1	0.0000	0.0000		0.0000	0.0000	0.0000		
MW-3.2	0.0000	0.0000	0.0330	0.0000	0.0000	0.0000		
MW-3.3	0.0000	0.0000		0.0000	0.0000	0.0000		
MW-3.4	0.0000	0.0000		0.0000	0.0000	0.0000		
MW-3.5	0.0000	0.0000		0.0000	0.0000	0.0000		
MW-3.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-3.7	0.0000	0.0000		0.0000	0.0000	0.0000		
BK-MW-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-6.1	0.0000	0.0000	0.0000	0.0000	0.0000			
MW-6.2	0.0000	0.0000	0.0000	0.0000	0.0000			
MW-6.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-6.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-6.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-6.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0040		
MW-6.7	0.0000	0.0000	0.0000	0.0000	0.0000			
MW-8.1								
MW-8.2								
MW-8.3								
MW-8.4								
MW-8.5								
MW-8.6								
MW-8.7								
MW-9.1								
MW-9.2						0.0250		
MW-9.3						0.1100		
MW-9.4						0.0770		
MW-9.5						0.0730		
MW-9.6								
MW-9.7						0.1000		
SM-MW-103	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0037
SM-MW-104	0.0000	0.0000	0.0000	0.0000	0.0000	0.0440	0.1200	0.0016
9705.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9705.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9705.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9705.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0179

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
MW-3.1	0.0050		0.0200	0.0500	0.0300	0.0500	0.0200					17.0000
MW-3.2	0.0070											27.0000
MW-3.3	0.0005	0.0200	0.0200	0.0500	0.0200	0.0500	0.0500		1.8900	353.0000	0.0200	5.8000
MW-3.4			0.0200		0.0200	0.0500	0.0500			66.2000		0.1000
MW-3.5			0.0200	0.0500	0.0200	0.0500	0.0500			54.4000		0.1000
MW-3.6	0.0270		0.0200	0.0200		0.1900	0.0300			54.0000		3.6000
MW-3.7			0.0080	0.0200	0.0080	0.0200	0.0200			65.7000	0.0200	0.0480
BK-MW-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9060	114.0000	0.0000	0.8760
MW-6.1	0.0090		0.0100	0.0300	0.0500	0.0500	0.0200					21.0000
MW-6.2	0.0060											13.0000
MW-6.3	0.0005	0.0300	0.0200	0.0500	0.0200	0.0500	0.0500		1.0000	18.2000	0.0500	0.1000
MW-6.4			0.0200	0.0500	0.0200	0.0500	0.0500			12.3000		0.1000
MW-6.5			0.0200	0.0500	0.0200	0.0500	0.0500			21.3000		0.1000
MW-6.6	0.0020		0.0200	0.1400		0.0500	0.0900			47.0000		4.6000
MW-6.7			0.0100	0.0200	0.0080	0.0280	0.0200			56.2000	0.0200	0.0520
MW-8.1	0.0280		0.0100	0.0300	0.0700	0.0500	0.1000					29.0000
MW-8.2	0.0190											20.0000
MW-8.3	0.0023	0.0200	0.0200	0.0500	0.0200	0.0500	0.0650		1.0000	175.0000	0.0500	7.8500
MW-8.4			0.0200	0.0500	0.0200	0.0500	0.0500			273.0000		0.1000
MW-8.5			0.0200	0.0500	0.0200	0.0500	0.0500			309.0000		0.1000
MW-8.6	0.0110		0.0200	0.0400		0.0500	0.1500			28.0000		53.0000
MW-8.7			0.0080	0.0200		0.0580	0.0700			151.0000		0.1100
MW-9.1			0.0100	0.0500	0.0100	0.0500	0.0080					74.0000
MW-9.2												53.0000
MW-9.3		0.0200	0.0200	0.0850	0.0200	0.0500	0.0050		1.0000	192.0000	0.0500	52.0000
MW-9.4			0.0200	0.0500	0.0200	0.0500	0.0500			189.0000		18,300.0000
MW-9.5			0.0200	0.0500	0.0200	0.0500	0.0500			250.0000		18.3000
MW-9.6			0.0200	0.0200		0.2400	0.0600			180.0000		58.0000
MW-9.7			0.0180	0.0200	0.0200	0.0200	0.0240			192.0000	0.0200	21.6000
SM-MW-103			0.0004	0.0015	20.0000	50.0000	50.0000		2.0450	121.0000		5.3000
SM-MW-104	0.0180		0.0003	0.0017	20.0000	50.0000	50.0000		0.2450	141.0000		20.0000
9705.1	0.0050											0.0000
9705.2	0.0040											0.0000
9705.3	0.0020											0.3460
9705.4	0.0010											0.0000
MW9705	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1060	140.0000	0.0000	0.0000

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
MW-3.1		0.8300				12.0000	0.0005		
MW-3.2		1.2000				13.0000			
MW-3.3	113.0000		129.0000	219.0000		6.5500	0.0005		
MW-3.4	39.1000		93.0000	179.0000		2.3000			
MW-3.5	34.4000	0.0650	80.0000	163.0000		1.9000			
MW-3.6	17.0000	0.0600		160.0000		16.0000			
MW-3.7	30.9000	0.0620	97.0000	181.0000		1.6000			
BK-MW-3	61.7000	0.0420	7.5500	753.0000	0.0000	0.0000		0.0000	0.0000
MW-6.1		0.4600				0.5200	0.0005		
MW-6.2		0.2400				0.2000			
MW-6.3	2.4000		1.1000	3.9000		0.1600	0.0005		
MW-6.4	3.3000		0.9000	6.0000		1.7000			
MW-6.5	5.8000	0.0450	1.1000	8.0000		1.5000			
MW-6.6	7.1000	0.7400		5.5000		2.6000			
MW-6.7	8.6000	0.6800	1.3000	4.0000		1.5000			
MW-8.1		1.9000				0.5100	0.0005		
MW-8.2		3.0000				0.3700			
MW-8.3	58.0000		51.0000	35.5000		0.5800	0.0005		
MW-8.4	57.0000		93.0000	51.6000		9.2000			
MW-8.5	68.0000	1.9000	103.0000	50.7000		4.3000			
MW-8.6	100.0000	3.0000		46.0000		3.0000			
MW-8.7	45.0000	3.0600	139.0000	40.4000		1.2000			
MW-9.1		0.9300				6.9000	0.0005		
MW-9.2		1.1000				1.4000			
MW-9.3	26.7000		30.0000	43.6000		13.0000	0.0005		
MW-9.4	24.9000		23.7000	18.6000		11.0000			
MW-9.5	19.8000	0.2000	28.0000	17.0000		1.9000			
MW-9.6	20.0000	0.7900		14.0000		12.0000			
MW-9.7	20.9000	1.1000	20.4000	14.7000		7.8000			
SM-MW-103	120.0000	0.0230	87.0000	248.0000		0.5380			
SM-MW-104	57.0000	0.8280	90.0000	186.0000		0.2900			
9705.1		0.0222							
9705.2		0.0262							
9705.3		0.8860							
9705.4		0.1460							
MW9705	58.4000	1.5500	15.6000	48.9000	0.0000	0.0000		0.0000	0.0000

POTENTIALLY IMPACTED WELLS (EAST OF THE LANDFILL)

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
Sump #4	7	MW-7.1	7/25/83	CH2M-Hill	Monitoring				
Sump #4	7	MW-7.2	9/21/83	CH2M-Hill	Monitoring				
Sump #4	7	MW-7.3	3/30/84	CH2M-Hill	Monitoring		7.7		
Sump #4	7	MW-7.4	3/20/86	CH2M-Hill	Monitoring		7.1		
Sump #4	7	MW-7.5	6/16/86	CH2M-Hill	Monitoring		7.5		
Sump #4	7	MW-7.6	3/3/87	CH2M-Hill	Monitoring		7.4		
Sump #4	7	MW-7.7	3/3/87	CH2M-Hill	Monitoring		7.6		
Sump #4	7	SM-MW-7	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	101	SM-MW-101	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	117	MW117	1/7/00	CRA	Monitoring			0.0000	0.0000
Sump #4	117	MW117R	1/7/00	CRA	Monitoring			0.0000	0.0000
Sump #4	201	MW201R.1	10/26/99	CRA	VAS	25		0.0000	0.0000
Sump #4	201	MW201R.2	10/26/99	CRA	VAS	20		0.0000	0.0000
Sump #4	201	MW201R.3	10/26/99	CRA	VAS	14		0.0000	0.0000
Sump #4	201	MW201R.4	10/26/99	CRA	VAS	0		0.0000	0.0000
Sump #4	201	MW201	1/7/00	CRA	Monitoring			0.0000	0.0000
Sump #4	201	MW201 d	1/7/00	CRA	Monitoring			0.0000	0.0000
Sump #4	201	MW201R MS/MSD	1/7/00	CRA	Monitoring			0.0000	0.0000
Sump #4	526	SM-MW-526-20	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	526	SM-MW-526-30	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	526	SM-MW-526-35	3/7/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	539	SM-MW-539-2-1	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	539	SM-MW-539-2-2	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	539	SM-MW-539-3-1	3/8/96	Dragun	Monitoring			0.0000	0.0000
Sump #4	9708	9708-2.1	9/29/99	CRA	VAS	22		0.0000	0.0000
Sump #4	9708	9708-2.2	9/29/99	CRA	VAS	17		0.0000	0.0000
Sump #4	9708	9708-2.3	9/29/99	CRA	VAS	12		0.0000	0.0000
Sump #4	9708	9708-2.4	9/29/99	CRA	VAS	7		0.0000	0.0000
Sump #4	9708	9708-2.5	9/29/99	CRA	VAS	0		0.0000	0.0000
Sump #4	9708	9708-3.1	10/5/99	CRA	VAS	56		0.0000	0.0000
Sump #4	9708	9708-3.2	10/5/99	CRA	VAS	51		0.0000	0.0000
Sump #4	9708	9708-3.3	10/5/99	CRA	VAS	51		0.0000	0.0000
Sump #4	9708	9708-3.4	10/5/99	CRA	VAS	46		0.0000	0.0000
Sump #4	9708	MW9708-2	1/5/00	CRA	Monitoring			0.0000	0.0000
Sump #4	9708	MW9708-2 d	1/5/00	CRA	Monitoring			0.0000	0.0000
Sump #4	9708	MW9708-3	1/5/00	CRA	Monitoring			0.0000	0.0000

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
MW-7.1								
MW-7.2								
MW-7.3								
MW-7.4								
MW-7.5								
MW-7.6								
MW-7.7								
SM-MW-7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R MS/MSD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-35	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
MW-7.1									
MW-7.2									
MW-7.3									
MW-7.4									
MW-7.5									
MW-7.6									
MW-7.7									
SM-MW-7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.4	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	10.0000
MW201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R MS/MSD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-30	0.0013	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-35	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-2	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-3-1	0.0000	0.0000	0.0000	0.0000	0.0082	0.0000	0.0000	0.0000	0.0000
9708-2.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
9708-2.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
9708-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
9708-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
9708-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
MW9708-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochloromethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
MW-7.1				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.2				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.3				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.4				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.5				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.6				0.0000	0.0000	0.0000	0.0000	0.0000
MW-7.7				0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R MS/MSD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-35	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-539-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9708-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichloroethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
MW-7.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-7.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
SM-MW-7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.4650	0.0041
SM-MW-101	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1000	
MW117	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW117R	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0106
MW201R.1	0.0000	0.0000	6.0000	0.0000	0.0000	0.0000		
MW201R.2	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000		
MW201R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW201R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW201	0.0000	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201 d	0.0000	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW201R MS/MSD	0.0000	0.0000	5.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-526-20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1100	0.0029
SM-MW-526-30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0780	0.0019
SM-MW-526-35	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0570	0.0012
SM-MW-539-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.0031
SM-MW-539-2-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0025
SM-MW-539-3-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1150	1.0000
9708-2.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9708-2.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-2.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-2.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-2.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-3.1	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000		
9708-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9708-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9708-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0076
MW9708-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0089
MW9708-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
MW-7.1	0.0300		0.0100	0.0400	0.0700	0.0500	0.0800					53.0000
MW-7.2	0.0310											78.0000
MW-7.3	0.0005	0.0200	0.0200	0.0500	0.0200	0.0500	0.0500		1.0000	66.5000	0.0500	0.1000
MW-7.4			0.0200	0.0500	0.2500	0.0500	0.0500			74.4000		0.1000
MW-7.5			0.0200	0.0500	0.0200	0.0500	0.0500			70.4000		0.1000
MW-7.6	0.0090		0.0200	0.1300		0.3300	0.3900			840.0000		81.0000
MW-7.7			0.0080	0.0200	0.0080	0.0500	0.0200			69.3000	0.0200	0.1900
SM-MW-7			0.2000	0.0014	20.0000	50.0000	50.0000		0.0560	126.0000		3.5000
SM-MW-101	0.0033		0.2000	1.0000	20.0000	50.0000	50.0000		0.0800	31.1000		100.0000
MW117	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0459	0.0000	1.3900	90.0000	0.0000	3.5200
MW117R	0.0000	0.0010	0.0000	0.0000	0.0000	0.0000	0.0807	0.0000	2.6500	145.0000	0.0000	10.8000
MW201R.1	0.0000											4.0100
MW201R.2	0.0000											0.0000
MW201R.3	0.0000											0.0000
MW201R.4	0.0000											0.0000
MW201	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1670	88.3000	0.0000	2.4200
MW201 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1700	85.1000	0.0000	2.4200
MW201R MS/MSD	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.2200	79.4000	0.0000	2.9800
SM-MW-526-20	0.0012		0.2000	1.0000	20.0000	50.0000	50.0000		0.0270	0.1000		510.0000
SM-MW-526-30			0.2000	1.0000	20.0000	50.0000	0.0650		0.1700	57.7000		4.5000
SM-MW-526-35			0.2000	0.0022	20.0000	50.0000	0.0550		0.5400	105.0000		6.6000
SM-MW-539-2-1	1.0000		0.2000	0.0014	20.0000	50.0000	50.0000		0.0072	84.3000		1.0500
SM-MW-539-2-2	0.0063		0.2000	0.0011	20.0000	50.0000	50.0000		0.1890	108.0000		3.7800
SM-MW-539-3-1	0.0046		0.2000	1.0000	20.0000	50.0000	50.0000		0.1320	470.0000		1.8000
9708-2.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.1500
9708-2.2	0.0000											6.2900
9708-2.3	0.0000											1.2500
9708-2.4	0.0000											0.2820
9708-2.5	0.0000											0.0000
9708-3.1	0.0000											0.0000
9708-3.2	0.0000											0.2780
9708-3.3	0.0000											0.2620
9708-3.4	0.0000											0.0000
MW9708-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0257	0.0000	0.8590	136.0000	0.0000	6.5800
MW9708-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0263	0.0000	0.8800	140.0000	0.0000	6.7900
MW9708-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	39.2000	0.0000	0.2050

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
MW-7.1		1.0000				0.4400	0.0005		
MW-7.2		1.4000				0.3800			
MW-7.3	32.7000		0.9000	10.3000		0.2500	0.0005		
MW-7.4	34.6000		2.7000	8.1000		2.1000			
MW-7.5	28.5000	160.0000	0.7000	6.4000		1.2000			
MW-7.6	240.0000	6.2000		17.0000		7.7000			
MW-7.7	33.4000	0.2200	0.7000	9.3000		0.1400			
SM-MW-7	49.0000	0.0490	0.6900	9.6000		0.3000			
SM-MW-101	14.6000	20.0000	0.8700	9.3000		0.0700			
MW117	145.0000	0.0000	127.0000	231.0000	0.0000	0.2440		0.0000	0.0000
MW117R	225.0000	0.0401	34.9000	329.0000	0.0000	0.0000		0.0000	0.0000
MW201R.1		0.0365							
MW201R.2		0.0534							
MW201R.3		0.0634							
MW201R.4		0.0000							
MW201	70.4000	0.0515	13.0000	90.7000	0.0000	0.0000		0.0000	0.0000
MW201 d	69.3000	0.0498	12.1000	90.8000	0.0000	0.0000		0.0000	0.0000
MW201R MS/MSD	90.1000	0.0520	20.1000	104.0000	0.0000	0.0000		0.0000	0.0000
SM-MW-526-20	63.0000	0.3400	1.8700	11.1000		50.0000			
SM-MW-526-30	85.0000	0.1000	49.0000	73.7000		50.0000			
SM-MW-526-35	1,160.0000	0.0270	64.0000	246.0000		50.0000			
SM-MW-539-2-1	37.8000	0.0260	1.1400	13.8000		50.0000			
SM-MW-539-2-2	60.0000	0.5410	46.6000	59.5000		50.0000			
SM-MW-539-3-1	26.2000	0.0530	9.6000	39.3000		50.0000			
9708-2.1	0.0000	0.0569	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000
9708-2.2		0.0521							
9708-2.3		0.1510							
9708-2.4		0.1040							
9708-2.5		0.0000							
9708-3.1		0.0237							
9708-3.2		0.0218							
9708-3.3		0.0215							
9708-3.4		0.0209							
MW9708-2	86.7000	0.0483	53.4000	118.0000	0.0000	0.0000		0.0000	0.0000
MW9708-2 d	89.3000	0.0504	53.5000	121.0000	0.0000	0.0000		0.0000	0.0000
MW9708-3	15.0000	0.0249	2.5100	9.2800	0.0000	0.0000		0.0000	0.0000

POTENTIALLY IMPACTED WELLS (SOUTH OF THE LANDFILL)

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
None	105	SM-MW-105	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	217	SM-MW-217	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	572	SM-MW-572-33	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	572	SM-MW-572-44	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	9711	9711.2	10/20/99	CRA	VAS	47		0.0000	0.0000
None	9711	9711.3	10/20/99	CRA	VAS	42		0.0000	0.0000
None	9711	9711.4	10/20/99	CRA	VAS	37		0.0000	0.0000
None	9711	9711.5	10/20/99	CRA	VAS	32		0.0000	0.0000
None	9711	9711.6	10/20/99	CRA	VAS	32		0.0000	0.0000
None	9711	9711.7	10/20/99	CRA	VAS	0		0.0000	0.0000
None	9711	9711.1	10/21/99	CRA	VAS	12		0.0000	0.0000
None	9711	9711.11	10/21/99	CRA	VAS	12		0.0000	0.0000
None	9711	9711.8	10/21/99	CRA	VAS	24		0.0000	0.0000
None	9711	9711.9	10/21/99	CRA	VAS	17		0.0000	0.0000
None	9711	MW9711	1/6/00	CRA	Monitoring			0.0000	0.0000
None	9711	MW9711(A)	1/6/00	CRA	Monitoring			0.0000	0.0000
None	401	401	3/5/96	Dragun	Monitoring			0.0000	0.0000

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
SM-MW-105	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-217	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-44	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711(A)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
401	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
SM-MW-105	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-217	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-44	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.7	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	10.0000
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711(A)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
401	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochlorormethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
SM-MW-105	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-217	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-572-44	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711(A)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
401	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichloroethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
SM-MW-105	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0058
SM-MW-217	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0053
SM-MW-572-33	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000
SM-MW-572-44	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0047
9711.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.8	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9711.9	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9711(A)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
401	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
SM-MW-105	0.0024		0.0002	0.0018	20.0000	50.0000	50.0000		1.8000	92.1000		4.3000
SM-MW-217	0.0290		0.2000	0.0013	20.0000	50.0000	50.0000		0.7700	233.0000		37.0000
SM-MW-572-33	0.0260		0.2000	0.0025	20.0000	50.0000	50.0000		0.6300	55.8000		2.7000
SM-MW-572-44	0.0045		0.2000	0.0042	20.0000	50.0000	0.0930		1.7000	56.4000		3.1000
9711.2	0.0000											0.1040
9711.3	0.0000											0.3940
9711.4	0.0000											0.9590
9711.5	0.0010											1.8300
9711.6	0.0010											1.8400
9711.7	0.0000											0.0000
9711.1	0.0030											2.3300
9711.11	0.0030											2.3700
9711.8	0.0030											4.6000
9711.9	0.0020											4.1500
MW9711	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.7880	110.0000	0.0000	1.8100
MW9711(A)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	38.8000	0.0000	0.0000
401	0.0600		0.2000	0.0016	20.0000	50.0000	50.0000		0.2010	38.6000		1.7800

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
SM-MW-105	95.0000	0.0280	109.0000	152.0000		0.5100			
SM-MW-217	100.0000	0.8600	7.2000	106.0000		50.0000			
SM-MW-572-33	98.0000	0.0590	125.0000	154.0000		0.0950			
SM-MW-572-44	152.0000	20.0000	201.0000	270.0000		50.0000			
9711.2		0.0000							
9711.3		0.0276							
9711.4		0.0481							
9711.5		0.1040							
9711.6		0.1040							
9711.7		0.0000							
9711.1		0.0792							
9711.11		0.0833							
9711.8		0.0366							
9711.9		0.0925							
MW9711	58.2000	0.0441	25.0000	91.9000	0.0000	0.0000		0.0000	0.0000
MW9711(A)	13.4000	0.0282	5.5200	11.4000	0.0000	0.0000		0.0000	0.0000
401	73.0000	0.0210	69.0000	213.0000		50.0000			

UNIMPACTED WELLS

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
None	5	MW-5.1	7/25/83	CH2M-Hill	Monitoring				
None	5	MW-5.2	9/21/83	CH2M-Hill	Monitoring				
None	5	MW-5.3	3/30/84	CH2M-Hill	Monitoring		7.2		
None	5	MW-5.4	3/20/86	CH2M-Hill	Monitoring		6.8		
None	5	MW-5.5	6/16/86	CH2M-Hill	Monitoring		7.0		
None	5	MW-5.6	3/3/87	CH2M-Hill	Monitoring		7.2		
None	5	MW-5.7	3/3/87	CH2M-Hill	Monitoring		7.2		
None	11	MW-11.1	7/25/83	CH2M-Hill	Monitoring				
None	11	MW-11.2	9/21/83	CH2M-Hill	Monitoring				
None	11	MW-11.3	3/30/84	CH2M-Hill	Monitoring		7.9	0.0000	
None	11	MW-11.4	3/20/86	CH2M-Hill	Monitoring		7.4	0.0000	
None	11	MW-11.5	6/16/86	CH2M-Hill	Monitoring		6.3	0.0220	
None	11	MW-11.6	3/3/87	CH2M-Hill	Monitoring		8.0	0.0000	
None	11	MW-11.7	3/3/87	CH2M-Hill	Monitoring		7.7	0.0000	
None	43	SM-MW-43	3/1/96	Dragun	Monitoring			0.0000	0.0000
None	100	SM-MW-100	3/1/96	Dragun	Monitoring			0.0000	0.0000
None	114	SM-MW-114	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	216	216	3/5/96	Dragun	Monitoring			0.0000	0.0000
None	503	503-2-1	3/12/96	Dragun	Monitoring			0.0000	0.0000
None	594	MW594R.1	10/14/99	CRA	VAS	30		0.0000	0.0000
None	594	MW594R.2	10/14/99	CRA	VAS	22		0.0000	0.0000
None	594	MW594R.3	10/14/99	CRA	VAS	17		0.0000	0.0000
None	594	MW594R.4	10/14/99	CRA	VAS	12		0.0000	0.0000
None	594	MW594R.5	10/14/99	CRA	VAS	12		0.0000	0.0000
None	598	598R-3.1	10/6/99	CRA	VAS	0		0.0000	0.0000
None	598	598R-3.2	10/7/99	CRA	VAS	48		0.0000	0.0000
None	598	598R-3.3	10/7/99	CRA	VAS	43		0.0000	0.0000
None	598	598R-3.4	10/7/99	CRA	VAS	38		0.0000	0.0000
None	598	598R-3.5	10/7/99	CRA	VAS	33		0.0000	0.0000
None	598	598R-3.6	10/7/99	CRA	VAS	33		0.0000	0.0000
None	598	598R-3.7	10/7/99	CRA	VAS	27		0.0000	0.0000
None	598	MW598R-3	1/5/00	CRA	Monitoring			0.0000	0.0000
None	9711	9711.1	10/20/99	CRA	VAS	0		0.0000	0.0000
None	9712	9712.1	10/12/99	CRA	VAS	45		0.0000	0.0000
None	9712	9712.2	10/12/99	CRA	VAS	37		0.0000	0.0000
None	9712	9712.3	10/12/99	CRA	VAS	30		0.0000	0.0000
None	9712	9712.4	10/12/99	CRA	VAS	0		0.0000	0.0000
None	9712	9712.5	10/12/99	CRA	VAS	15		0.0000	0.0000
None	9712	MW9712	1/6/00	CRA	Monitoring			0.0000	0.0000
None	114	114	3/5/96	Dragun	Monitoring				

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
MW-5.1								
MW-5.2		0.0000						
MW-5.3		0.0000	0.0000					
MW-5.4		0.0000	0.0000					
MW-5.5		0.0021	0.0011					
MW-5.6		0.0000	0.0000					
MW-5.7		0.0000	0.0000					
MW-11.1								
MW-11.2								
MW-11.3								
MW-11.4								
MW-11.5								
MW-11.6								
MW-11.7								
SM-MW-43	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
503-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW598R-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
114								

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
MW-5.1									
MW-5.2	0.0000								
MW-5.3	0.0079								
MW-5.4	0.0000								
MW-5.5	0.0000								
MW-5.6	0.0000								
MW-5.7	0.0016								
MW-11.1									
MW-11.2									
MW-11.3						0.0000			
MW-11.4						0.0000			
MW-11.5						0.0250			
MW-11.6									
MW-11.7									
SM-MW-43	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0000	0.0000
SM-MW-100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
503-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
MW594R.3	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
MW594R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.1	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
598R-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.3	0.0000	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
598R-3.4	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
598R-3.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.7	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
MW598R-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.1	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	7.0000
9712.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.4	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
9712.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
114									

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochlorormethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
MW-5.1	0.0500		0.0000	0.0000		0.0000	0.0000	0.0000
MW-5.2	0.0000		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-5.3			0.0000	0.0000		0.0000	0.0000	0.0000
MW-5.4	0.0000		0.0000	0.0000	0.0300	0.0000	0.0000	0.0000
MW-5.5			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-5.6	0.0000		0.0000	0.0000		0.0000	0.0000	0.0000
MW-5.7			0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-11.1								
MW-11.2								
MW-11.3								
MW-11.4								
MW-11.5								
MW-11.6								
MW-11.7								
SM-MW-43	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
503-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW594R.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.1	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.3	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.4	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
598R-3.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW598R-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9712.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
114								

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichlorcethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
MW-5.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-5.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW-11.1								
MW-11.2								
MW-11.3								
MW-11.4								
MW-11.5								
MW-11.6								
MW-11.7								
SM-MW-43	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	50.0000	0.0031
SM-MW-100	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0031
SM-MW-114	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
216	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0058
503-2-1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	8.8000	0.0021
MW594R.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW594R.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW594R.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW594R.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW594R.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
598R-3.7	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW598R-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0057
9711.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9712.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9712.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9712.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9712.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9712.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
114							0.0700	0.0081

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
MW-5.1	0.0180		0.0100	0.0700	0.0200	0.0500	0.0200					19.0000
MW-5.2	0.0180											24.0000
MW-5.3	0.0014	0.0200	0.0200	0.0500	0.0200	0.0500	0.0500		1.0000	124.0000	0.0200	4.7000
MW-5.4			0.0200	0.0500	0.0200	0.0500	0.0500			104.5000		1.0000
MW-5.5			0.0200	0.0500	0.0200	0.0500	0.0500			170.0000		4.3000
MW-5.6	0.0800		0.0200	0.0200		0.0600	0.0400			74.0000		30.0000
MW-5.7			0.0080	0.0200	0.0080	0.0200	0.0200			88.6000	0.0200	0.4420
MW-11.1	0.0180		0.0100	0.0500	0.0700		0.0500					25.0000
MW-11.2	0.0050											12.0000
MW-11.3	0.0005	0.0200	0.2000	0.0500	0.2000	0.0500	0.0500		1.0000	34.6000	0.0500	0.1100
MW-11.4			0.0200	0.0500	0.0200	0.0500	0.0500			37.3000		0.1000
MW-11.5			0.0200	0.0500	0.0200	0.0500	0.0500			41.0000		0.1000
MW-11.6	0.0020		0.0200	0.0500		0.0500	0.0500			93.0000		27.0000
MW-11.7			0.0320	0.0200	0.0080	0.0520	0.0200			43.2000	0.0200	0.0400
SM-MW-43	0.1700		0.2000	0.0141	20.0000	50.0000	50.0000		0.3500	82.7000		11.9000
SM-MW-100			0.2000	1.0000	20.0000	50.0000	50.0000		0.0500	21.4000		100.0000
SM-MW-114												
216	0.0280		0.2000	0.0023	20.0000	50.0000	50.0000		1.8300	296.0000		11.3000
503-2-1	0.0096		0.2000	0.0056	20.0000	50.0000	50.0000		0.1200	45.0000		9.8000
MW594R.1	0.0040											2.2800
MW594R.2	0.0040											1.7100
MW594R.3	0.0030											1.1700
MW594R.4	0.0030											0.0000
MW594R.5	0.0030											0.0000
598R-3.1	0.0000											0.0000
598R-3.2	0.0000											0.3970
598R-3.3	0.0040											0.0000
598R-3.4	0.0040											0.1060
598R-3.5	0.0040											0.1290
598R-3.6	0.0040											0.1220
598R-3.7	0.0040											0.0000
MW598R-3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	37.2000	0.0000	0.1660
9711.1	0.0000											0.0000
9712.1	0.0040											0.1150
9712.2	0.0010											0.3350
9712.3	0.0030											0.3130
9712.4	0.0020											0.0000
9712.5	0.0070											0.1340
MW9712	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1530	194.0000	0.0000	0.0000
114	0.0080		0.0006	0.0019	20.0000	0.0600	50.0000		5.0000	1,000.0000		100.0000

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
MW-5.1		5.4000				0.6700	0.0005		
MW-5.2		9.1000				0.3800			
MW-5.3	26.0000		19.9000	25.8000		1.7000	0.0005		
MW-5.4	21.9000		20.0000	11.9000		3.9000			
MW-5.5	22.0000	6.5500	32.3000	16.3000		1.4000			
MW-5.6	14.0000	8.8000		10.0000		3.2000			
MW-5.7	18.4000	6.6000	23.0000	10.6000		1.5000			
MW-11.1		0.4500				0.2400	0.0005		
MW-11.2		0.2100				0.1400			
MW-11.3	6.5000		2.6000	4.1000		0.1300	0.0005		
MW-11.4	7.6000		1.1000	2.4000		0.1200			
MW-11.5	7.7000	0.3400	2.7000	5.1000		0.5500			
MW-11.6	22.0000	1.0000		4.8000		2.0000			
MW-11.7	8.5000	0.0980	4.7000	5.2000		0.2800			
SM-MW-43	79.0000	0.0440	137.0000	132.0000		50.0000			
SM-MW-100	9.0000	20.0000	0.8800	14.0000		50.0000			
SM-MW-114									
216	164.0000	0.1080	26.3000	539.0000		50.0000			
503-2-1	13.9000	0.1800	0.0035	34.6000		50.0000			
MW594R.1		0.0366							
MW594R.2		0.1120							
MW594R.3		0.1740							
MW594R.4		0.2290							
MW594R.5		0.2870							
598R-3.1		0.0000							
598R-3.2		0.0000							
598R-3.3		0.0000							
598R-3.4		0.0000							
598R-3.5		0.0000							
598R-3.6		0.0000							
598R-3.7		0.0000							
MW598R-3	16.4000	0.0266	3.0000	18.6000	0.0000	0.0000		0.0000	0.0000
9711.1		0.0000							
9712.1		0.0000							
9712.2		0.0207							
9712.3		0.0000							
9712.4		0.0000							
9712.5		0.0000							
MW9712	0.1880	0.0000	24.1000	13.6000	0.0000	0.0000		0.0000	0.0000
114	1,000.0000	20.0000	2.0800			0.2700			

UNIMPACTED WELLS (OFF-SITE OR BACKGROUND)

Sump	Well No.	Well Identification	Date	Source	Type of Well	Depth of Sample	ph	1,1,1, Trichloroethane	1,1,2,2 Tetrachloroethane
None	2	BK-MW-2	2/3/00	CRA	Background			0.0000	0.0000
None	2	BK-MW-2 d	2/3/00	CRA	Background			0.0000	0.0000
None	115	SM-MW-115	3/6/96	Dragun	Monitoring			0.0000	0.0000
None	515	MW-515	3/12/96	Dragun	Monitoring			0.0000	0.0000
None	549	SM-MW-549	3/6/96	Dragun	Monitoring			0.0000	0.0000
None	573	SM-MW-573-33 DUP	3/4/96	Dragun	Monitoring			0.0000	0.0000
None	581	SM-MW-581-52	3/8/96	Dragun	Monitoring			0.0000	0.0000
None	9701	9701.1	9/21/99	CRA	VAS	0		0.0000	0.0000
None	9701	9701.2	9/21/99	CRA	VAS	32		0.0000	0.0000
None	9701	9701.3	9/21/99	CRA	VAS	27		0.0000	0.0000
None	9701	9701.4	9/21/99	CRA	VAS	22		0.0000	0.0000
None	9701	9701.5	9/21/99	CRA	VAS	17		0.0000	0.0000
None	9701	9701.6	9/21/99	CRA	VAS	12		0.0000	0.0000
None	9701	MW9701	1/6/00	CRA	Monitoring			0.0000	0.0000
None	9702	9702.1	9/22/99	CRA	VAS	32		0.0000	0.0000
None	9702	9702.2	9/22/99	CRA	VAS	32		0.0000	0.0000
None	9702	9702.3	9/22/99	CRA	VAS	27		0.0000	0.0000
None	9702	9702.4	9/22/99	CRA	VAS	22		0.0000	0.0000
None	9702	9702.5	9/23/99	CRA	VAS	17		0.0000	0.0000
None	9702	9702.6	9/23/99	CRA	VAS	12		0.0000	0.0000
None	9702	MW9702	1/6/00	CRA	Monitoring			0.0000	0.0000
None	9709	9709.1	11/10/99	CRA	VAS	41		0.0000	0.0000
None	9709	9709.2	11/10/99	CRA	VAS	35		0.0000	0.0000
None	9709	9709.3	11/10/99	CRA	VAS	29		0.0000	0.0000
None	9709	MW9709	1/5/00	CRA	Monitoring			0.0000	0.0000
None	402	402	3/5/96	Dragun	Monitoring			0.0000	0.0000
None	PB	SM-MW-PB	3/7/96	Dragun	Monitoring			0.0000	0.0000
None	PB-P2	SM-PB-P2	3/4/96	Dragun	Monitoring			0.0000	0.0000

Well Identification	1,1,2 Trichloroethane	1,1 Dichloroethene	1,2 Dichloroethene	1,2 Dichloropropane	2-Butanone	2-Hexanone	4-Methyl-2-Pentanone	Acetone
BK-MW-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BK-MW-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-115	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-515	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-549	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-573-33 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-581-52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9701	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9702	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9709	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
402	0.0000	0.0000	0.0000	0.0000	20.0000	0.6700	0.1400	5.0000
SM-MW-PB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-PB-P2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	Benzene	Bromodichloromethane	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform
BK-MW-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BK-MW-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-115	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW-515	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-549	0.0078	0.0000	0.0000	0.0000	0.0000	0.0000	0.0057	0.0000	0.0000
SM-MW-573-33 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-581-52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.1	0.0000	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
9701.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.3	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
9701.4	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
9701.5	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
9701.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9701	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.3	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.5	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
9702.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9702	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9709	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
402	0.0510	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-PB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-PB-P2	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012

Well Identification	Chloromethane	cis-1,3 Dichloropropene	Dibromochlorormethane	Ethylbenzene	Methylene chloride	Styrene	Tetrachloroethene	Toluene
BK-MW-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
BK-MW-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-115	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024
MW-515	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-549	0.0000	0.0000	0.0000	0.0080	0.0000	0.0000	0.0000	0.0000
SM-MW-573-33 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-581-52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.1	0.0000	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.3	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9701.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9701	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9702	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9709.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MW9709	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
402	0.0000	0.0000	0.0000	0.0490	0.0000	0.0060	0.0000	3.2000
SM-MW-PB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-PB-P2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Well Identification	trans-1,3 Dichloropropene	Trichloroethene	Vinyl chloride	cis-1,2 Dichloroethene	trans-1,2 Dichloroethene	Xylenes, total	Aluminum	Antimony
BK-MW-2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059
BK-MW-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SM-MW-115	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0015
MW-515	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	5.9000	0.0033
SM-MW-549	0.0000	0.0000	0.0000	0.0000	0.0000	0.0045	50.0000	0.0021
SM-MW-573-33 DUP	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	1.0000
SM-MW-581-52	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1.6000	0.0023
9701.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9701.2	0.0000	4.0000	0.0000	0.0000	0.0000	0.0000		
9701.3	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000		
9701.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9701.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9701.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9701	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
9702.1	0.0000	2.0000	0.0000	0.0000	0.0000	0.0000		
9702.2	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000		
9702.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9702.4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9702.5	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000		
9702.6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9702	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0063
9709.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9709.2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
9709.3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		
MW9709	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
402	0.0000	0.0000	0.0250	0.0000	0.0000	0.1750		
SM-MW-PB	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0015
SM-PB-P2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	50.0000	0.0031

Well Identification	Arsenic	Berylium	Cadmium	Chromium	Copper	Lead	Nickel	Selenium	Barium	Calcium	Cobalt	Iron
BK-MW-2	0.0050	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.6100	194.0000	0.0000	0.0000
BK-MW-2 d	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.5900	193.0000	0.0000	0.0000
SM-MW-115			0.2000	1.0000	20.0000	50.0000	50.0000		0.0800	64.5000		0.0890
MW-515	0.0027		0.2000	0.0055	0.0220	50.0000	50.0000		0.0410	62.7000		9.9000
SM-MW-549	0.0690		0.2000	0.0017	20.0000	50.0000	50.0000		0.4000	112.0000		18.0000
SM-MW-573-33 DUP	0.0260		0.2000	0.0023	20.0000	50.0000	50.0000		0.6300	53.5000		2.8000
SM-MW-581-52	0.0091		0.2000	0.2000	20.0000	50.0000	50.0000		0.9000	133.0000		1.8000
9701.1	0.0000											3.1100
9701.2	0.0000											0.0000
9701.3	0.0000											0.0000
9701.4	0.0000											0.0000
9701.5	0.0000											0.0000
9701.6	0.0000											0.0000
MW9701	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	71.7000	0.0000	0.2950
9702.1	0.0000											1.2500
9702.2	0.0000											0.0000
9702.3	0.0000											0.0000
9702.4	0.0000											0.0000
9702.5	0.0000											0.0000
9702.6	0.0000											0.0000
MW9702	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1710	65.7000	0.0000	0.3680
9709.1	0.0000											0.3550
9709.2	0.0000											0.1870
9709.3	0.0000											0.1800
MW9709	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	35.6000	0.0000	0.0000
402												
SM-MW-PB	1.0000		0.2000	0.0026	20.0000	50.0000	50.0000		5.0000	1.0000		100.0000
SM-PB-P2			0.0002	1.0000	20.0000	50.0000	50.0000		0.0080	2.9000		100.0000

Well Identification	Magnesium	Manganese	Potassium	Sodium	Vanadium	Zinc	Mercury	Silver	Thallium
BK-MW-2	29.8000	0.0000	7.2900	478.0000	0.0000	0.0000		0.0000	0.0000
BK-MW-2 d	29.0000	0.0000	7.1400	465.0000	0.0000	0.0000		0.0000	0.0000
SM-MW-115	35.2000	0.1300	33.9000	35.2000		0.2100			
MW-515	14.1000	0.1600	0.0022	3.4000		0.0570			
SM-MW-549	40.0000	0.1100	91.0000	52.4000		50.0000			
SM-MW-573-33 DUP	97.0000	0.0600	125.0000	153.0000		50.0000			
SM-MW-581-52	15.2000	0.0400	1.3600	28.7000		50.0000			
9701.1		0.0000							
9701.2		0.0653							
9701.3		0.0000							
9701.4		0.0632							
9701.5		0.0000							
9701.6		0.0988							
MW9701	26.5000	0.0858	2.9800	4.7200	0.0000	0.0000		0.0000	0.0000
9702.1		0.1080							
9702.2		0.0536							
9702.3		0.0231							
9702.4		0.0328							
9702.5		0.1060							
9702.6		0.0819							
MW9702	25.4000	0.0627	3.3400	9.4400	0.0000	0.0000		0.0000	0.0000
9709.1		0.0000							
9709.2		0.0000							
9709.3		0.0000							
MW9709	16.0000	0.0000	2.9800	14.9000	0.0000	0.0000		0.0000	0.0000
402									
SM-MW-PB	1,000.0000	20.0000	100.0000	1,000.0000		50.0000			
SM-PB-P2	1.9000	20.0000	0.5900	5.5000		0.0540			

RTI LABORATORIES, INC.
Chemical, Metallurgical & Environmental Testing

REPORT OF ANALYTICAL SERVICES

TO: Petro Environmental Technolgy
7851 Palace Drive
Cincinatti, OH 45245

Report Date: 03/06/01

Lab Number: 01-0671A

Customer P.O. #:

Attn: Daniel Duffy

Customer #:

RTI Quote #:

PART / SAMPLE IDENTIFICATION:

RTI Sampling Grab 2/23/01
Wastewater Grab Received 2/23/01

Received: 02/23/01 Tests Completed: 03/06/01 Reported: 03/06/01

WORK REQUESTED / PERFORMED:

pH, CN, FOG, PHENOLS, METALS, TSS, BOD, TP, TTO ANALYSIS

THE RESULTS OF ALL TESTS and/or ANALYSES REQUESTED ARE REPORTED ON THE PAGES WHICH FOLLOW.

Number of pages including this page 8

APPROVED BY: Pat Springs REPORTED BY: AF

data and information presented herein, while not guaranteed, are to the best of our knowledge accurate and true. No warranty or guarantee ied or expressed is made regarding these analytical results, since securing and properly preserving representative samples and since the mple custody chains are beyond RTI control. The results provided by RTI are neither intended to suggest product merchantability, nor for use in infringement of any existing patent. RTI will not assume any liability or responsibility for any such infringement. Alteration or reproduction other than in its entirety is not authorized by RTI Laboratories, Inc.

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RTI LABORATORIES, INC.
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WASTEWATER ANALYSIS REPORT

Submitted by : Daniel Duffy Lab. No. : 01-0671A

Client : Petro Environmental Technolgy Report Date : 03/06/01
Cincinatti, OH

Sample ID :

RTI Sampling Grab 2/23/01
Wastewater Grab Received 2/23/01

SAMPLING LOCATION: South Macomb Disposal Authority
Leachate Station 9A

PERMIT #: SAMPLED BY: RTI-SJ DATE SAMPLED: 02/23/01
DATE RECEIVED: 02/23/01 ANALYSES COMPLETED: 03/06/01

Object :

pH, CN, FOG, PHENOLS, METALS, TSS, BOD, TP, TTO ANALYSIS

METHODOLOGIES: Methods for Chemical Analysis of Water and Waste, US EPA Publicaton EPA-600/4-79-020 March 1983.

Results and Discussion :

PROCESS WASTEWATER GRAB RESULTS 2/23/01

PARAMETER	RESULTS	LOD-S	DATE OF ANALYSIS	TECH
pH (150.1)	4.71	1.0-14.0	02/23/01	SJ
CN (335.2)	ND	0.02	02/27/01	LS
FOG* (413.1)	ND	1.0	03/02/01	LS
PHENOL (420.1)	5.4	0.1	02/27/01	LS

* = Method 1664-Hexane Extraction
pH Sampling - 2/23/01 at 10:15 am.
pH Analysis - 2/23/01 at 10:15 am at 5.8 degree C.
ND = Not Detected or less than LOD-S
NA = Not Applicable or Not Analyzed
LOD-S = Limit of Detection for the reported sample(s)
Trip/Field Blank Submitted: No
Test Parameters Subcontracted: None
All parameters are reported in ppm except pH.

RTI LABORATORIES, INC.
Chemical, Metallurgical & Environmental Testing

WASTEWATER ANALYSIS REPORT
Lab. No. : 01-0671A

PROCESS WASTEWATER GRAB RESULTS 2/23/01

COMPOUNDS	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
VOLATILE ORGANIC COMPOUNDS (Method EPA 624)			
Acrolein	1.0	50	ND
Acrylonitrile	1.0	50	ND
Benzene	1.0	50	ND
Bis(Chloromethyl) ether	1.0	50	ND
Bromoform	1.0	50	ND
2-butanone	1.0	50	55000
Carbon tetrachloride	1.0	50	ND
Chlorobenzene	1.0	50	ND
Chlorodibromomethane	1.0	50	ND
Chloroethane	1.0	50	ND
2-Chloroethylvinylether	1.0	50	ND
Chloroform	1.0	50	ND
Dichlorobromomethane	1.0	50	ND
1,4-Dichlorobenzene	1.0	50	ND
1,2-Dichloroethane	1.0	50	ND
1,1-Dichloroethane	1.0	50	84
1,1-Dichloroethylene	1.0	50	ND
cis-1,2-Dichloroethylene	1.0	50	1800
trans-1,2-Dichloroethylene	1.0	50	ND
Dichlorofluoromethane	1.0	50	ND
1,2-Dichloropropane	1.0	50	ND
1,3-Dichloropropylene	1.0	50	ND
Ethylbenzene	1.0	50	130
Methyl Bromide	1.0	50	ND
Methyl Chloride	1.0	50	ND
Methylene chloride	1.0	50	1400
1,1,2,2,-Tetrachloroethane	1.0	50	ND
Tetrachloroethene	1.0	50	ND
1,1,2-Trichloroethane	1.0	50	ND
1,1,1-Trichloroethane	1.0	50	ND
Trichloroethylene	1.0	50	74
Trichlorofluoromethane	1.0	50	ND
Toluene	1.0	50	1200
Vinyl chloride	1.0	50	62

Date of Analysis: 2/28/01 Analyst: MT3

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RTI LABORATORIES, INC.
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WASTEWATER ANALYSIS REPORT
Lab. No. : 01-0671A

PROCESS WASTEWATER GRAB RESULTS 2/23/01

PARAMETER	RESULTS	LOD-S	DATE OF ANALYSIS	TECH
As (200.7)	ND	0.50	03/01/01	JSI
Cd (200.7)	ND	0.50	03/01/01	JSI
Cu (200.7)	0.61	0.50	03/01/01	JSI
Fe (200.7)	1150	0.50	03/01/01	JSI
Pb (200.7)	ND	0.50	03/01/01	JSI
Hg (245.1)	ND	0.0002	03/05/01	LS
Ni (200.7)	ND	0.50	03/01/01	JSI
Ag (200.7)	ND	0.50	03/01/01	JSI
Cr (200.7)	ND	0.50	03/01/01	JSI
Zn (200.7)	36.3	0.50	03/01/01	JSI
TSS (160.2)	1250	1.0	03/02/01	LS
BOD-1 (405.1)	7270	30	02/26/01	LS
BOD-3 (405.1)	11800	30	02/27/01	LS
BOD-5 (405.1)	25500	30	03/01/01	LS
P (365.3)	10	0.2	02/27/01	LS

PROCESS WASTEWATER GRAB RESULTS 2/23/01

COMPOUNDS	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
BASE/NEUTRAL EXTRACTABLE COMPOUNDS (Method EPA 3510, 625)			
Acenaphthene	5.0	5.0	ND
Acenaphthylene	5.0	5.0	ND
Aniline	5.0	5.0	ND
Anthracene	5.0	5.0	ND
Benzidine	5.0	5.0	ND
Benzyl alcohol	5.0	5.0	ND
Benzo(a)anthracene	5.0	5.0	ND
Benzo(a)pyrene	5.0	5.0	ND
Benzo(ghi)perylene	5.0	5.0	ND
Benzo(b)fluoranthene	5.0	5.0	ND
Benzo(k)fluoranthene	5.0	5.0	ND
Bis (2-chloroethoxy) methane	5.0	5.0	ND
Bis (2-chloroethyl) ether	5.0	5.0	ND
Bis (2-chloroisopropyl) ether	5.0	5.0	ND
Bis (2-ethylhexyl) phthalate	5.0	5.0	18
4-bromophenyl phenyl ether	5.0	5.0	ND

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WASTEWATER ANALYSIS REPORT
Lab. No. : 01-0671A

PROCESS WASTEWATER GRAB RESULTS 2/23/01

COMPOUNDS	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
BASE/NEUTRAL EXTRACTABLE COMPOUNDS (Method EPA 3510, 625)			
Butyl benzyl phthalate	5.0	5.0	ND
Carbozole	5.0	5.0	ND
4-chloroaniline	5.0	5.0	ND
2-chloronaphthene	5.0	5.0	ND
4-chlorphenyl phenyl ether	5.0	5.0	ND
Chrysene	5.0	5.0	ND
Dibenzo(a,h)anthracene	5.0	5.0	ND
Dibenzofuran	5.0	5.0	ND
1,2-Dichlorobenzene	5.0	5.0	ND
1,3-Dichlorobenzene	5.0	5.0	ND
1,4-Dichlorobenzene	5.0	5.0	ND
3,3-dichlorobenzidine	5.0	5.0	ND
Diethyl phthalate	5.0	5.0	330
Dimethyl phthalate	5.0	5.0	ND
Di-n-butyl phthalate	5.0	5.0	14
2,4-dinitrotoluene	5.0	5.0	ND
2,6-dinitrotoluene	5.0	5.0	ND
Di-n-octyl phthalate	5.0	5.0	ND
Fluoranthene	5.0	5.0	ND
Fluorene	5.0	5.0	ND
Hexachlorobenzene	5.0	5.0	ND
Hexachlorobutadiene	5.0	5.0	ND
Hexachlorocyclopentadiene	5.0	5.0	ND
Hexachloroethane	5.0	5.0	ND
Indeno(1,2,3-cd)pyrene	5.0	5.0	ND
Isophorone	5.0	5.0	ND
2-methylnaphthalene	5.0	5.0	ND
Azobenzene	5.0	5.0	ND
Naphthalene	5.0	5.0	ND
2-Nitroaniline	5.0	5.0	ND
3-Nitroaniline	5.0	5.0	ND
4-Nitroaniline	5.0	5.0	ND
Nitrobenzene	5.0	5.0	ND
N-nitrosodimethylamine	5.0	5.0	ND
N-nitrosodi-n-propylamine	5.0	5.0	ND
N-nitrosodiphenylamine	5.0	5.0	ND
Phenanthrene	5.0	5.0	ND
Pyrene	5.0	5.0	ND
1,2,4-trichlorobenzene	5.0	5.0	ND

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WASTEWATER ANALYSIS REPORT
Lab. No. : 01-0671A

PROCESS WASTEWATER GRAB RESULTS 2/23/01

COMPOUNDS	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
ACID EXTRACTABLE COMPOUNDS (Method EPA 3510, 625)			
Benzoic Acid	5.0	5.0	ND
2-chlorophenol	5.0	5.0	ND
2,4-dichlorophenol	5.0	5.0	ND
2,6-dichlorophenol	5.0	5.0	ND
2,4-dimethylphenol	5.0	5.0	ND
4,6-dinitro-0-cresol	5.0	5.0	ND
2,4-dinitrophenol	5.0	5.0	ND
2-methylphenol	5.0	5.0	ND
4-methylphenol	5.0	5.0	ND
2-nitrophenol	5.0	5.0	ND
4-nitrophenol	5.0	5.0	ND
4-Chloro-3-methyl phenol	5.0	5.0	ND
Pentachlorophenol	5.0	5.0	ND
Phenol	5.0	5.0	ND
2,4,5-trichlorophenol	5.0	5.0	ND
2,4,6-trichlorophenol	5.0	5.0	ND
2,3,4,6-tetrachlorophenol	5.0	5.0	ND
2-chloro-o-cresol (cresol)	5.0	5.0	ND

Date of Extraction: 2/28/01 Analyst: SS1
Date of Analysis: 3/1/01 Analyst: JG3

PROCESS WASTEWATER GRAB RESULTS 2/23/01

Parameter	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
PCB's (Method EPA 3510B, 3665, 3620A, 608)			
Arochlor 1016	0.1	0.1	ND
Arochlor 1221	0.1	0.1	ND
Arochlor 1232	0.1	0.1	ND
Arochlor 1242	0.1	0.1	ND
Arochlor 1248	0.1	0.1	ND
Arochlor 1254	0.1	0.1	ND
Arochlor 1260	0.1	0.1	ND

Date of Extraction: 2/27/01 Analyst: SS1
Date of Analysis: 3/1/01 Analyst: JG3

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WASTEWATER ANALYSIS REPORT
Lab. No. : 01-0671A

PROCESS WASTEWATER GRAB RESULTS 2/23/01

Parameter	MDL (ppb)	LOD-S (ppb)	RESULTS (ppb)
PESTICIDES/HERBICIDES (Method EPA 3500A, 3510B, 3620A, 8151, 608)			
a-BHC	0.01	0.01	ND
b-BHC	0.01	0.01	ND
d-BHC	0.01	0.01	ND
Lindane	0.01	0.01	ND
Heptachlor	0.01	0.01	ND
Aldrin	0.01	0.01	ND
Heptachlor Epoxide	0.01	0.01	ND
Endosulfan I	0.01	0.01	ND
Dieldrin	0.01	0.01	ND
4,4'- DDD	0.01	0.01	ND
4,4'- DDE	0.01	0.01	ND
Endrin	0.01	0.01	ND
Endosulfan II	0.01	0.01	ND
Endosulfan Sulfate	0.01	0.01	ND
4,4'- DDT	0.01	0.01	ND
Methoxychlor	0.01	0.01	ND
Endrin Ketone	0.01	0.01	ND
Endrin Aldehyde	0.01	0.01	ND
a-Chlordane	0.01	0.01	ND
g-Chlordane	0.01	0.01	ND
Toxaphene	1.00	1.00	ND
2,4-D	1.00	1.00	ND
Silvex	1.00	1.00	ND

Date of Extraction (Pesticide): 2/27/01 Analyst: SS1
Date of Extraction (Herbicide): 2/28/01 Analyst: LS
Date of Analysis (Pesticide): 3/5/01 Analyst: JG3
Date of Analysis (Herbicide): 3/6/01 Analyst: JG3

BOD-1 - Started: 2/24/01 Completed: 2/26/01
BOD-3 - Started: 2/24/01 Completed: 2/27/01
BOD-5 - Started: 2/24/01 Completed: 3/01/01
ND = Not Detected or less than LOD-S
NA = Not Applicable or Not Analyzed
LOD-S = Limit of Detection for the reported sample(s)
Trip/Field Blank Submitted: No
Test Parameters Subcontracted: None
Results are reported in ppm or ppb.

RTI LABORATORIES, INC.
Chemical, Metallurgical & Environmental Testing

WASTEWATER ANALYSIS REPORT Page : 7
Lab. No. : 01-0671A

All sampling and analyses reports are in accordance with the methods and techniques specified in 40 CFR Part 136 and any amendments.
Issuing of this report certifies that all cited method control criteria have been met unless otherwise indicated or qualified in the quality control section.

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MAR-06-01 15:54 FROM:RTI LABORATORIES INC. ID:7344225342 PAGE 9/9

CHAIN OF CUSTODY

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PO # _____
RTI Lab # 01-[illegible] (LAB ONLY)

SUBMITTING COMPANY	PROJECT NAME	PROJECT NO.

SPECIAL INSTRUCTIONS / COMMENTS

South Macomb Co. LF
24 mile Rd Card Rd

REPORT TO: CONTACT NAME: Dan Duffy
COMPANY: Petro Env Tech
ADDRESS:
CITY, STATE, ZIP:
PHONE:
FAX:

BILL TO:

SAMPLE I.D.	DATE	TIME	GRAB	COMPOSITE	NO. OF CONTAINERS	SAMPLE TYPE (water, soil, air, sludge, etc.)	PRESERVATION Y	PRESERVATION N	BOD	TSS	TP	10 DISSD metals	TCN	FOG	VOA TTC	SVOC TTC	PCB TTC	LAB WEIGHT TO H+P	TOTAL phenols	SOIL WEIGHT	TOTAL WEIGHT	Comments on Sample (include Major Contaminants
Discharge Leachate Eff	2-23-01	1015	X			Wastewater Leachate			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				PH 4.71
																						Temperature 5.5
																						2-23-01 1015 SJ
BLANK # ( )						METHANOL																

COLLECTED BY:	DATE / TIME:	RECEIVED BY:
Stephan Jordan	2-23-01 1015	[signature]
RELINQUISHED BY: [signature]	DATE / TIME: 2-23-01 1020	RECEIVED BY: [signature]
RELINQUISHED BY:	DATE / TIME: 2-23-01 15:15	RECEIVED BY: [signature]
RELINQUISHED BY:	DATE / TIME:	RECEIVED BY:

ADDITIONAL REMARKS:

SAMPLE CONDITION UPON LAB RECEIPT (LAB ONLY)

- Seals Intact Upon Receipt ☐ Yes ☐ No ☒ N/A
- Broken Containers ☐ Yes ☒ No ☐ Samples Stored @ 4°C
- All Containers Labeled ☒ Yes ☐ No ☐ Lab Received Samples On Ice

REQUIRED TURNAROUND TIME:

Date Results Needed By: _____

☒ Routine ☐ Rush ☐ Internal Rush

WHITE: LABORATORY YELLOW: CLIENT

TABLE 1.2
PHYSICAL HAZARD SUMMARY
MACOMB COUNTY LANDFILL SITE
MACOMB COUNTY, MICHIGAN

Activity	***Potential Hazard***	***Hazard Prevention***
Groundwater, Leachate, Gas Vents, Clearing and Grubbing, Regrading, Final Cover, Seeding and Mulching	slip/trip/fall	wear proper safety boots avoid muddy slippery areas avoid horseplay work carefully keep work area neat
	excess dust	use dust suppressants, e.g. water
	sunburn	use proper sun block
	ticks/insects	wear full coveralls use hair net and/or hood tyvek use insect repellent
	noise	wear proper hearing protection (29 CFR 1910.95)
	organic/explosive vapors (methane, hydrogen, sulfide)	conduct air monitoring use action levels as stated in HASP
	snakes	avoid walking in brush be alert
	heavy equipment	use only personnel trained in drill rig operations give heavy equipment right-of-way exercise extreme caution wear reflecting vests do not walk under boom
	cuts/scrapes	wear proper PPE Level C wear gloves
	back strain	use proper lifting methods
	electrical cables	check and mark buried cables avoid overhead lines follow 29 CFR 1910.180

4.0 RESPONSIBILITIES AND ADMINISTRATION

Petro Environmental will designate an individual to act as the on-Site Health and Safety Officer and will be responsible for the health and safety of workers. The HSO will be responsible for decisions regarding when work will be stopped or started for health and safety considerations.

The responsibilities of the HSO are as follows:

i) be responsible for implementation of the HASP at the initiation of Site work;
ii) conduct the initial briefing sessions for all on-Site personnel with regard to the HASP and other safety requirements to be observed during field construction activities, including:

    a) potential hazards,
    b) personal hygiene principles,
    c) personal protective equipment, and
    d) emergency procedures dealing with fire and medical situations;

iii) review and modify the HASP as more information becomes available concerning the hazards involved, and review all monitoring reports;
iv) supervise and enforce safety equipment usage;
v) supervise and inspect maintenance of safety equipment;
vi) personnel training in safety equipment usage and emergency procedures;
vii) monitoring of the health and safety program;
viii) suspend work activity if unsafe working conditions develop;
ix) inform workers of the nature of chemical exposure risk as required by the "Right-to-Know" Law (29 CFR 1910.1200);
x) coordination of emergency procedures;
xi) maintain a sign in/out log at the Site office for personnel and visitors entering the Work Area.
xii) conducting air monitoring

5.0 MEDICAL SURVEILLANCE

In accordance with requirements detailed in 29 CFR 1910.120 and 29 CFR 1910.134, as Site personnel are not expected to come in contact with potentially contaminated materials, medical surveillance by a licensed physician or physician's group is not required. However, medical surveillance will be required for personnel trained in the use of respirators.

Medical records for all on-Site construction personnel will be maintained by their respective employers. The medical records will detail the tests that were taken and will include a copy of the consulting physician's statement regarding the tests and the employee's suitability for work.

Each employer will ensure that its personnel involved in on-Site work will have all necessary medical examinations prior to commencing work that requires respiratory protection. Personnel not obtaining medical certification will not perform refuse regrading work within the Macomb County Landfill.

Interim medical surveillance will be completed if an individual exhibits poor health or high stress responses due to on-Site activity or when accidental exposure to elevated concentrations of contaminants occurs. Periodic or special exams are administered only as needed and are not scheduled on a regular basis.

6.0 TRAINING

Prior to commencing Site activities, a Site-specific initiation session will be conducted. This session will be used to instruct the on-Site personnel as to what the potential Site hazards are, level of PPE required, Site-specific requirements, and the basis of the Health and Safety Plan. All personnel who attend this session will sign a Training Acknowledgment Form, an example of which is presented as Attachment I. Each employer will be required to verify that operators and helpers have been adequately trained for the equipment they will be using.

7.0 WORK AREAS

Petro Environmental will clearly layout and identify work areas in the field and will limit equipment, operations and personnel in these areas. These work areas may be established as temporary or permanent; depending on the work activity and the sequence in which it is performed.

Petro Environmental will maintain the following:

i) an entry for personnel, material and equipment to the work area;
ii) an exit area for personnel, materials and equipment from the work area;
iii) the housing of Site special services;
iv) a storage area for clean safety and work equipment and materials; and
v) a Site support area including Site offices, toilet facilities and parking.

8.0 PERSONAL PROTECTIVE EQUIPMENT

Petro Environmental will require that all on-Site personnel are equipped with PPE appropriate for the nature of work being completed. Petro Environmental will require that all safety equipment and protective clothing are kept clean, well maintained and that their integrity is intact.

Safety equipment and apparel as required for general work on Site will be Level D.

Level D protective equipment consists of the following:

i) work boots with steel toe and shank;
ii) hard hat;
iii) latex and/or cotton gloves; and
iv) safety glasses and/or goggles.

Modified Level C protective equipment, which will be used on site should it be found necessary (1), consists of the following:

i) chemical-resistant disposable coveralls, tyvek (polyethylene);
ii) latex and/or cotton inner gloves;
iii) nitrile outer gloves
iv) work boots with steel toe and shank;
v) chemical-resistant overboots or booties, butyl rubber or neoprene;
vi) hard hat;
vii) safety glasses and/or chemical-resistant goggles; and
viii) half-face or full-face NIOSH approved air-purifying respirators with appropriate cartridges for organic vapors and particulates.

Additional protective equipment usage guidelines to be implemented include:

i) prescription eyeglasses in use on the Site will be safety glasses;
ii) contact lenses will not be permitted;
iii) all disposable or reusable nitrile, latex and/or cotton gloves worn on the Site will be changed or discarded at the end of each day;
iv) during periods of respirator usage, respirator cartridges and filters will be changed daily, or upon breakthrough, whichever occurs first;
v) on-Site personnel who have not passed a respirator fit test will not be permitted to enter or work on refuse regrading operations. Personnel will not be permitted to have beards, or long sideburns or mustaches as these interfere with a proper fit of the respirator;
vi) duct tape will be used to ensure that disposable coveralls and gloves are tightly secured when personnel are working within refuse regrading areas; and

vii) no watches, rings or other accessories will be permitted during refuse regrading activities.

(1) The HSO or his designated representative will observe work areas for visible signs of hazardous chemical or waste. Should an apparent hazardous waste source be observed, work adjacent to the potential source will be halted immediately. The area in question will be cordoned off with yellow warning tape. Samples of the suspected hazardous waste will be taken and analyzed at a local laboratory. Should the sample indicate the presence of dangerous levels of hazardous waste, employees working in the area will wear level C protection.

9.0 RESPIRATOR PROGRAM

It is not anticipated that respirators will be required during implementation construction activities except during refuse regrading activities when respirators may be required. Prior to arriving at the Site, on-Site personnel designated to work in refuse regrading areas will have received training in the use of, and have been fit tested for, either half or full-facepiece respirators. All on-Site personnel will be required to comply with their employer-specific written respiratory protection program developed in accordance with OSHA 29 CFR 1910.134, which will be attached to each employers Site-specific HASP. A copy of Petro Environmental's written respiratory protection program is included in Attachment II.

10.0 PERSONAL HYGIENE

All personnel performing or supervising work within the work area will be required to comply with the personal hygiene-related provisions of this section.

On-Site personnel found to be disregarding the personal hygiene-related provisions of this HASP will, at the direction of the HSO, be barred from the Site.

Each employer will be required to ensure that the following equipment/facilities are available for the personal hygiene of all their on-Site personnel:

i) suitable disposable outerwear, gloves, and footwear on a daily basis for the use of on-Site personnel;
ii) disposal containers for used disposable outerwear;
iii) potable water and a suitable sanitation facility;
iv) lunch area; and
v) smoke area.

The following regulations for personnel actively participating in the work activities will be enforced:

i) on-Site personnel will wear appropriate PPE when in the work area;
ii) used disposable outerwear will not be reused if deemed to be unsuitable to provide the necessary protection, and when removed, will be placed inside disposal containers provided for that purpose.
iii) on-Site personnel will thoroughly cleanse their hands, face, neck area and other exposed areas before smoking, eating or drinking and before leaving the Site.

11.0 AIR MONITORING

Prior to and during implementation of work activities, engineering controls, such as wetting the surface of the work area prior to during earth moving activities to minimize the generation of dust, will be implemented as directed by the HSO.

Real-time air monitoring for total VOC's will be conducted by using a Hnu with a 11.7 eV probe or a PID with a 10.6 Electron Volt (eV) probe during the refuse regrading activities. Additionally, during refuse regrading activities, a combustible gas meter will be used to measure % LEL.

Calibrations of all monitoring equipment will be performed on a daily basis and recorded in the Site log book. The Project Manager will be notified when results indicate excessive exposure to workers and or modifications to existing Site protocols are required

12.0 PARTICULATE EMISSION CONTROL

During remedial activities, a dust control program will be implemented and strictly enforced to minimize the generation and potential off-Site migration of fugitive particulate emissions. Excavations and excavated material will be kept moist while uncovered due to Site activities.

All roadways, designated work areas and other possible sources of dust generation will be controlled by application of water as required.

13.0 EQUIPMENT AND PERSONNEL CLEANING

During the initiation of the field investigative program, procedures will be implemented to reduce the amount of contact of both personnel and equipment with the refuse constituents. These procedures include the following:

i) proper work practices that would lead to minimal direct contact with refuse material; and
ii) use of disposable equipment and clothing as much as practicable.

All personnel will remove their protective clothing and wash their hands, face, neck area and other exposed areas before entering the lunch and break areas to eat, drink or smoke.

Waste materials generated during construction activities (used PPE, miscellaneous trash, etc.) will be secured in plastic bags on Site until such time as they can be transferred to and be placed under the proposed final cover.

14.0 WASTE MIGRATION CONTROL

All vehicles and equipment used within the work area will be cleaned on Site as determined necessary by the HSO prior to leaving the Site. Cleaning, when required, will consist of the thorough cleaning of those parts of the equipment which come in contact with refuse or muddy material. The HSO will certify that each piece of equipment is clean prior to removal from the Site.

15.0 COMMUNICATIONS

Emergency numbers including police, fire, ambulance, hospital and appropriate directions to the hospital are presented in Table 1.3 and will be prominently posted in each construction office.

A route map to the nearest emergency medical facility is presented in Figure 1.1 and will be posted in each construction office. Prior to initiating Site activities, the emergency medical facility will be notified of Site activities to ensure preparedness to respond to any Site-related injuries.

EMERGENCY HOSPITAL ROUTE PAGE
Figure 1.1

(See attached)

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Search

Search Public Records on Mt Clemens General Hosp Before You Call

Mt Clemens General Hosp Website
1000 Harrington St, Mount Clemens, MI 48043
Phone: (586) 493-8000

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- Physicians & Surgeons Information Bureau
- Hospitals

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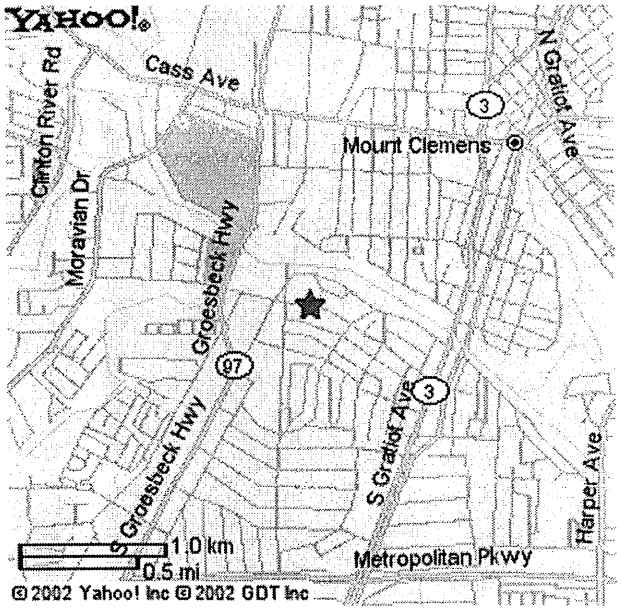
Map and Directions



Interactive Map

Driving Directions

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Mt Clemens General Hosp
1000 Harrington St, Mount Clemens, MI 48043
(586) 493-8000

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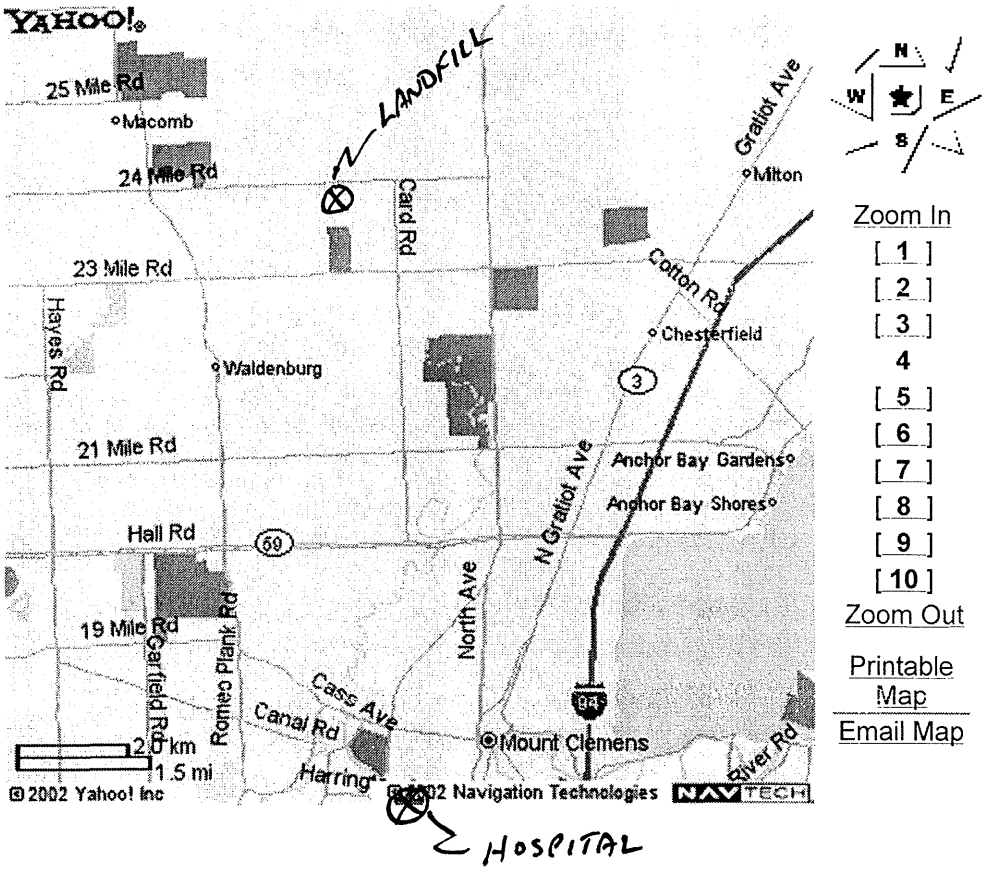

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Driving Directions

- To this location
- From this location

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-- My Locations -- Sign I

Address, Intersection or Airport Coc
1000 Harrington St

City, State or Zip
Mount Clemens, MI 480

United States

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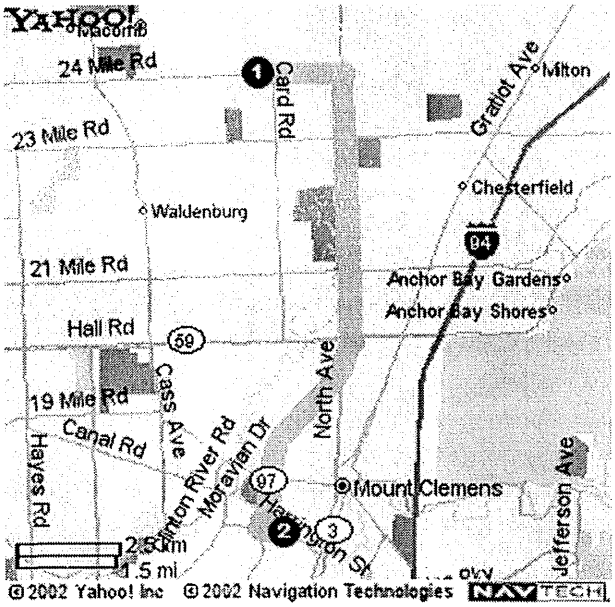
Starting from: 21290 24 Mile Road, Macomb, MI 48042

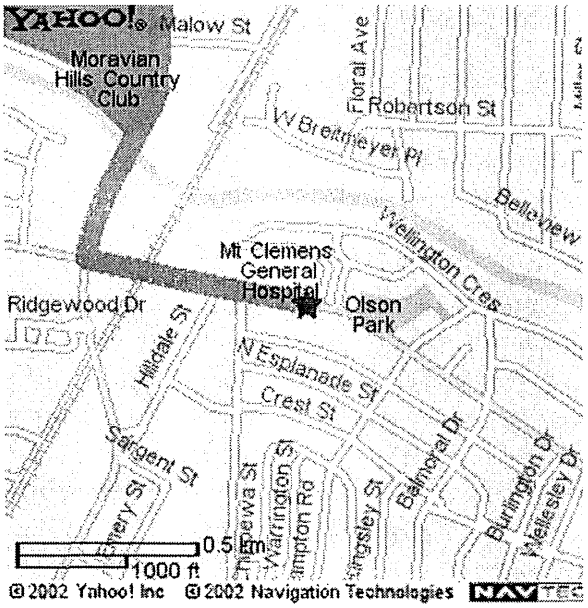
Arriving at: ★Mt Clemens General Hosp
1000 Harrington St, Mount Clemens, MI 48043-2920
(586) 493-8000

Distance: 9.0 miles **Approximate Travel Time:** 17 mins

- Email Directions
- Get Reverse Directions
- Text Only Driving Direct



Full Route



Destination

	Directions	Miles
1.	Start on **24 MILE RD** going towards **NORTH AVE**	1.2
2.	Turn Right on **NORTH AVE**	4.1
3.	Continue on **N GROESBECK HWY**	2.4
4.	Continue on **S GROESBECK HWY**	0.8
5.	Turn Left on **HARRINGTON ST**	0.4
6.	Arrive at destination	

TABLE 1.4

EMERGENCY TELEPHONE NUMBERS
MACOMB COUNTY LANDFILL
MACOMB COUNTY, MICHIGAN

General Emergency (Sheriff's Dept.)	911
Ambulance	911
Hospital (Medical First response) (1)	(810) 566-7666
Michigan Department of Public Health	(517)-373-3740
Macomb County Health Department	(810) 412-6393
Michigan DEQ	(734) 953-8905
Poison Control Center	(313) 745-5711
USEPA Emergency Response & Removal Branch	404/562-8705 (404/562-8700 24hr)
State Police	(810) 752-3521
Pollution Emergency Alert System (PEAS)	1-800-292-4706

Notes:

(1) Directions to Medical First Response Hospital from the Macomb County Landfill:

(See attached)

16.0 EMERGENCY CONTINGENCY PLAN

16.1 General Information

This plan is intended to provide immediate response to a serious Site occurrence such as injury, explosion or fire.

In the event of injury to on-Site personnel, the following protocol will be followed:

i) activate Site Alarm (three short blasts on air horn);
ii) notify the HSO;
iii) contact the designated hospital and describe the injury;
iv) administer appropriate first aid; and
v) transport personnel to the medical facility along a pre-defined route.

A route map to the Medical First Response Hospital is shown on Figure 1.1.
A map of the Site is shown on Figure 1.2

16.2 DRUM REMOVAL/COMPRESSED GAS CYLINDER WORK PLAN

In the event that a compressed cylinder or drum is encountered during remediation activities at the site, Petro Environmental will store it on-Site. Petro will have readily available the following spill control and overpacking equipment: Overpack drums, absorbent pads, 55-gallon drums, barricade tape, spark resistant tools and accident/incident reports.

If the release of a hazardous waste occurs from a drum, or a compressed gas cylinder is discovered that may be unstable, the primary concern will be the protection of personnel and the surrounding community. The situation will be contained as quickly as possible using the personnel and resources at hand. If it cannot be contained safely or remotely, evacuation of the zones will be necessary until an initial assessment of the situation can be made. Petro Environmental's emergency evacuation route is shown on Figure 1.3. It there is a potential threat to the surrounding community, notifications will be made. At a minimum, level B protection will be worn by personnel investigating a leaking drum or compressed cylinder. Air monitoring will be conducted using an organic vapor detector (Hnu) and 4-gas meter to determine for the presence of potentially hazardous constituents and oxygen levels. In the event of any hazardous material spills, the appropriate State and Federal emergency contacts listed in Table 1.4 will be notified. Prompt response to all on-site spills will minimize the risk that spilled material will migrate off-site. If necessary, berms, dikes, or trenches will be constructed, under the direction of the Project Manager and HSO to prevent any spills from migrating into the stream.

If a liquid spill does occur, it will be contained immediately using a small earthen dike established by hand shoveling, and all personnel will be wearing the appropriate level of personal protective equipment to be determined on a site specific basis. The contained liquid will then be cleaned up using a sorbent material . All materials used during cleanup activities will be drummed and stored on Site for later disposal. All drums and cylinders discovered will be overpacked and stored on-Site for later disposal.

16.3 INCIDENT REPORTING

After an emergency event has occurred and has been resolved, the Project Manager will conduct a meeting with all concerned individuals and all personnel on Site at the time of the event. This meeting will be held as soon as possible after the event. This meeting will be for discussions of the following topics, at a minimum:

- What was the cause of the event?
- What parts of the Contingency Plan worked well?
- What parts of the Contingency Plan did not work well?
- What is being done to correct the results of the incident?
- What is being done to prevent similar events from happening again?

17.0 EMERGENCY AND FIRST AID EQUIPMENT

Emergency safety equipment will be available for use by Site personnel and will be located and maintained on Site. The safety equipment will include, but is not limited to, the following:

i) two 20-pound ABC type dry chemical fire extinguishers;
ii) approved first-aid kit for a minimum of 25 personnel;
iii) fire blanket; and
iv) portable air horn.

18.0 HEAT STRESS

The combination of warm ambient temperature and protective clothing increases the potential for heat stress. In particular, heat stress can be evident as:

i) heat rash;
ii) heat cramps;
iii) heat exhaustion; and
iv) heat stroke.

These hazards will be discussed during daily safety meetings before commencement of work activities, when relevant. Personnel must increase consumption of water and electrolyte-containing beverages, such as Gatorade ™, during warm and hot weather conditions.

At a minimum, workers will break approximately every two hours for 10- to 15-minute rest periods. In addition, workers will be encouraged to take rests whenever they feel any adverse effects that may be heat related. The frequency of breaks may need to be increased upon worker recommendation to the HSO.

A work/rest schedule will be calculated based on heat stress monitoring results. Monitoring will consist of taking the radial pulse of a worker for 30 seconds immediately after exiting the work area. The frequency of monitoring the radial pulse will be as follows:

Ambient Temp.	*Level D PPE*	*Modified Level C PPE*
90.0F or above	After 45 min. of work	After 15 min. of work
87.50F - 900 F	After 60 min. of work	After 30 min. of work
82.50F - 87.50F	After 90 min. of work	After 60 min. of work
77.50F - 82.50F	After 120 min. of work	After 90 min. of work
72.50F - 77.50F	After 150 min. of work	After 120 min. of work

If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by 1/2 and the rest period will be kept the same. If the heat rate still exceeds 110 beats per minute at the next rest period, the following rest period will be increased by 1/3. The initial rest period will be at least five minutes.

Monitoring for heat stress will begin when the ambient temperature reaches or exceeds 700F when wearing modified Level C, Level C or Level B PPE, or 800F when wearing Level D PPE and humidity levels are above 50 percent. initial rest period will be at least five minutes.

19.0 COLD STRESS

With outdoor work in the winter months, the potential exists for hypothermia and frostbite.

Protective clothing greatly reduces the possibility of hypothermia in workers. However, personnel will be instructed to wear warm clothing and to stop work to obtain more clothing if they become too cold. Employees must also change into dry clothes if their clothing becomes wet from perspiration or from exposure to precipitation.

In cold weather, the potential for frostbite exists, especially in body extremities. Personnel must pay particular attention to hands, feet and any exposed skin when dressing. Personnel will be advised to obtain more clothing if they begin to experience loss of sensation due to cold exposure.

Employees will be encouraged to seek heated shelter at regular intervals, depending upon the severity of ambient temperatures. Symptoms of cold stress, including heavy shivering, excessive fatigue, drowsiness, irritability or euphoria will necessitate immediate return to the heated shelter.

20.0 POSTED REGULATIONS

Where appropriate, "No Smoking" signs will be posted at the work area entrance and on the perimeter of the work area in addition to signs which state "Work Area, Do No Enter Unless Authorized", or similar. In addition, a notice directing visitors to the office will be posted at the Site.

Safety regulations and safety reminders will be posted at conspicuous locations throughout the Site.

ATTACHMENT I - ACKNOWLEDGEMENT FORM

ATTACHMENT 1

TRAINING ACKNOWLEDGMENT FORM

Please Print:

NAME:

ADDRESS:

SOCIAL SECURITY NUMBER:

EMPLOYER:

JOB SITE: Macomb County Landfill Sites 9 and 9A

I have attended and understood the mandatory Site-specific initiation session for the above-referenced job site where I read or was provided with an explanation of the Health and Safety Plan. This program referenced the following topics:

i) known potential hazards on Site;
ii) level of personal protection equipment required;
iii) emergency procedures for the Site; and
iv) explanation of the basics of the Health and Safety Plan.

_____
Signature

_____
Date

ATTACHMENT II - RESPIRATOR PROGRAM

ATTACHMENT II

PETRO ENVIRONMENTAL'S RESPIRATORY PROTECTION PROGRAM

1. Policy

Appropriate respiratory protection shall be worn as specified by a facility or department's procedures or a project's Health and Safety plan.

When working within a client's facility, the respiratory protection requirements of the client or Petro Environmental shall be complied with, whichever is more stringent.

Only employees who have been medically cleared to wear respirators shall do so.

The respiratory protection and practices identified below are required for all employees while on a work site (either facility or project). This includes visits to clients' facilities and job walks as appropriate.

Only Petro Environmental authorized respirators shall be worn.

2. Scope

This policy applies to all Petro Environmental employees, visitors and contractors.

3. Provisions

A. Engineering Controls

Whenever practical, contaminant levels shall be reduced through engineering controls. These controls shall include ventilation, dust control and substitution of less toxic materials.

B. Selection

1. Selection of respirators shall be based on the hazards that might be encountered. Contaminant levels, toxicity and emergency conditions that might arise shall be considered in the selection of respiratory protection for a particular project or operation.

2. Unless otherwise approved by Petro Environmental Health and Safety Officers, at a minimum, fullface respirators with appropriate chemical cartridges and filters shall be worn whenever the presence of contaminants

is suspected or has been detected and the possibility exists that they may become airborne.

C. Facial Hair

All employees who may be required to wear a respirator in the course of their duties must be clean-shaven where the respirator touches the face when they report to work.

D. Fit Testing

1. Positive/Negative

Respirators must be fit tested to the user's face with a positive/negative fit test prior to *each* use to ensure proper sealing.

2. Qualitative

a) A qualitative (irritant smoke) test shall be administered to all new employees prior to the use of a respirator and at least annually thereafter.

b) Tests shall also be administered whenever:

1. Employees change makes, models or sizes of respirators;

2. Employees experience any condition which alters the configuration of the face; e.g. weight gain or loss of more than ten pounds, broken nose, loss of teeth, facial surgery; and

3. Employees perceive that their respirator does not seal properly.

c) The Petro Environmental Qualitative Respirator Fit Test Procedures shall be followed in administering the tests.

d) Qualitative fit tests shall be documented on a form such as the Respirator Fit Test Certificate.

E. Self-Contained Breathing Apparatus (SCBA, ALE)

1. Breathing air quality shall, at a minimum, meet the Compressed Gas Association's Grade D specification. A certification of air quality must be

obtained from the supplier at the time of purchase. If a certification is not obtained, the air must be tested and certified by a qualified lab prior to use.

2. SCBAs and ALEs must be inspected prior to each use or a least monthly. Records of inspections must be maintained for a minimum of twelve months.

F. Cleaning/Maintenance/Storage

1. If a respirator is not individually assigned, it must be cleaned and disinfected after each use.

2. Individually assigned respirators shall be cleaned as frequently as necessary to insure that proper protection is provided.

3. Respirators shall be inspected; straps, valves, facepiece, fittings, hoses, etc., and repaired as necessary after each cleaning.

4. Respirators shall be stored in tightly sealed containers in a location where the mask is not distorted and temperatures do not exceed 130°F.

G. Training

Once each calendar year, employees who are required to wear respirators shall be trained in the use of respiratory protection equipment. At a minimum, training shall include:

- Proper Selection
- Use
- Fit Testing Procedures (positive/negative and qualitative)
- Cleaning
- Maintenance
- Storage
- Limitation of Use

H. Responsibilities

The responsibility for enforcement of the Petro Environmental Respiratory Protection Policy is as follows:

1. Employees - each employee is responsible for:

   a) Following the instructions received in training;

   b) Selecting the proper respirator for a job; and

c) Insuring that their respirator fits properly and is clean and maintained in a serviceable condition.

2. Supervisor/Manager - the Supervisor/Manager is responsible for seeing that:

   a) Employees are properly fitted with the appropriate type of respirator;

   b) Employees receive respirator clearance exams (pulmonary function tests);

   c) Employees are properly trained;

   d) The use of respiratory equipment is enforced in situations/operations where such use is required;

   e) That respiratory protection equipment is readily available and accessible; and

   f) That conditions are evaluated which will allow for proper selection of respiratory protection.

3. Corporate Health and Safety Staff - the Corporate Health and Safety Staff will:

   a) Assist in specifying the types of respirators needed;

   b) Provide assistance in the training of Supervisors/Managers and employees; and

   c) Provide periodic, comprehensive audits of the respirator program. The Medical Monitoring ground will oversee respirator clearance exams.

QUALITATIVE RESPIRATOR FIT TEST GUIDELINES

Introduction

In order to achieve the maximum protection possible from a respirator, it must be worn properly and seal tightly against the user's face. If a respirator is not sealed properly against the face, contaminated air may enter the facepiece from around the edges of the mask during inhalation.

A respirator fit test determines the ability of a respirator wearer to obtain a satisfactory fit with a specific make, model and size of respirator. Briefly, the qualitative test consists of exposing a respirator wearer to an irritant smoke test agent. If the wearer is unable to detect penetration of the test agent into the respirator, the wearer has achieved a satisfactory fit.

The irritant smoke is produced by breaking the ends off a glass tube and connecting it to a squeeze bulb. As the bulb is squeezed and air is forced through the tube, moisture in the air reacts with the material in the tube (commonly stannic chloride or titanium tetrachloride) and produces hydrochloric acid which appears as smoke. The smoke is very irritating to the eyes and respiratory tract and must be used properly.

Frequency of Testing

Respirator fit tests shall be administered before initial assignment to jobs requiring he use of a respirator and at least annually thereafter.

Tests shall also be administered whenever:

1. Employees change makes, models or sizes of respirators;

2. Employees experience any activity which alters the configuration of the face; e.g. weight gain or loss of more than ten pounds, broken nose, loss of teeth, facial surgery; or

3. Employees perceive that their respirator does not seal properly.

Record Keeping

Respirator fit test records shall be kept for at least the duration of employment.

The records shall include:

1. Employee name

2. Employee number

3. Job title

4. Specific make, model, size and approval number of each respirator tested

5. Test results

6. Name of person administering test

7. Date

8. Testing agent

Test Procedures

1. Explain the purpose of the test and the test procedures to the employee.

2. Allow the employee to smell a weak concentration of the irritant smoke.

3. Inspect the respirator which will be worn (either the employee's own respirator or the one which will be used for the test) to insure that the straps, valves, facepiece etc. are in satisfactory condition. Refer to the manufacturer's literature for proper inspection procedures if necessary.

The respirator used in the test must be capable of filtering fumes in order to purify the test agent from inspired air. Make sure fume filters or cartridges are on the respirator before starting the test (regardless of which filters or cartridges an employee normally uses).

4. Have the individual put the respirator on and tighten the straps, position the facepiece etc. until the respirator is adjusted as he/she normally wears it.

5. Insure that the employee is clean shaven where the respirator touches the face.

If facial hair does interfere with the seal of the respirator, discontinue the test until the employee is clean shaven.

6. If this is the first test for an employee, have the employee wear the respirator for at least ten minutes before starting the test.

7. If a half-mask respirator is being tested, insure that the employees wear goggles during the test so that his/her eyes are protected from the smoke.

8. Once the respirator is adjusted, have the employee perform a positive/negative fit test.

If a seal cannot be obtained with a positive/negative fit test, have the employee change size or models until a good seal is obtained.

9. Have the employee stand in front of an exhaust hood or outdoors and instruct him/her to keep their eyes closed during the test even though goggles or a full face respirator are worn to avoid irritation of the eyes.

10. Keeping the smoke tube about two feet from the respirator, cautiously direct a minimal amount of smoke toward the center of the respirator which watching the wearer's reactions.

If the wearer is able to detect the smoke, stop the test. Instruct the employee to readjust the respirator and begin the test again at Step 6. In some cases, it may be necessary to change to a different size or model of respirator.

11. If the user does not detect the test agent, move the smoke tube progressively closer to the respirator, and increase the density of the smoke, until the tube is within 4" to 5" of the facepiece. (Do *not* move the tube closer than 4" because this distance is required for the hydrochloric acid vapor to condense and form smoke.)

Again, if smoke penetrates the facepiece, readjust the respirator, change sizes, etc. and return to Step 6.

12. If no leakage is detected, direct the smoke at potential points of leakage in the seal of the respirator; under the chin, along the jaws, across the nose pieces of half-masks, from a distance of approximately 4" to 5".

Again if leakage occurs, stop the test and return to Step 6.

13. Next, while directing smoke at the potential leakage points, have the user perform a series of exercises designed to simulate movements which he makes during a normal work period. Each exercise shall be performed for one minute.

These exercises include:

a) Turn the head from side to side. Inhale on each side.

b) Nodding the head up and down. Do not bump the respirator on the shoulders. Inhale in the up position.

c) Repeat the Rainbow Passage or count backward from 100.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long, round arch, with its path high above and its two ends apparently beyond the horizon. There is according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

Repeat the Rainbow Passage aloud.

d) Breath deeply. Be sure breaths are deep and regular.

e) Any other movements which might be specific to the respirator user's job, which might affect the seal of the respirator; e.g. bending over and touching the toes; squatting.

f) Jog in place.

If leakage is detected at any point during this portion of the test, return to Step 6.

14. If the wearer is unable to detect the penetration of smoke into the respirator, then a satisfactory fit has been obtained and approval shall be given for use of that particular respirator.

15. Repeat the entire test for each respirator the employee uses.

F:\CUR_JOBS\WC6-060\HASP96

Appendix B
Quality Assurance Program Plan (with Chain of Custody)

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.

QUALITY ASSURANCE PROGRAM PLAN

for

SOUTH MACOMB DISPOSAL AUTHORITY
LANDFILLS 9 AND 9A

Petro Environmental Technologies, Inc.
7851 Palace Drive
Cincinnati, Ohio 45249

January 2002

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LIST OF ACRONYMS

AM/S	Area Manager/Superintendent
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing and Materials
CD/TS	Construction Drawings and Technical Specifications
CFR	Code of Federal Regulations
CM	Construction Manager
CQAP	Contractor Quality Assurance Plan
CQC	Construction Quality Control
DCN	Design Change Notices
DCS	Document Control Specialist
DOE	Department of Energy
ECDC	Engineering/Construction Document Control
EHS&TRM	Environmental Health & Safety and Training Requirements Matrix
EPA	Environmental Protection Agency
FAR	Federal Acquisition Regulation
GS	General Superintendent
HDPE	High Density Polyethylene
NRF	Nonconformance Report Form
PE	Project Engineer
PM	Project Manger
PO	Purchase Order
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
QC	Quality Control
QCR	Quality Control Record
RCI	Request for Clarification of Information
S/HM	Safety and Health Manager
S/HR	Safety and Health Representative
SM	Site Manager
SSHP	Site Safety & Health Plan
TBCs	To Be Considered Criteria
USACE	U.S. Army Corps of Engineers

POLICY STATEMENT

This Quality Assurance Program Plan (QAPP) identifies and documents Quality Assurance requirements. This QAPP is but one of several planning documents employed by Petro Environmental Technologies, Inc. (Petro Environmental) for projects. Work performed by Petro Environmental shall comply with this Quality Assurance Program Plan. All Construction Quality Assurance (CQA) standards whether stated in the CQA plan, QAPP, or technical specifications are for internal Petro Environmental guidance and internal corporate documentation only.

PURPOSE AND SCOPE

The purpose of this Quality Assurance Program Plan (QAPP) is to define QA requirements for Petro Environmental projects. The QAPP was developed in response to DOE Order 5700.6C, Quality Assurance, and 10 CFR 830.120.

This Quality Assurance Program Plan has been prepared to provide assurance by Petro Environmental that work performed will be of the quality required to satisfy program objectives. This QAPP controls all work performed by Petro Environmental. QA requirements shall be applied to subcontractors through procure documents as applicable.

INTRODUCTION

Petro Environmental shall follow the Quality Assurance (QA)/Quality Control (QC) requirements as set forth in specific job specifications established by the Client. Additionally, Petro Environmental will institute the procedures outlined in this Quality Assurance Program Plan (QAPP). The procedures delineated in this QAPP will be employed to ensure overall project quality and compliance with project specifications. The procedures presented will describe the planned and systematic means and actions taken by Petro Environmental to ensure that the proper materials, equipment, construction methods, operations, and workmanship are provided such that the project is completed on schedule and in accordance with the Construction Drawings and Technical Specifications (CD/TS).

1.0 QUALITY ASSURANCE PROGRAM

This Quality Assurance Program Plan identifies ten sections which outline Petro Environmental's quality philosophy and strategy. The QAPP is controlled by the Document Control Specialist (DCS) for the Project Manager. It will be revised by the QA Coordinator and the Project Manager as required to meet the needs of the specific project. Revisions will require approvals at the same levels as the original document. The QAPP summarizes the overall organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing the work. As appropriate, planning documents should address administrative, technical, safety, environmental and quality assurance issues. The Project Manager is responsible for assigning responsibility for preparation of planning documents. The following are the primary Petro Environmental project planning documents:

- Site-Specific Work Plans – Define site activity requirements.

- Quality Assurance Project Plans (QAPjP) – Define QA requirements for a particular task/project.

- Site-Specific Health and Safety Plans – Project planning documents must be reviewed by the affected organizations, and comment resolution must be documented. Records showing document review for the current version will be maintained.

- Contractor Quality Control Plans – Plan in conjunction with QAPjP to ensure that the proper materials, equipment, construction methods and operations are provided in accordance with contract requirements and project schedule.

1.1 Organizational Structure

Petro Environmental is committed to establishing an organizational and management structure to ensure the successful completion of this project. Figure 1 (Appendix A) is an organizational chart showing the lines of authority for general phases of work during a project. Petro Environmental's home office will support the on-site management team through its owners and Payroll Administrator. The Project Manager (PM) will report directly to the Owners and shall coordinate and manage the day-to-day activities of the project. Reporting directly to the PM will be the General Superintendent (GS), who is principally responsible for directing the Area Managers/Superintendents (AM/S) for their defined work areas. As shown in Figure 1, reporting directly to the GS are the AM/S, each responsible for coordinating, organizing, and exercising authority over the completion of their phase of the project. Reporting directly to the AM/S will be Field Foremen/ Superintendents who will direct work conducted by laborers and operators within each specific work area. The AM/S shall also provide direct supervision to any subcontractor's Foremen contracted to perform specialty trade work within their work area. The Quality Assurance Manager (QAM) and the Safety and Health Manager (S/HM) report directly and only to the PM for coordination of daily activities, however, they have no responsibility for, and are completely independent of, all project cost and schedule issues. All field QC Inspectors and Safety & Health Representatives (S/HRs) individually assigned to a work area will report directly to the QAM and S/HM, respectively. Finally, all on-site administrative support needs will be handled by the Project Administrator.

1.2 Duties & Responsibilities

1.2.1 Upper Level Management

Petro Environmental's Officers shall form the upper level management support required to successfully complete the project. The owners of Petro Environmental will be responsible for providing overall guidance to the project personnel assigned to complete the work for the project.

1.2.2 Project Manager

The Project Manager (PM) will report directly to the Owners of Petro Environmental and shall be responsible for the overall coordination and management of the project. The PM shall also be responsible for: establishing and maintaining communication with the Client's vendors, subcontractors; procurement/financial

activities; directing Petro Environmental's AM/S; and other related plans required for the performance of work. Ultimately, the PM is accountable for quality, safety, engineering submittals, scheduling, budgeting, work plans, contract administration and change order management. The other key management positions (i.e. - GS, S/HM, QAM, etc.) and other corporate resources shall be utilized by the PM, as required, to implement work plans, ensure a safe working environment and direct construction activities.

1.2.3 General Superintendent

The GS reports to the PM and directs/controls the daily field activities of Petro Environmental's personnel, equipment, sub-tier subcontractors and suppliers. The GS will be principally responsible for directing the Area Managers/Superintendents (AM/S) for the defined work areas. His oversight will be to ensure that construction activities within the defined work areas are in compliance with all planning documents, QA/QC requirements, and the CD/TS. The GS will also assist with scheduling, resource allocation, engineering and the preparation of technical submittals. He will be assisted in this endeavor by Petro Environmental's Safety and Quality Control Staff.

1.2.4 Project Engineer

The main responsibilities of the PE will be to provide engineering support to the management team, prepare engineering technical and other material-related submittals as required per the Technical Specifications, and maintain all As-Built Drawings. Petro Environmental's QAM, will assist the PE in this capacity by preparing the completed documents for submittal to Engineering/Construction Document Control (ECDC).

1.2.5 Quality Assurance Manager

The Quality Assurance Manager (QAM) reports only to the PM and is principally responsible for ensuring and documenting that the proper materials, equipment, construction methods and operations are provided in accordance with the CD/TS. More specifically, the QAM's responsibilities shall include: managing and overseeing all subcontractor-required QC activities and ensuring that all QC Inspectors are performing their field-related tasks as required; verifying that all subcontractor-required phases of the project and Petro Environmental's QAP are being implemented; providing QC orientation/training to on-site employees, as required; establishing and performing the three-phase system of QC for both workmanship and materials; documenting all inspection-related activities and maintaining all QC reports and associated documentation; implementing all nonconformance procedures and corrective action processes; maintaining control of Client-issued Control Documents; verifying the performance of work is in compliance with all CD/TS; and ensuring that all project-related submittals are processed and completed as required by contract. The QAM will complete all QC & Safety-related submittals and may assist in preparing some material-related submittals; all engineering-related submittals will be completed by others. The QAM shall be responsible for tracking and monitoring the status of all submittals via a submittal

register. The QC Staff will assume the responsibility of distributing all Client-approved submittals to the field staff, as necessary.

The QAM shall have the authority to stop any aspect of the project due to poor workmanship; the delivery of non-conformable materials; use of improper equipment to complete work tasks, including unacceptable methods/work protocols; or any other aspect of this project that is determined to be in noncompliance with Construction Drawings and Technical Specifications. Any affect such incidents may have on project costs or schedules shall be the responsibility of the PM. All QA/QC Managers for various contractor subcontractors will report to Petro Environmental's QAM, who will ensure that all aspects of this project are completed in accordance with the CD/TS. The QAM will also closely coordinate all QA/QC activities with the Client's QA staff and the Construction Quality Control (CQC) Consultant.

1.2.6 Quality Control Inspectors

QC Inspectors may be assigned to a project at various stages to conduct field-related QC inspections for areas of work depending on the size and nature of the project. A QC Inspector is independent from each AM/S and GS, and reports directly to the QAM. Their responsibilities will entail: inspecting all of the work-related activities associated within their particularly assigned area to ensure compliance with the CD/TS; verifying accuracy of field and/or laboratory soil testing results performed by CQC Consultant; informing the AM/S and QAM of any discrepancies between the CD/TS and the actual field conditions; distributing project-related documentation to the AM/S in a timely manner; maintaining a daily log of all construction activities occurring within their assigned area; implementing and verifying all QC procedures required by the various project-related documents; and assisting the QAM as needed/required via conducting Initial Phase QC meetings, providing field training to on-site field staff as warranted, performing monthly inspections, inspecting delivered materials and completing Material Inventory Logs, etc.

1.2.7 Safety & Health Manager

The Safety & Health Manager (S/HM) shall implement and enforce the Site Safety & Health Plan (SSHP) and all Client safety requirements, oversee and manage the activities of each S/HR assigned to particular work areas, participate in weekly safety inspections of all active work areas, and ensure that all safety-related documentation is being completed as required by the contract. The S/HM shall be assigned to the site on a full-time basis for the entire duration of the field activities and shall have no other duties than Safety and Health-related responsibilities. The S/HM shall work in conjunction with the QAM on matters relating to safety and health, and shall have the authority to stop work if unacceptable health or safety conditions exist.

1.2.8 Safety & Health Representatives

A S/HR may be individually assigned to conduct field-related safety and health inspections at one or more areas of work, depending on the size and nature of the project. The S/HR's responsibilities will entail: inspecting all of work-related activities associated with his particularly-assigned area to ensure compliance with all site-related safety and health documents, permits, the Environmental Health & Safety and Training Requirements Matrix (EHS&TRM), SSHP, Final Safe Work Plan, etc.; conducting and documenting daily and weekly safety meetings; holding safety briefings and coordinating/presenting safety-specific training sessions as needed; informing the AM/S and S/HM of any discrepancies between these health and safety documents and actual field conditions; distributing project-related documentation to the AM/S in a timely manner; maintaining a daily log of construction activities occurring within his assigned area(s); and assisting the S/HM as needed/required.

1.2.9 Area Managers/Superintendents

Petro Environmental may employ an AM/S for each designated work area, as needed, depending on the size and nature of the project. The primary responsibilities of each AM/S will be to: direct all area Field Foremen/Superintendents during the performance of work in order to ensure a smooth and efficient completion of the work tasks, provide key management oversight and direction to the tasks being completed within each of the defined areas, verify that all work is being completed in accordance with the CD/TS, ensure that all work is performed and completed in a safe manner and that quality workmanship is obtained, and complete daily documentation as required or warranted. Each AM/S shall also provide direct supervision to any subcontractor's Foreman contracted to perform specialty trade work within their work area.

1.2.10 Field Foremen/Superintendents

The Field Foremen/Superintendents report directly to the AM/S and are responsible for organizing manpower, materials and equipment to complete their assigned tasks.

1.2.11 Project Administration

The Project Administrator will be responsible for assisting all key management staff as needed, maintaining training records for on-site employees to ensure that all are current on their required training, interface with Union personnel as necessary, administer the termination procedures to employees terminated from this project, complete and distribute project-related correspondence as needed, and respond to incoming telephone calls.

1.3 Orientation/Training

To ensure that a high quality product is delivered throughout the performance of work and to assure that all work is completed in accordance with CD/TS, all on-site personnel will be trained to understand the project and the expected quality of work. The first step in accomplishing this goal will be to conduct an initial on-site orientation and training program with all pertinent project personnel prior to the beginning of field activities. All

personnel will be required to sign an employee indoctrination sheet signifying that they attended the orientation/training meeting (see Appendix B). These forms will be maintained on file as part of the Quality Control Records (QCR), located in Petro Environmental's Administration Office Trailer. Topics to be addressed during employee indoctrination will include, but not be limited to:

- Overall scope and goals of project
- Client rules, regulations, and policies
- General safety policy and pertinent provisions of the SSHP
- Requirements for employee safety and health - Final Safe Work Plan and EHS&TRM
- Medical facilities and required treatment procedures (i.e. - work-related injuries)
- Personal protective clothing
- Safety/Health and QC Structure; identification of Safety and QC Personnel
- General QC procedures; QC goals and objectives
- The Three Phase QC Program:
  - Preparatory Phase Meetings
  - Initial Phase Meetings
  - Follow-Up Phase Inspections
- Final Inspections and approval of work
- Awareness of quality of work, notification of unsatisfactory work to QAM
- Notices of deficiency and deficiency tracking procedures
- Re-work and repairs - quality of such work
- Daily reporting requirements to QAM by subcontractors

Carefully reviewing the qualifications of all subcontractors and their personnel prior to initiating field activities and implementing and utilizing the three phase system of QC, will help to ensure that all project personnel are properly trained. This system will also provide a check that the correct procedures are being used in the field during the performance of work and that all completed tasks are in compliance with contract documents. The result will be a product that is of high quality and in conformance with all CD/TS.

2.0 PERSONNEL TRAINING AND QUALIFICATIONS

The QAM and S/HM will be responsible for ensuring that all pertinent project personnel and sub-tier contractors are appropriately trained to perform their associated tasks. This will be accomplished by requiring that sub-tier contractors submit to Petro Environmental the appropriate documentation demonstrating their personnel's qualifications and experience to complete the corresponding tasks for which their firm was hired. Any additional Client on-site training requirements will be scheduled and administered by qualified on-site personnel prior to allowing sub-tier contractor personnel to begin work. Documentation of such training will be completed and maintained as part of the QCR.

In addition to initial orientation and training, a three phase system of QC will be implemented and utilized throughout the course of this project.

2.1 Preparatory Phase

The Preparatory Phase will be performed prior to the beginning of work for each pay item description or definable work features (e.g. - liner installation, seeding, etc.). The meeting will be an open discussion between: Petro Environmental, pertinent subcontractor personnel, the CQC Consultant (if required), and any additional on-site personnel as stipulated or required by the contract. This meeting will address the scope of work to be completed, CD/TS, quality of workmanship, potential safety hazards, equipment requirements, and any necessary training and/or permit requirements. Any individual not properly trained to complete such work will either be trained accordingly or not permitted to perform such work. Minutes of this meeting will be documented on a "Preparatory Phase Meeting Minutes" form and maintained as a part of the QCR (sample included in Appendix B).

2.2 Initial Phase

The second phase of QC to be implemented will be the Initial Phase Meeting. This phase will occur at the beginning of a definable work feature. This meeting will provide a review of the Preparatory Phase Meeting minutes, confirm the procedures to be implemented, and add any further explanation to improve the quality of work. Again, the minutes of this meeting will be documented on an "Initial Phase Meeting Minutes" form (sample included in Appendix B) and maintained as a part of the QCR. Any individual not performing the required tasks in conformance with QC standards will be notified of such, instructed as to the proper procedures to employ during his/her performance of work, and monitored accordingly.

2.3 Follow-Up Phase

The third phase of QC is the Follow-Up Phase. This phase, to be performed by the QC Inspectors, involves conducting daily checks, including any required control testing, to assure continuing compliance with CD/TS. Follow-Up Inspections are performed until a particular work feature is fully completed. Final follow-up checks will be conducted and all deficiencies corrected prior to the start of additional features of work. Documentation of these inspections will be provided on a "Follow-Up Inspection" form (sample included in Appendix B) and maintained as part of the QCR.

3.0 QUALITY IMPROVEMENTS

3.1 Nonconformance Procedures

Nonconformance is defined as material or workmanship that does not meet the specified requirement(s). Items of deficiency will be identified in the field via QC field inspectors and/or by the QAM conducting daily Follow-Up Inspections during the performance of work, or by the QAM reviewing the manufacturer's QC certificates. Any items of nonconformance identified by parties other than Petro Environmental must be reported to the QAM for inclusion into the daily report. Each item reported to be deficient with the CD/TS will be recorded on a Nonconformance Report Form (NRF)(see Appendix B), and thoroughly investigated. Materials determined to be non-conformant will be identified by a red-tag attached by the QAM and labeled so as to clearly indicate that material is not to be used on this project. Corrective actions shall be reviewed and implemented as agreed

to by all pertinent parties, with the final resolution recorded and documented. At a minimum, the NRF will document the following information:

- A unique identifying sheet number for cross-referencing and document control;
- Detailed description of the problem;
- Location of the problem;
- Probable cause;
- How and when the problem was located:
- Estimation of how long the problem has existed;
- Suggested corrective action;
- Documentation of correction (reference to inspection data sheets);
- Final resolution;
- Suggested method to prevent similar problems; and,
- Signature of appropriate QC Inspector or QAM, CQC Field Monitor, and concurrence by the CQC Site Manager (SM).

Instances of nonconformance shall be fully investigated and documented to prevent and avoid similar occurrences in the future. When NRF's are generated by Petro Environmental's QC Staff, the QAM will distribute the NRF to ECDC, the CQC SM, and the Client's Construction Manager (CM) for further discussion/action as deemed necessary or required. Additionally, any NRF's issued on a particular day shall be attached to the corresponding Daily QC Report and submitted accordingly for distribution to the Client and the CQC Consultant.

3.2 Corrective Action Approval Process

Instances of nonconformance can be identified and reported to Petro Environmental via field staff (i.e. - employees, QC Inspectors), the management team (i.e. - AM/S, QAM) and/or the CQC Consultant or CLIENT personnel. Whenever an instance of nonconformance arises, Petro Environmental's QAM shall be immediately notified. The QAM will conduct an initial site investigation to determine the validity of the reported deficiency. Very minor infractions will be corrected prior to allowing work to proceed, will be fully documented on a NRF by the QAM, and the CQC SM shall be notified. Immediate steps will be taken with all pertinent on-site personnel to prevent the reoccurrence of such an infraction (i.e. - on-site training, specification clarification, etc.). In the event of significant nonconformances, the QAM shall notify Petro Environmental's PM, the CQC SM and the Client's CM. An investigation of the nonconformance shall be conducted to determine the validity and the magnitude of the deficiency. Depending upon the nature of the situation, a meeting may be scheduled to discuss the nature of the problem and recommended corrective measures. Upon agreement with all appropriate parties, the approved corrective measure will be employed, along with any additional QC control procedures to avoid similar nonconformances. Throughout the entire corrective action process, all information will be fully documented and maintained as part of the QCR. Copies of all NRF's shall be submitted to ECDC, the Client and the CQC Consultant as directed.

3.3 Control of Materials/Workmanship

As part of the joint material inspection process with the CQC Consultant, Petro Environmental's QAM will match purchase order (PO) requisitions with material bills of lading and the manufacturer's QA/QC documentation to ensure that nonconforming materials have not been delivered to the jobsite. In the event that nonconformable materials are delivered, the materials will be identified, red-tagged, marked as nonconformable for use, and segregated from all conformable materials. All such nonconformable materials will be sent back to the vendor. Concerning nonconformable workmanship, the QAM will make every effort to ensure that only qualified and trained personnel are present on the jobsite. As previously mentioned in Section 2.0, the three phase system of QC will be employed to check on the quality of workmanship. All nonconformable workmanship will be addressed as described in Section 3.1.

4.0 DOCUMENTS & RECORDS

4.1 Control of ECDC-Issued Controlled Documents

All ECDC-issued controlled documents will be handled only by the QAM for distribution to Petro Environmental's Managers, QC Inspectors and sub-tier subcontractors. Upon initially receiving such documents, the QAM will verify that ECDC numbers correspond with those on the corresponding transmittal form, Supplier Submittal Form and Petro Environmental's submittal register; verify the document name, document number, and date received. The QAM shall then identify the number of managers and on-site subcontractors requiring copies of controlled documents, obtain the proper quantity from ECDC, and then distribute to each pertinent party. Each person receiving controlled documents will be noted on Petro Environmental's Controlled Documents Issuance Log (see Appendix B) by the QAM to indicate their receipt of the documents. Each manager, etc., will be responsible for distributing such documents to their personnel. Any deviations will be reported to ECDC and corrected prior to distribution of any controlled documents.

The QAM shall sign the ECDC transmittal forms indicating Petro Environmental's receipt of the documents and return them to ECDC. Certified construction documents received by Petro Environmental which do not have an ECDC Controlled Copy stamp with a red control number will be returned to ECDC. Superseded and canceled documents will be marked "VOID" and removed from the field work area. Only voided drawings will be maintained in the field office.

All work shall be performed from current documents marked "ECDC/Controlled". Approved Design Change Notices (DCN) containing the "ECDC/Controlled" stamp will be annotated on the affected Controlled Contract Documents and Construction Drawings. As part of the QC process, the QAM will routinely review all documents to assure that only current Controlled Documents are in use, that DCNs are properly noted on the affected documents and drawings, and that work is performed in compliance with applicable subcontract documents. Copies of all DCNs affecting CD/TS will be issued to those persons identified as having received affected documents on the Controlled Documents Issuance Log, and shall be documented on Petro Environmental's DCN/RCI (Request for

Clarification of Information) Transmittal Form (see Appendix B). The affected CD/TS shall additionally be annotated by recording the specific DCN/RCI Numbers within the spaces provided by a stamp stating: "This Document Is Affected By The Following".

4.2 Control of Subcontractor Submittals

The QAM will be responsible for ensuring that all submittals are completed in accordance with CD/TS. The QAM will review all submittals for accuracy, completeness, and compliance with the subcontract requirements. QCRs are revised (i.e. - inspection reports, test reports, etc.), revisions will be made by striking a line through the error or items deleted, initialed and dated by the QAM or person making the revision. All project-related documents will be maintained in files located in the field office by the QAM. Only key personnel will be granted access to these files and only copies identified with an ECDC red stamp will be permitted to be taken into the field.

5.0 WORK PROCESSES

Work shall be performed to established Construction Drawings and Technical Specifications (CD/TS). Special work processes may be required during the course of a project (e.g. welding High Density Polyethylene (HDPE) pipe, geomembrane seam welding, hydrostatic testing of HDPE pipe, etc.). With each of these type procedures, there are applicable or relevant and appropriate requirements (ARARs) and to be considered criteria (TBCs) that are important to the success of a particular special work process. These requirements and criteria must be incorporated into procedures outlining how each of these work processes will be completed. Such procedures, along with pertinent ARARs and TBCs shall be incorporated into the QC program and shall be evaluated and discussed during the Preparatory, Initial, and Follow-Up Phases of QC. A review of established procedures for each special work process will help to ensure that all of the proper equipment and materials are on hand, that knowledgeable and trained personnel are performing these tasks, the end product is of high quality, and that all work is completed in accordance with the ARARs, TBCs and contract requirements.

6.0 DESIGN

Each AM/S will be responsible for maintaining all as-built drawings during the course of a project for the PE. All drawings will be handled in accordance with the appropriate provisions of the contract. All appropriate documents will be redlined at the end of each workday or when applicable, and will be clearly identified as containing as-built information. The redlined notations will be clear, concise, up-to-date, and present a legible representation of subcontract changes.

7.0 PROCUREMENT

7.1 Subcontract Requirements

Petro Environmental uses both subcontracts and POs when contracting with subcontractors/vendors to provide materials and/or services for a particular project. POs are used for all companies not present on the jobsite (i.e. - material vendors, testing laboratories, etc.). All other services requiring the presence of the subcontractor and his personnel to be on-site (i.e. - liner installer, landscaping company, etc.) are obligated to sign subcontracts which outline the terms and conditions for their portion of the work process. When executing subcontracts with a firm, the contract includes the following items:

- *Statement of Acknowledgment Form* - This assigns a subcontractor number, gives a brief description of the work, delineates which contract clauses the firm will be expected to comply with (i.e. - wage rates, Davis-Bacon Act, work hours, safety requirements, etc.);
- *Request for Submittal of Certificates of Insurance* - This a letter defining the requirements, limits and format of comprehensive general liability, comprehensive automobile liability, worker's compensation and other required insurance coverages. This letter is sent to ensure that all subcontractors understand the insurance requirements and obtain/maintain the appropriate coverages. Applicable Federal Acquisition Regulation (FAR) clauses are likewise included.
- *Statement Appointing Paymaster Form* - This appoints an individual within the subcontracted firm whom is authorized to complete payroll;
- *Facility Rules* - This is a listing of the significant rules and/or regulations the subcontracted firm is expected to adhere to while working on the project site;
- *Contract Form* - This is the actual contract the selected firm must sign to execute the contract between them and Petro Environmental. Article 2 of this form is used to track costs to ensure that all services were provided by the selected company at the agreed to cost. Additionally, each selected firm must provide an Experience Modification Rate (EMR) that shall be reviewed and approved by the Client prior to beginning on-site work; and,
- *Request for Subcontractor's Schedule* - This is the subcontractor's schedule to complete their portion of the work and is to be included Petro Environmental's overall schedule.

A list is maintained by the administrative staff so that all subcontracts are tracked and to ensure that all applicable documents are signed and returned to Petro Environmental. Once all required documents have been received and verified to have been completed correctly, the documentation is then submitted to the Client CM.

Regarding POs, every PO has a unique number that is used for tracking purposes and is specific for that selected company. Each PO must be completed clearly and accurately and is checked by the PM for correctness prior to being issued to the selected firm. As with subcontracts, the POs are also utilized for tracking costs and ensuring that all invoices are correct.

7.2 Purchased Items

Several procedures are employed to ensure that purchased materials received are in accordance with CD/TS. The vendor is required to submit to Petro Environmental samples and required documentation that their product meets required specifications. This documentation is submitted to the Client's CM and no materials are ordered from the manufacturer until approval of the submittal has been received from the Client. Manufacturer's QA/QC testing results are also reviewed to again ensure that the product meets all

requirements. Once the product is delivered to the jobsite, materials shall be jointly inspected by the QAM/QC Inspector, CQC Consultant, and/or Client QA Staff to check for damage, correct quantities, proper labeling, and other information that may be required to accompany the delivery order (i.e. - operation & maintenance manuals, installation directions, etc.). This information is recorded on a Materials Inventory Log by the QAM and maintained as part of the QCR. The quantities and invoiced amount are checked against the PO to ensure that all documentation is accurate. The findings of the QAM/QC Inspector's inspection (Inventory Log) of the delivered goods are attached to the Daily QC Report and all documentation is maintained on file in the field office.

7.3 Nonconforming Items

Materials delivered to the jobsite which are damaged or determined not to be in compliance with CD/TS, shall be immediately red-tagged as being nonconformable and documented on a NRF. All nonconformable items shall be segregated from the acceptable items and will not be permitted to be used during the performance of work. Such findings are documented in the Daily QC Report and the PM is notified by the QAM. The PM and/or QAM are responsible for addressing the problem with the vendor to not only rectify the problem, but also to ensure that all future shipments meet specifications. The PM/QAM may address the situation with the vendor verbally and/or via letters in an effort to rectify all problems. The PM is also responsible for reviewing, coding and paying all invoices from the vendors, therefore Petro Environmental may hold payment as allowed by the contract until the matter is fully resolved. The PM may also refer the situation to Petro Environmental's ownership if the situation warrants. All nonconformable items will be shipped back to the manufacturer.

8.0 INSPECTION & ACCEPTANCE TESTING

Daily inspections and monitoring of the work being performed will be conducted by either field QC Inspectors and/or the QAM in conjunction with the CQC Consultant. Field QC Inspectors shall consist of key Petro Environmental Management personnel as previously identified, in addition to our sub-tier subcontractor Craft Foremen. The objective of each inspection is to ensure that: all workmanship is being conducted in accordance with the CD/TS; the proper equipment and methods are being used to complete the work task; all materials on hand have been approved and are of high quality; and that all technical specifications are being met throughout the particular phase of work. The results of each inspection will be fully documented in both Daily QC Reports, Follow-Up Inspection Report forms, and/or NRFs as required. Copies of all QC reports will be maintained in the field office and distributed to the Client as required. Petro Environmental will utilize a Daily QC Report format (see Appendix B), which at a minimum, will include the following items:

- Summary of construction activities performed;
- On-site manpower and equipment;
- Types and results of QC inspections performed;
- Minutes of QC meetings, copies of Preparatory and Initial Phase meetings with subcontractor personnel, and minutes of safety meetings;
- Identification of any instances of nonconformance and discussion of corrective measures initiated, issuance of any NRFs (see Section 5.1);

- Tests performed as required by specifications and the results of such tests;
- Materials received - note inspection results and storage provided, attach copy of Materials Inventory Log;
- Any verbal instructions received from the Client or the CQC Consultant via the Client;
- Remarks concerning conflicts in plans, specifications, or instructions; acceptability of incoming materials; any offsite surveillance activities; progress of work, delays, causes or extent thereof; days of no work with reasons for same; etc.; and,
- Summary of on-site safety activities and reporting of infractions of approved safety plan, safety manual, or any instructions from the Client or the CQC Consultant via the Client.

Additionally, all subcontractors will be required to submit to the QAM, daily reports documenting all work activities performed that day and summarizing any problems or difficulties encountered. The information received in these reports will be incorporated into the Daily QC Reports, then discarded.

Any required subcontractor testing will be conducted in accordance with the technical specifications and/or referenced industry standards, and in concert with the CQC Consultant. If Petro Environmental is required to acquire the services of a testing laboratory, every effort will be made to ensure that all QA/QC objectives of the project are met and that the laboratory is approved by the Client and the CQC Consultant.

9.0 MANAGEMENT ASSESSMENT

Petro Environmental's PM, GS and/or PE will meet periodically to conduct overviews of the work process to assure continual compliance with the CD/TS and to assess the QC Program. This overview process will be documented upon request and copies of the report maintained in the field office with other QCRs. Any changes or noted deficiencies may be outlined in an Action Plan which will identify solutions, corrections, and procedures to be implemented to prevent future reoccurrences. Copies of the overview process will be available for review by the Client and their CQC Consultant upon request.

10.0 INDEPENDENT ASSESSMENT

Petro Environmental recognizes that the Client's QA Staff will conduct periodic oversight of Petro Environmental's QC Program. The QAM will cooperate with the Client in the identification, control, correction, and reporting of material or process deficiencies. Petro Environmental will provide Client personnel access to work being performed and to project documentation. It is understood that Client QA/QC monitoring may include, but not be limited to: inspection of materials, inspection of work in progress, and programmatic surveillance's.

APPENDIX A.

ORGANIZATIONAL STRUCTURE

APPENDIX B.

QUALITY CONTROL REPORTING FORMATS

APPENDIX C.

SAMPLING PROTOCOLS AND CHAIN OF CUSTODY

XYZ PROJECT
Subcontract No. ABC 111
Petro Environmental Technologies, Inc.

EMPLOYEE INDOCTRINATION

The following General Project, Health & Safety and Quality Control items were discussed with the undersigned prior to beginning work:

- Scope and goals of project
- Site/Client rules, regulations and policies
- General safety policy and pertinent provisions of the SSHP
- Requirements for employee safety & health - Safe Work Plan and EHS&TRM
- Medical facilities and required treatment procedures (i.e. - work-related injuries)
- Procedures for reporting or correcting unsafe conditions or practices
- Personal protective clothing requirements
- Safety/Health and QC Structure; identification of Safety and QC Personnel
- General QC procedures; QC goals and objectives
- Three Phase QC Program
  - Preparatory Phase Meetings
  - Initial Phase Meetings
  - Follow-Up Phase Meetings
- Final inspections and approval of work
- Awareness of quality of work; notification of unsatisfactory work to QAM
- Notices of Nonconformance and deficiency tracking procedures
- Re-work and repairs - quality of such work
- Daily reporting requirements to QAM by subcontractors

Employee's Acknowledgment of Agreement:

The above items have been presented and discussed with you on the date indicated below. By your signature, you understand and agree to follow these discussed requirements and procedures during the execution of your duties while working on the ABC Project.

_____	_____	_____
Date	Employee's Signature	Company/Firm

XYZ PROJECT
Petro Environmental Technologies, Inc.

PREPARATORY PHASE MEETING MINUTES

Date: _____

Definable Work Feature:

Personnel Present:

Review of Applicable Sections (list):

Review of Contract Plans: __4__ (3)

Material and Equipment Submittals Complete and Approved (list):

Testing/Inspections/Controls Required (Describe):

Work Area Inspection. Required Preliminary Work Complete and Acceptable? __4__ Yes _____ No
If No, Describe Deficiency & Corrective Action.

All Required Materials and Equipment on Hand: __4__ Yes _____ No
If No, Describe Deficiencies and Corrective Action.

Safety Activity Hazard Analysis Reviewed: __4__ (3) (reference Safe Work Plan)

Discussion of Procedures for Completing Work: __4__ (3)

Construction Tolerances and Level of Workmanship:

Comments During Preparatory Phase Meeting (DOE/HCN/Client):

Applicable Pre-Work Plans Accepted by Client: __4_ Yes ____ No
If No, Is An Interim Plan Being Utilized?: _____ Yes _____ No

_____
John Smith, QA Manager
Petro Environmental Technologies, Inc.

XYZ PROJECT
Petro Environmental Technologies, Inc.

INITIAL PHASE MEETING MINUTES

Date: _____

Definable Work Feature:

Personnel Present:

Review of Preparatory Phase Meeting Minutes: _____ (3)

Preliminary Work Being Performed (Describe):

Preliminary Work in Compliance with Contract Requirements: _____ Yes _____ No
If No, Corrective Action Taken:

Materials Being Installed (List with Submittal Number and Action Code):

Equipment Utilized in Executing Work (List):

Any Deviations From the Previously Approved Submittal(s)?: _____ Yes _____ No
If Yes, Describe Deviation (Materials or Construction Methods):

Testing/Inspections/Quality Control Required (Describe):

All Required Materials and Equipment on Hand: _____ Yes _____ No
If No, Describe Deficiencies & Corrective Action:

Discussion of Procedures/Methods for Completing Work: _____ (3)

Workmanship Meets Minimum Acceptable Standards: _____ Yes _____ No
If No, Corrective Action Taken:

Safety Measures Comply with Requirements of SSHP & Activity Hazard Analysis: _____ Yes _____ No
If No, Corrective Action Taken:

Safety Activity Hazard Analysis Reviewed: _____ (3) (reference Safe Work Plan)

Is a Change in the Activity Hazard Analysis Required?: _____ Yes _____ No
If Yes, Describe Changes and Reason(s) Why:

Comments During Initial Phase Meeting (DOE/HCN/Client):

Deficiencies Noted In This Report Have Been Addressed/Resolved: _____ Yes _____ No
If No, Describe Reason(s) Why and Action Items Initiated:

QA/QC Representative Verification:

The above information is complete and correct. Materials being installed are the same as those approved. All equipment, materials and workmanship in this phase or work are in strict compliance with the QA/QC procedures and requirements of the contract.

_____
John Smith, QA Manager
Petro Environmental Technologies, Inc.

XYZ PROJECT
Petro Environmental Technologies, Inc.

FOLLOW UP PHASE REPORT

Date: _____

Definable Work Feature:

Types of Control Testing and Inspections Being Performed (Describe):

Deficiencies Noted Previously Corrected (List and Explain):

New Deficiencies Noted: _____ Yes _____ No
If Yes, List and Explain Corrective Action:

Next Follow-Up Inspection Date: _____ or _____ None
If None, All Deficiencies, Corrected so that Next Phase Can Proceed: _____ Yes _____ No
If No, Corrective Action Taken:

All Noted Deficiencies Have Been Addressed/Resolved: _____ Yes _____ No
If No, Explain Why:

_____
John Smith, QA Manager
Petro Environmental Technologies, Inc.

XYZ PROJECT
Subcontract No. ABC 111
Petro Environmental Technologies, Inc.

NONCONFORMANCE REPORT FORM
NOTICE OF NONCONFORMANCE

To: (Contractor/Subcontractor) Nonconformance Notice No.: _____

_____ Date: _____

_____ Time: _____

CONTRACTOR: Your attention is directed to the following occurrence of nonconformance:

Location & Feature of Work:

Description of Problem (Include contract specification/plan/drawing or Client reference):

Probable Cause of Problem:

How and When Problem Was Located (Include estimate of how long the problem has existed):

Suggested Corrective Action:

Suggested Method to Prevent Future Similar Problems:

Contractor Action Taken:

CLIENT Rep/CQC Rep. Comments:

Receipt Acknowledged: Date: _____ Time: _____

_____
Subcontractor Representative

_____
John Smith, QA Manager
Petro Environmental Technologies, Inc.

_____
Construction Manager
Client

_____
CQC Consultant Field Monitor
(XYZ Inc.)

INSERT CONTROLLED DOCUMENT FORM

INSERT MATERIAL INVENTORY LOG

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
DAILY QUALITY CONTROL REPORT

Date:	Daily Report No.:	Project Nos.:	Contract No.:	Description/Location of Work:
May 26, 1998	xxx	XYZ	ABC 111	XYZ Project, Cincinnati, Hamilton, Ohio

WEATHER CLASSIFICATION:		METEOROLOGICAL DATA:
CLASS A:	No interruptions of any kind from weather conditions occurring on this or previous shifts.	**CLASSIFICATION** **CLASS:** A
CLASS B:	Weather occurred during this shift that caused a complete stoppage of all work.	**TEMPERATURE:** **MAX.:** 83° F **MIN.:** 52° F
CLASS C:	Weather occurred during this shift that caused a partial stoppage of work.	**PRECIPITATION:** **INCHES:** 0.00
CLASS D:	Weather overhead excellent or suitable during shift. Work completely stopped due to previous adverse weather.	
CLASS E:	Work overhead excellent or suitable during shift, but work partially stopped due to previous adverse weather.	
OTHER:	Explain.	

1. Contract/Subcontractors and Area of Responsibility:

XXX Work Area:

No.	Trade	Hours	Location/Description of Work

YYY Work Area:

No.	Trade	Hours	Location/Description of Work

2. Equipment (Not Hand Tools):

XXX Work Area:

Equipment	Arrival Date	Departure Date	Date of Safety Check	Hours Used	Hours Idle	Hours for Repair

YYY Work Area:

Equipment	Arrival Date	Departure Date	Date of Safety Check	Hours Used	Hours Idle	Hours for Repair

3. **Work Performed Today (Indicate location and description of work performed by prime and/or subcontractors):**

   - **XXX Work Area:**

   - **YYY Work Area:**

4. **Type and Results of Inspections (Indicate whether: Preparatory, Initial, or Follow-Up & include satisfactory work completed or deficiencies with action to be taken):**

5. **Tests Required by Plans and/or Specifications Performed and Results of Tests:**

6. **Materials Received (Note inspection results and storage provided):**

7. **Verbal Instructions Received (List any instructions given by the DOE/HCN/Client personnel on construction deficiencies, re-testing required, etc., with action to be taken):**

8. Remarks (Cover any conflicts in plans, specifications, or instructions; acceptability of incoming materials; offsite surveillance activities; progress of work, delays, causes and extent thereof; days of no work with reasons for same):

NOTE: **Attached are the SSHO's Daily Safety Logs summarizing daily on-site safety activities and which describe any infractions of the approved safety plan, safety manual or instruction from Client personnel.**

Contractor's Certification:

I certify that the above report is complete and correct and that all material and equipment used, work performed and test conducted during this reporting period were in strict compliance with the contract plans and specifications except as noted above.

_____
John Smith, QA Manager
Petro Environmental Technologies, Inc.

INSERT MEETING ROSTER FORM

INSERT DAILY REPORTING FORM

APPENDIX C.

SAMPLING PROTOCOLS AND CHAIN OF CUSTODY

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
STANDARD OPERATING PROCEDURE

CHAIN-OF-CUSTODY AND LABELING

SOP #P1-1
Page 1 of 4
Version 1.0
Date: 01/01/92

Scope: The following Standard Operating Procedure (SOP) is to be used to outline the requirements that provide the ability to trace possession and handling of samples from time of collection through transportation to the laboratory for analysis and final disposition of the data.

Equipment: Sample Labels
Chain-of-Custody Record
Waterproof Ink Pen

Definition:

Samples are considered to be in a person's custody if they are:

1. In a person's physical possession.
2. In view of a person after taking possession.
3. Secured by that person so that no one can tamper with it, or secured by that person in an area that is restricted to authorized personnel.

Procedure:

1. Sample labels are necessary to prevent misidentification of samples. An example of a sample label is included as Figure No. 1. Sample labels must include the following information:

   a. Project name.
   b. Date of collection.
   c. Time of collection.

   d. Sample identification: 1st two letters of project, sampling location designation, and depth of sample (XX-00-00).
   e. Location.
   f. Analysis.
   g. Sampler's initials.

Labels should be securely affixed to sample containers prior to or at the time of collection.

2. All sampling activity will be recorded in the field notebook. In the sequential portion of the notebook, the following information will be recorded:

   a. Sample location and number.
   b. Type and number of samples.
   c. Reference to the particular sample location.
   d. Date and Time of sampling.

3. Upon completion of sample collection, a chain-of-custody record will be completed and will accompany the sample-shipment container to the laboratory. If more than one sample-shipment container is used, a separate chain-of-custody form should be completed for each container. An example of a completed chain-of-custody form is included as Figure No. 2.

4. The chain-of-custody record will include the following information.

   a. Petro project name and number.
   b. Sampler's signature.
   c. Unique sample (station) identification.
   c. Date and time of collection.

   d. Composite or grab sample designation.
   e. Sample (station) location or description.
   f. Number of containers.
   g. Indication of analytical parameters to be performed.
   h. Remarks, if necessary.
   I. Signature of persons involved in the chain of possession.

5. Upon completion of a Chain-of-Custody Record, these will be placed in a waterproof container (zip-lock plastic bag) and placed inside the sample-shipment container (cooler).

6. Using bubble packing or styrofoam sheets, securely wrap samples and arrange in the shipping cooler in such a way as to minimize the chance for breakage during shipment. Place a layer of ice packs over the samples and wrap cooler securely with strapping tape for shipment by common carrier.

7. Samples should be delivered to the laboratory for analysis as soon as possible. The samples must be delivered to the person in the laboratory authorized to receive samples.

8. There are three routes through which samples reach the laboratory, including:

   a. Petro personnel who collected samples delivers them to Petro Analytical Services directly.

   b. Petro personnel who collected samples delivers them to the Petro offices and a laboratory representative will come to the Petro office to pick them up.

   c. Petro personnel delivers samples to a common carrier; i.e., UPS, Federal Express, etc. to be shipped to the laboratory. In this case, the Bill of Lading number becomes part of the chain-of-custody documentation.

The actual chain-of-custody document contains three separate copies. These will be distributed as follows:

Yellow Copy - retained by lab for their records.

Pink Copy - kept by Petro sampling personnel and retained in the project file.

White Copy - returned to Petro project personnel with the analysis data package and retained in the project file.

CHAIN-OF-CUSTODY AND LABELING

PETRO ENVIRONMENTAL TECHNOLOGIES
Project 97-002
Date 1/2/98
Time 3:00 AM/PM
Sample I.D. GTP-3
Location N. End, East UST
Analysis BTEX/TPH
Sampler's Initials APT

PETRO environmental technologies
7251 Palace Drive
Cincinnati, Ohio 45249
(513) 489-6789
Fax 489-7208

CHAIN OF CUSTODY RECORD

PROJ. NO. 002
PROJECT NAME ABC Company
SAMPLERS: (Signature) [signature]

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	BTEX 8020	TPH 8015	BTEX 602				REMARKS
GTP-3	1/2/98	3:00		X	N. End, East UST	1	X	X					(Soil)
MW-2	1/3/98	4:15		X	Monitoring Well #2	2			X				(Water)

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
[signature]	1/3/98 5:00				
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)

Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks
		Lab Representative	1/3/98 5:00	Samples kept on ice

Distribution: Original Accompanies Shipment; Copy to Field File

Appendix C
Technical Specifications

Specification Number	Section Title
Division 1	**General Requirements**
01050	Surveying and Grade Control
01500	Temporary Construction Facilities and Utilities
01669	Testing Piping System
Division 2	**Site Work**
02100	Site Preparation
02210	Site Grading
02210A	Turf and Vegetative Cover
02220	Earthwork
02221	Trenching, Backfilling, and Compacting
02247	General Earth Fill
02270	Erosion and Sediment Control
02426	Leachate Collection and Groundwater Interception Systems
02433	Gas and Leachate Extraction Wells

SECTION 01050
SURVEYING AND GRADE CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Proposed Work will be staked once, by Superintendent.

1. SUBCONTRACTOR shall maintain survey stakes.
2. These stakes will delineate the limits of waste for both landfills.

1.02 PRIMARY CONTROL MONUMENT

A. Bench marks to establish primary vertical control for Work are indicated on Drawings. Elevations are referenced to MSL datum.

B. Monuments or references for primary horizontal control for construction of Work are indicated on Drawings.

C. Preserve and maintain primary control monuments.

1.03 PRIMARY LINE AND GRADE

A. Primary line and grade will be provided by means of stakes placed along route or at site of Work.

B. Stakes for utilities installed by open cut construction will be set:

1. Parallel to centerline of utility at 100-ft intervals.
2. Offset to best serve SUBCONTRACTOR.
3. Adjacent to appurtenances and force main or fittings.
4. At significant changes in grade.

C. SUBCONTRACTOR shall:

1. Provide assistance as required.
2. Arrange operations to avoid interference with establishment of primary lines and grades.
3. Check accuracy of line and grade by visual inspection, checks between stakes, and periodic checks (with surveying equipment) between primary control monuments and stakes.
4. Be responsible for protection and preservation of stakes.
5. Prepare and submit as-built drawings.

1.04 CONSTRUCTION LINE AND GRADE

A. The SUBCONTRACTOR bears sole responsibility for correct transfer of construction lines and grades from primary line and grade points and for correct alignment and grade of completed Work based on lines and grades shown on Drawings.

B. Transfer line and grade for open cut construction of utilities from primary line and grade stakes to Work by grade boards, laser beam or other acceptable methods.

1.05 LOT CORNERS AND SURVEY MONUMENTS

A. If such marked corners and monuments are damaged by SUBCONTRACTOR, replace by Registered Land Surveyor at SUBCONTRACTOR'S expense.

* * * END OF SECTION * * *

SECTION 01500
TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code, Article 100.

B. Regulatory Requirements:

1. National Electrical Code: Components and installation shall comply with NFPA 70.

C. Comply with federal, state, and local codes and regulations, and with utility company requirements.

PART 2 PRODUCTS

2.01 TEMPORARY ELECTRICITY AND LIGHTING

A. General:

1. Temporary lighting shall be sufficient to enable SUBCONTRACTOR to complete Work and to observe Work as it is being performed. Illumination shall meet or exceed state code requirements. Electricity is to be provided by portable generator or other means.

B. Responsibilities:

(Not Used)

2.02 TEMPORARY HEAT

A. General:

1. Cold Weather Protection: Heating required before building is enclosed.
2. Temporary Heat: Heating required after enclosure of building or structure. Building or structure shall be considered as enclosed when it is roofed and has such protection at doorways, windows, and other openings as will provide reasonable heat retentions.

B. Responsibilities:

(Not Used)

2.03 TEMPORARY TELEPHONE SERVICE

A. Arrange with local telephone company to provide telephone service throughout duration of Work.

B. Locate telephone in Project construction office for local calls.

2.04 WATER FOR CONSTRUCTION

A. Water is available from hydrants. Secure permission from Water Department, obtain necessary permits, and notify Fire Department before obtaining water from fire hydrants. Make arrangements and pay costs for water, connecting to hydrants, and temporary piping required to transport water to point of use.

B. Connection to hydrant shall prevent backflow to system.

C. Use only special hydrant operating wrenches to open hydrants. Make certain hydrant valve is open full. If hydrants are damaged, SUBCONTRACTOR shall be responsible and shall notify appropriate agency so damage can be repaired as quickly as possible. Fire hydrants shall be completely accessible to Fire Department at all times.

2.05 WATER FOR TESTING

A. SUBCONTRACTOR shall provide water necessary for testing prior to acceptance of Work, unless specifically stated otherwise in Specifications for equipment, system or facility.

2.06 SANITARY FACILITIES

A. Provide temporary sanitary toilet facilities conforming to state and local health and sanitation regulations, in sufficient number for use of SUBCONTRACTOR and SUBCONTRACTOR's employees.

B. Maintain in sanitary condition and properly supply with toilet paper.

2.07 TEMPORARY FIRE PROTECTION

A. Provide and maintain in working order, minimum of one fire extinguisher in each building, and such other fire protective equipment and devices as would be reasonably effective in extinguishing fires during early stages by personnel at Project site.

2.08 TEMPORARY SITE AND OTHER ROADS

A. Maintain existing roads and public roads used during construction free from accumulations of dirt, mud and construction debris resulting from construction operations. Roads shall be considered "maintained" when material has been removed by a sweeper.

2.09 SECURITY

A. SUBCONTRACTOR shall be responsible for loss or injury to persons or property where Work is involved, and shall provide security and take precautionary measures to protect SUBCONTRACTOR'S and OWNER'S interests.

2.10 TEMPORARY PARKING

A. Designated areas of existing parking facilities may be used for parking of construction personnel's private vehicles and of SUBCONTRACTOR'S light-weight vehicles.

1. Do not allow heavy vehicles or construction equipment in parking areas.

2.11 TEMPORARY FENCING

A. Provide temporary fencing or postings sufficient to prevent trespass by SUBCONTRACTOR'S employees and suppliers onto private property and by public onto construction site.

B. Materials shall be sufficiently durable to be effective for duration of construction period.

2.12 PROJECT IDENTIFICATION

A. Provide signs suitably supported and erected on Project site.

1. Provide one 4-ft by 8-ft sign with names of SUBCONTRACTOR and Site name lettered thereon.

B. Locate sign at entrance to the site.

2.13 FIELD OFFICES AND BUILDINGS

A. If required by SUBCONTRACTOR, erect and maintain in good condition, temporary field office, tool, and storage building(s) for SUBCONTRACTOR'S use.

1. Tool storage building(s) shall be of ample size to provide space for tools and equipment.
2. Building(s) shall be neat and well constructed, surfaced with plywood, drop siding, masonite, or other similar material, well painted and void of advertisements.

2.14 MDEQ FIELD OFFICE

(Not Used)

2.15 OWNER'S USE

(Not Used)

PART 3 EXECUTION

3.01 GENERAL

A. Maintain and operate systems to ensure continuous service.

B. Modify and extend systems as Work progress requires.

3.02 REMOVAL

A. Completely remove temporary materials, equipment, signs, and structures when no longer required.

B. In unfinished areas, clean and repair damage caused by temporary installations or use of temporary facilities, restore drainage, and evenly grade, seed or plant as necessary to provide

appearance equal to or better than original.

C. In finished areas, restore existing or permanent facilities used for temporary services to specified, or original condition.

3.03 DAMAGE TO EXISTING PROPERTY

A. SUBCONTRACTOR is responsible for replacing or repairing damage to existing buildings, structures, sidewalks, roads, parking lot surfacing, and other existing assets.

B. SUBCONTRACTOR shall have option of having OWNER contract for such Work and have cost deducted from Contract amount.

* * * END OF SECTION * * *

SECTION 01669
TESTING PIPING SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Low-pressure air testing of piping segments done in the field by the SUBCONTRACTOR (high pressure air testing is not allowed).

1.02 SUBMITTALS

A. SUBCONTRACTOR shall submit test report for each piping segment tested and for installed piping system.

PART 2 EXECUTION

2.01 GENERAL

A. Pressure test in presence of designated representative.

B. Furnish necessary piping connections between section of piping being tested and nearest available source of air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to perform specified tests. Low pressure testing to be in accordance with the pipe manufacturer's recommendations.

C. Provide bulkheads, flanges, valves, bracing, blocking or other temporary sectionalizing devices that may be required.

D. Remove temporary sectionalizing device after tests complete.

E. Perform tests on exposed piping in sumps after piping is completely installed, including supports, hangers, and anchors.

F. Perform tests on piping system before completing the backfilling of the trench to visually detect leakage at pipe joints.

G. Perform tests on piping that is clean and free of dirt, sand, or other foreign material.

H. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

I. Add test air slowly as specified herein to allow for initial pipe expansion.

J. Include regulator set to avoid over-pressurizing and damaging piping.

K. Perform pressure testing in strict accordance with pipe manufacturer's written instruction, these Specifications, and in accordance with applicable local, state, and federal safety requirements.

L. Correct leaks or defects and retest.

M. Pressure gauges used for testing purposes shall be marked in increments of 1 psi. Provide documentation of latest gauge calibration to verify accuracy of gauge in use.

2.02 AIR PRESSURE TESTING

A. Perform air pressure testing for installed and completed piping system or on isolated piping sections to accommodate construction, as identified in other sections to be air pressure tested. Test pressure shall be as specified as follows.

1. Carrier Pipe Forcemain: 45 psig at high point in test section.
2. Testing as required by permit.

B. Air/hydrostatic pressure testing of isolated piping sections shall not replace requirements to provide hydrostatic testing of completed piping system.

C. Open vents at high points to purge air pockets while piping system is filling. Venting may also be provided by loosening flanges or with equipment vents.

2.03 LOW-PRESSURE AIR TESTING

A. General:

1. Perform low-pressure air testing where requested or otherwise approved to evaluate initial pipe fusion welding techniques.
2. Air test pressure for evaluating initial pipe fusion welding shall not exceed 5 psi for 5 minutes at high point of test section.
3. Test medium shall be compressed air only; pressurized gas is not acceptable.

B. Preparation:

1. Isolate pipe section to be tested by plugging each end with air tight plugs. Plug ends of branches, laterals and wyes which are to be included in test section.
2. Brace plugs to prevent slippage and blowout due to internal pressure.
3. One plug shall have inlet tap or other provision for connecting supply air hose.
4. Connect one end of air hose to plug used for air inlet; other end to portable air control equipment.
5. Air control equipment shall consist of valves and pressure gauges to control rate at which air flows into test section and gauges to monitor air pressure inside pipe.
6. Connect air hose between source of compressed air and control equipment.

C. Pre-Installation Testing:

1. If pipe to be tested is an out of trench condition, provisions to temporarily restrain pipe test section shall be SUBCONTRACTOR'S responsibility.
2. Lay test segment on ground surface and allow to reach constant ambient air temperature before test.
3. Perform test during period when pipe segment will be out of direct sunlight to minimize pressure changes as result of temperature fluctuations.
4. Fill pipe section with air and gradually increase pressure to 1/2 of specified test pressure, then increase pressure in small increments until required test pressure is reached.
5. Maintain pressure for minimum of 5 minutes after pressure in pipe has stabilized.
6. Pipe segment considered to have failed pressure test if specified test pressure changes

more than 1 psi at any time during testing.

7. Repair pipe and fused joint leaks by cutting out leaking area and rebond suitable segments.
8. Retest after leaks or defects are repaired.
9. Piping system shall show no evidence of leakage.

2.04 TEST REPORTING

A. Designated representative will witness and document final pressure test of piping system.

B. Test report for each piping system tested shall include following minimum information:

1. Date of test
2. Description and identification of piping system tested
3. Type of test performed
4. Test fluid
5. Test pressure
6. Test Results
7. Type and location of leaks detected
8. Corrective action taken to repair leaks
9. Results of retesting

* * * End of Section * * *

SECTION 02100
SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Clearing and grubbing.
2. Stripping topsoil.
3. Demolition and miscellaneous surface features.

1.02 DEFINITIONS

A. Structures and Surface Features: Existing structures and surface features including signs, posts, fences, trees, shrubs, landscaped surface features, and other miscellaneous items.

B. Utilities: Existing gas mains, water mains, steam lines, electric lines and conduits, telephone and other communication lines and conduits, sewer pipe, cable television, leachate collection pipelines, other utilities, and appurtenances.

C. Clearing and Grubbing: Cutting and disposing of trees, brush, windfalls, logs, and other vegetation, and removing and disposing of roots, stumps, stubs, grubs, logs, and other timber.

D. Salvaged Topsoil: Natural loam, sandy loam, silt loam, silty clay loam, or clay loam humus-bearing soils available from overlying portions of areas to be excavated for construction.

1.03 PROJECT/SITE CONDITIONS

A. Do not block or obstruct roads or streets with excavated or grubbed materials.

1.04 METHOD OF MEASUREMENT AND PAYMENT

(Not Used)

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 PROTECTION

A. Protect existing utilities against damage.

B. Contact Local or State Underground Protection Agency before beginning excavation.

C. Locate existing underground utilities by hand excavation.

D. If uncharted utilities are encountered during excavation, stop work.

E. Preserve and protect groundwater monitoring wells. Replace damaged or destroyed monitoring wells.

F. Cap or remove and relocate services. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in place during work.

3.02 PREPARATION

A. Remove obstructions such as mounds of dirt, stone or debris located within limits of construction. Obstructions such as culverts, end walls, and guard posts may be removed if replaced when need for removal is completed. Replace to original condition.

3.03 CLEARING AND GRUBBING

A. Clear and grub to provide access to construction area, drives, and where grade is to be raised of shrubs, trees, stumps, vegetation, rubbish, and other perishable or objectionable matter.

B. Grub stumps to depth of not less than 12 inch below original ground surface or subgrade.

C. Remove cleared material from site and dispose of materials in accordance with applicable regulations, or use in the construction of the landfill.

D. Do not remove or cut down trees unless located within limits of excavation as indicated on Construction Drawings.

E. Do not trim trees unless located within easements or rights-of-way shown on Construction Drawings. Cut interfering tree roots and branches 1 inch or greater in diameter perpendicular to direction of growth on tree side of trench.

3.04 STRIPPING TOPSOIL

A. Cut or mow and remove grass, weeds, and other vegetation before stripping topsoil.

B. Remove topsoil to entire depth in areas where construction is to be performed and where grade is to be raised. Stockpile for proper drainage.

C. Strip stockpile areas of vegetation prior to stockpiling.

D. Stripped topsoil shall be free from clay, stones, vegetation, and debris.

3.05 DEMOLITION

A. Demolition includes cutting and breaking out existing concrete and masonry, and removal of equipment, piping, pavement, utilities, structures, and surface features in direct conflict with Work or required to be demolished as shown on Drawings.

B. Salvage and dispose of materials according to applicable regulations.

C. Protect utilities, structures, surface features, and facilities which are to remain in-place.

3.06 RESTORATION

A. Restore existing utilities, surface features, and structures to condition equal to condition which

existed prior to construction.

B. Replace to original condition or better, damaged landscape work within and outside of construction limits in accordance with Section 02930.

* * * END OF SECTION * * *

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Clearing and grubbing.

1.02 DEFINITIONS

A. Structures and Surface Features: Existing structures and surface features including signs, posts, fences, trees, shrubs, landscaped surface features, and other miscellaneous items.

B. Utilities: Existing gas mains, water mains, steam lines, electric lines and conduits, telephone and other communication lines and conduits, sewer pipe, cable television, leachate collection pipelines, other utilities, and appurtenances.

C. Clearing and Grubbing: Cutting and disposing of trees, brush, windfalls, logs, and other vegetation, and removing and disposing of roots, stumps, stubs, grubs, logs, and other timber.

1.03 PROJECT/SITE CONDITIONS

A. Do not block or obstruct roads or streets with excavated or grubbed materials.

1.04 METHOD OF MEASUREMENT AND PAYMENT

(Not Used)

PART 2 SUBMITTALS

A. Health and Safety Plan for Administrative Subcontractor as described in the Health and Safety Plan.

B. Compliance with Contractor's Quality assurance program (if any).

C. Proof of workers compensation, insurance, bonding, liability, and automobile coverage.

D. Work progress schedule.

E. Subcontractor's license number (if applicable).

PART 3 EXECUTION

3.01 PROTECTION

A. Protect existing utilities against damage.

B. Contact Local or State Underground Protection Agency before beginning excavation.

C. Locate existing underground utilities by hand excavation, as needed.

D. If uncharted utilities are encountered during excavation, stop work.

E. Preserve and protect groundwater monitoring wells. Replace damaged or destroyed monitoring wells.

F. Cap or remove and relocate services. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in place during work.

G. Damage to monitoring wells, casings, existing structures will be repaired at own expense.

H. All work rules to abide by the State of Michigan and local municipalities' rules and regulations.

I. No water to be discharged off-site without owner's consent.

3.02 PREPARATION

(Not Used)

3.03 CLEARING AND GRUBBING

A. Clear and grub to provide access to construction area, drives, and where grade is to be raised of shrubs, trees, stumps, vegetation, rubbish, and other perishable or objectionable matter.

B. Grub stumps to depth of not less than 12 inch below original ground surface or subgrade.

C. Remove cleared material from site and dispose of materials in accordance with applicable regulations, or use in the construction of the landfill.

D. Do not remove or cut down trees unless located within limits of excavation as indicated on Construction Drawings.

E. Do not trim trees unless located within easements or rights-of-way shown on Construction Drawings. Cut interfering tree roots and branches 1 inch or greater in diameter perpendicular to direction of growth on tree side of trench.

F. Stockpiles from chipping and mulching to be leveled in accordance with state and local fire and safety regulations.

3.04 RESTORATION

A. Restore existing utilities, surface features, and structures to condition equal to condition which existed prior to construction.

B. Replace to original condition or better, damaged landscape work within and outside of construction limits in accordance with Section 02930.

* * * END OF SECTION * * *

SECTION 02210
SITE GRADING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Surface Preparation
2. Placing fill
3. Field Quality Control
4. Erosion Controls

B. CONSTRUCTION MANAGER or SUBCONTRACTOR will obtain materials including subgrade structural fill, straw bales, silt fence, or other erosion control materials.

C. Measurement and Payment:

(Not Used)

D. See Section 02221 for trenching, backfilling, and compaction requirements for drainage pipe installation.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 1140-92 - Standard Test Method for Amount of Material in Soils Finer than No. 200 (75-um) Sieve.
2. ASTM D 1557-91 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft (2,700 kN-m/m)).
3. ASTM D 4253-91 - Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
4. ASTM D 4318-84 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
5. ASTM D 4632-91 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

1.03 DEFINITIONS

A. Unsuitable Material: Topsoil, peat, organic soils, and materials containing slag, cinders, foundry sand, debris, and rubble or soil with less than required bearing capacity as determined by ENGINEER.

1.04 PROJECT/SITE CONDITIONS

A. Notify corporations, companies, individuals or authorities owning above or below ground conduits, wires, pipes or other utilities running to property or encountered during grading operations.

B. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in accordance with requirements of owners of said services.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. Conform to requirements of subgrade structural fill specified in Section 02247.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive fill to determine existence of areas loosened by frost action, softened by flooding or weather, of unsuitable materials, or of unsuitable bearing capacity.

3.02 PREPARATION

A. Fill settled areas where excavations or trenches were backfilled and holes made by demolition, tree removal, and site preparation work as specified in Section 02100.

B. Natural soils or compacted fill softened by frost, flooding or weather shall be removed, replaced, and compacted.

C. Proof-roll areas to receive fill material to detect soft or loose zones prior to placing fill. Remove and replace unsuitable material in accordance with Section 02247.

D. Keep construction site free-draining.

E. Scarify existing surfaces to receive fill.

3.03 FILL USAGE

A. As needed to created stable foundation.

3.04 PLACING FILL

A. Conform to requirements of Section 02247.

3.05 FIELD QUALITY CONTROL

A. Rough Grading Tolerances:

1. Grade to 4 inches below finished grade in areas to receive topsoil, unless new grade is less than 4 inches above existing grade. Grade to bottom of base course in areas to receive riprap. Maximum allowable variation from design elevation is ±3 inches.
2. Rough grading areas, including excavated and filled sections and adjacent transition areas shall be reasonably smooth, compacted, and free from irregular surface changes.

B. Conform to requirements of Section 02247.

3.09 EROSION CONTROL

A. Install silt fence, straw bale berms, and other measures where shown on Drawings and as needed throughout construction activities to protect wetlands from sediment.

B. Drainage from Project area shall be directed toward existing on-site detention basin(s). Drainage which cannot be directed to detention basin shall be controlled to prevent erosion or deposition of sediment outside Project area.

3.10 ADJUSTMENT AND CLEANING

A. Stockpile material suitable for backfill in area designated by OWNER.

B. Place material not suitable for backfilling or site grading and unsuitable materials in spoil areas designated by OWNER and grade to drain.

C. Rough grade areas to mitigate erosion which are disturbed to achieve lines and grades for construction as indicated on Drawings.

* * * END OF SECTION * * *

SECTION 02210A
TURF AND VEGETATIVE COVER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Seed, fertilize and mulch

B. SUBCONTRACTOR will obtain materials including seed, fertilizer, and mulch.

D. Measurement and Payment:

(Not Used)

E. See Section 02221 for trenching, backfilling, and compaction requirements for drainage pipe installation.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 1140-92 - Standard Test Method for Amount of Material in Soils Finer than No. 200 (75-um) Sieve.
2. ASTM D 1557-91 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft (2,700 kN-m/m)).
3. ASTM D 4253-91 - Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
4. ASTM D 4318-84 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
5. ASTM D 4632-91 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

1.03 DEFINITIONS

(Not Used)

1.04 PROJECT/SITE CONDITIONS

(Not Used)

PART 2 PRODUCTS

2.01 SEED, FERTILIZER, AND MULCH

A. Following is general requirements for seeding, fertilizer and mulch to be implemented on all disturbed areas unless they are receiving some other type of cover (e.g., rip rap) and to stabilize disturbed areas susceptible to excessive erosion.

B. Seed Mixture for Drainage Ditches and Graded Areas Stripped of Vegetation with Long-Term Exposure:

Seed	% of Mixture
Tall Fescue	48
Creeping Red Fescue	20
Kentucky Bluegrass	5
Domestic Ryegrass	10
Redtop	2
Timothy	5
Birds Foot Trefoil	10

D. Fertilizer shall be organic or inorganic material of natural or synthetic origin or as approved by the CONSTRUCTION MANAGER and contain percentage composition expressed as follows.

Component	% Composition
Total Nitrogen	12
Total Potash (Water-Soluble)	12
Total Phosphoric Acid	12

E. Mulch shall be unweathered small grain clean straw or hay free of weeds, weed seed, chopped paper, or wood product.

PART 3 EXECUTION

3.01 EXAMINATION

(Not Used)

3.02 PREPARATION

(Not Used)

3.03 FILL USAGE

(Not Used)

3.04 PLACING FILL

(Not Used)

3.05 FIELD QUALITY CONTROL

(Not Used)

3.06 SEED, FERTILIZER, AND MULCH

A. Seed, fertilize, and mulch disturbed areas outside cell (not including roads), sedimentation basin, drainage ditches, and areas striped of vegetation due to construction activities that will be exposed for more than 12 months.

1. Sow seed in conjunction with fertilizer and while seed bed is in friable condition. Immediately prior to seeding, topsoil shall be harrowed horizontally across face of slope. Seed shall not be sown through mulch. Seed mixture shall be applied at rate of 150 lbs/acre for detention basin and 45 lbs/acre for other areas with mechanical drills, hydroseeders or by broadcast method in areas inaccessible to drills or hydroseeds.
2. In areas requiring fertilizer, apply fertilizer evenly at rate of 300 lbs/acre, minimum, and work into seed bed before or during final seed bed preparation.
3. Spread mulch over surface to uniform thickness at rate of 1-1/2 to 2 tons/acre. Mulch shall be loose enough to allow sunlight to penetrate and air to slowly circulate, but thick enough to shade ground and prevent or reduce water or wind erosion.

    a. Displaced mulch shall be replaced at SUBCONTRACTOR'S expense.
    b. Anchor mulch in place with mulch adhesive or OWNER-approved equal.
    c. Excelsior blanket may be used in lieu of mulch in drainage ditches or other areas of concentrated runoff.

4. Hydroseeding is acceptable to meet the above requirements.

* * * END OF SECTION * * *

SECTION 02220
EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavation and Grading to shape final cover grades.

1.02 QUALITY ASSURANCE

A. SUBCONTRACTOR will perform construction quality assurance (CQA) on various aspects of the construction to confirm compliance with the project specifications and to assemble a record of the construction quality.

1.03 METHOD OF MEASUREMENT AND PAYMENT

(Not Used)

1.04 RELATED SECTIONS

A. Section 02210 Site Preparation

B. Section 02221 Trenching, Backfilling, and Compacting

PART 2 PRODUCTS

2.01 GENERAL EARTH FILL

A. Properties:

1. The general earth fill will be free of organic material.

2. The general earth fill can consist of soil fill or rock fill.

2.02 STRUCTURAL FILL

A. The structural fill shall be free of organic material.

B. The structural fill can consist of soil fill or rock fill.

2.03 COARSE AGGREGATE

A. Clean sands or gravels or other permeable material generally classified according to Unified Soil Classification System as SW, SP, GW or GP.

2.04 GRANULAR MATERIAL

A. Clean sands or gravels or other permeable material generally classified according to Unified Soil Classification System as SW, SP, GW or GP.

2.05 SOIL COVER LAYER

A. Index Characteristics:

USCS Classifications: CL, CH or ML

B. Permeability: No greater than 1 x 10^{-5} cm/sec, or be in conformance with the permeabilities of on-site clays

C. Free of tree roots, wood or other decayable materials.

D. SUBCONTRACTOR shall obtain material from on-site sources, as much as possible.

PART 3 EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Protect bench marks and survey layout stakes from excavation equipment and vehicular traffic.

C. The subgrade shall be proof-rolled using a loaded 4-tire scraper (20 yd^3 size) or other suitable equipment. Visual observations shall determine the stability of the subgrade by continuous visual observation during proof-rolling. Determination of soft areas by proof-rolling will be based on visual observations, but generally detected by deflection of greater than 2 inches and accompanied with stress cracks in subgrade.

D. Soft areas identified by proof-rolling shall be replaced and/or reparied.

E. The subgrade should be acceptable prior to the placement of the cover soil layer.

3.02 COVER SOIL LAYER CONSTRUCTION

A. Do not place cover soil layer until installation of subgrade is completed.

B. Placement: The maximum final compacted thickness of each lift of the soil cover layer shall be six (6) inches or the thickness necessary to protect the integrity of underlying components and achieve the required standards.

D. Prior to compaction, cover soil will be placed and spread in eight (8) inch thick loose lifts or the thickness demonstrated in compaction testing.

E. At the end of each day, the exposed surface of the cohesive layer shall be protected from adverse weather conditions.

F. Any cover soil layer surface which is smooth shall be scarified prior to placement of a subsequent lift.

G. Equipment used for the compaction of the cover soil layer shall be sufficient to achieve compaction requirements.

H. The SUBCONTRACTOR shall be responsible for preparing the materials for the cohesive layer.

3.03 FIELD QUALITY CONTROL

A. Survey:

1. After completion of construction of cover soil layer, the SUBCONTRACTOR will verify all lines and grades.

2. Tolerance for cover soil layer thickness shall be 0 to +0.1 feet to verify acceptable work.

3. Cross sections shall be taken at 100-foot intervals and referenced to existing site control. These cross sections will be taken to show the completed subgrade elevations. These cross sections will be used as documentation.

4. The cover soil layer shall be at least twenty four (24) inches thick at all sections of the final cover.

5. The top of the cover soil layer should have a minimum slope of one (1) percent.

B. Pre-Construction Testing:

1. Density and moisture content requirements during placement for each material type to be used for the construction of the cover soil layer should be determined prior to construction. Samples of soil cover material will be tested in a laboratory prior to construction in accordance with ASTM D-1557, Modified Proctor.

   Previous testing and evaluations of the proposed cover soil layer material may also be used to evaluate density and moisture content requirements for the cohesive layer during placement.

2. The material source shall be accepted based on the results of the tests performed during Pre-Construction Testing.

C. Conformance Testing:

1. Conformance testing of the cohesive layer material should be performed in accordance with the procedures and organization described in the Quality Assurance Program Plan.

2. Determine soil classification using ASTM D2487-93 (USCS dry sieve) at a frequency of 1 test per 50,000 cy.

3. Perform laboratory hydraulic conductivity test using ASTM D5084-90 (flexible wall permeameter) at a frequency of 1 test per 50,000 cy.

4. Determine soil moisture-density compaction characteristics using ASTM D1557-91 (Modified Proctor) at a frequency of 1 test per 50,000 cy.

5. All conformance testing requirements and standards are for Petro Environmental internal guidance and internal documentation only.

D. Construction Testing.

1. A demonstration area will be constructed so as to determine the number of passes required with compaction equipment to achieve the moisture/density requirements for each lift in accordance with the results of the CQA pre-construction testing.

2. In-place moisture density of compacted soil per ASTM D2922 (nuclear gauge) at a

frequency of 1 per acre per lift.

3. During construction, the SUBCONTRACTOR shall observe and document the items outlined in the QA Plan.

4. If during construction material differs from previously tested materials, then different material shall be considered unqualified and additional laboratory testing shall be performed to identify characteristics of different material and establish acceptable field moisture and density values noted.

5. All construction testing requirements and standards are for Petro Environmental internal guidance and internal documentation only.

* * * END OF SECTION * * *

SECTION 02221
TRENCHING, BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Trenching for installation of dewatering pipelines and laterals.

2. Backfilling and compacting after installation of dewatering pipelines and laterals.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D 422 - Standard Method for Particle-Size Analysis of Soils.
2. ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft (2,700 kN-m/m)).
3. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate In-place by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Unsuitable Material: Topsoil, peat, organic soils, and materials containing slag, cinders, foundry sand, debris, and rubble.

1.04 QUALITY ASSURANCE

A. OWNER will perform construction quality assurance as defined in Quality Assurance Plan.

1.05 PROJECT/SITE CONDITIONS

A. Do not block or obstruct access roads with excavated materials.

1.05 METHOD OF MEASURMENT AND PAYMENT

(Not Used)

PART 2 PRODUCTS

2.01 GRANULAR BACKFILL

A. Granular material, consisting of durable particles ranging in size from fine to coarse in substantially uniform combination. Unwashed bank-run sand and crushed rock will be considered.

1. Carbonate content of the granular backfill shall not exceed 5%.

2. Percent passing No: 200 sieve shall not exceed 15 % provided collector pipes are inspected and cleaned out in accordance with the O&M Plan.

2.01A TIRE CHIPS

A. Tire chips can be used instead of granular backfill. Tire chips shall be processed from automobile and truck tires to an average size no larger than four (4) inches by four (4) inches. No significant steel belting will remain in the tire chips after processing. Application will be made to the MDEQ, Waste Management Division to obtain designation of inertness for the tire chips. Tire chips will not be used as bedding for the collection pipes. Any mound of tire chips in direct contact with the collection pipes will be wrapped in a 6 oz. nonwoven geotextile filter.

2.02 GENERAL EARTH FILL

A. Comply with requirements for general earth fill of Section 02247.

B. If the pipes are installed within structural fill placement areas compacted to a specified density, the backfill shall conform to the specifications for the structural fill material.

2.02A RECOMPACTED WASTE

A. Recompacted waste must be used as general backfill for the lateral pipeline trenches located within the limits of waste.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive fill to determine existence of areas loosened by frost action, softened by flooding or weather, of unsuitable materials, or of unsuitable bearing capacity.

3.02 PREPARATION

A. Sheeting, Bracing, and Shoring:

1. To be used where necessary in accordance with applicable OSHA regulations.

3.03 DEWATERING

A. Keep construction site free-draining.

B. Keep excavations free from water.

C. Maintain dewatering systems to prevent uplifting of structures.

D. Protect adjacent properties from damage resulting from dewatering operations.

E. OWNER/SUPERINTENDENT to provide water disposal location either to an adjacent sanitary sewer manhole or temporary storage tank(s) located on site, and indicated on the drawings.

3.04 TRENCH EXCAVATION

A. Excavate to elevations and dimensions necessary to complete construction.

B. Remove and replace or compact natural soils or compacted fills softened by frost, flooding or

weather.

C. Remove unsuitable material from within trenches.

D. Remove soil disturbed by pressure or flow of leachate or groundwater and replace with free-draining material.

E. Trenching Tolerances:

1. Excavate so pipes, conduits, and appurtenances, can be laid straight at uniform grade, without sags or humps, between elevations shown on Drawings. Grade tolerance shall be held to ±0.5 feet for trenches and ±0.2 feet for sumps unless noted otherwise on Drawings.
2. Minimum trench width shall be outside pipe diameter plus 12 inches.

F. Place pipe to grade and depth shown on Drawings. The lateral pipeline trench is to be placed in full contact with the waste, or as directed by the superintendent.

G. Ultimate responsibility and liability of trench excavation and backfill shall be SUBCONTRACTOR'S. Under no circumstances shall slopes of embankments be steeper than those approved by OSHA. Obtain, and keep active, necessary permits required by OSHA and local authorities to perform excavation and backfill.

3.05 MATERIAL SELECTION

A. Bedding Material:

1. Dewatering and Lateral pipelines: Granular Backfil or Tire Chips

B. Initial Backfill Material:

Same as bedding material

C. General Earth Fill: Other areas not previously specified.

3.06 PLACING TRENCH MATERIALS

A. Do not use frozen material or place fill on frozen subgrade.

B. Place granular bedding in 2- to 4- inch thick layers as needed to maintain pipe gradient.

C. Dewatering and Lateral Pipelines: Minimum of two (2) inches below and twenty-four (24) inches above the pipe.

D. General Earth Fill and Structural Fill Material Limits:

1. For trenches located outside Structural Fill placement areas, general earth fill should be placed outside the limits of the bedding and the initial backfill up to the top of the trench and within the entire trench width.

F. Backfill Placement:

1. Do not backfill trenches until tests and inspections are completed. Avoid damage or displacement of pipe systems during backfilling.

2. Area shall be finished off to uniform contour to properly drain, and entire surface graded to result in neat-appearing surface. In event of natural cross-drainage, depressed section shall be formed through crowned backfill.
3. Immediately after backfill, remove excess dirt from area. In addition, damage to existing roadways, ditches, culverts, driveways, and other existing improvements shall be repaired at this time.
4. Waste is not to be removed from the site. Waste left over from lateral trench excavation and backfill will be redeposited on-site at the direction of the superintendent.
5. At the discretion of the site superintendent, if an excavation is extremely wet backfilling and machine compaction may not be suitable.

G. Where pipes or electrical ducts cross, protect piping or ducts at higher elevation by backfilling trench within higher pipe or duct influence zone down to bedding of lower pipe or duct with structural fill.

3.07 COMPACTION

A. Provide mechanical compaction for general fill material.

B. Lift Thickness and Compaction: Place and compact general fill materials to minimum 85% Modified Proctor densities as determined by ASTM D 1557 and D 2922.

3.08 ADJUSTMENT AND CLEANING

A. Stockpile excavated material suitable for backfill on designated site and grade to drain. Place no fill where trenches for other utilities will be located.

B. Place excavated material not suitable for backfilling or site grading and other unsuitable materials in designated spoil areas and grade to drain.

* * * END OF SECTION * * *

SECTION 02247
GENERAL EARTH FILL

PART 1 GENERAL

1.01 DEFINITIONS

A. Unsuitable Material: Topsoil, peat, organic soils, and materials containing slag, cinders, foundry sand, debris, and rubble.

1.02 QUALITY ASSURANCE

A. SUBCONTRACTOR will perform construction quality assurance (CQA) as defined in Quality Assurance (QA) Plan for the installation of lining systems.

1.03 METHOD OF MEASUREMENT AND PAYMENT

(Not Used)

PART 2 PRODUCTS

2.01 GENERAL EARTHFILL

A. Properties:

1. The general earth fill will be free of organic material.

2. The general earth fill will consist of soil fill or rock fill.

B. SUBCONTRACTOR will obtain soil fill or rock fill from on-site and/or off-site sources.

PART 3 EXECUTION

3.01 EXAMINATION

A. The subgrade shall be prepared in accordance with the requirements of the construction drawings and the project specifications.

1. The upper organic layer should be thoroughly stripped within the fill placement areas.

2. Adequacy of the existing on-site soils to support the design loads should be verified by observing the amount of deflection and/or rutting which takes place under the wheels of construction equipment.

3. Soft areas identified by proof-rolling should be undercut and replaced by compacted soil fill.

3.02 EXCAVATION

A. Excavate within limits of Project to lines, grades, and elevations shown in the Construction Drawing.

B. Segregate excavated materials into soil fill, rock fill, and unsuitable material.

C. Transport excavated materials to fill areas, or to designated stockpile.

D. Dispose of unsuitable material in accordance will applicable regulations.

E. Dewatering:

1. Maintain surface water control and free drainage.

2. Provide surface water pumps, hoses and other necessary equipment and labor to keep excavation free of standing water.

F. Over excavate to remove unsuitable material.

3.03 FILL PLACEMENT

A. Scarify prepared subgrade surface before placement of fill material to provide bonding between fill material and prepared placement areas.

B. Prior to placement, all fill materials should be classified as soil fill. The classification should be performed at the excavation area prior to placement of fill in the designated fill area or at the designated stockpile.

C. All fill materials shall be placed in maximum 12-inch loose lifts. However, layers less than 12 inches in loose thickness will be required, when necessary, to obtain the specified density.

E. The maximum size of the particle in the fill should not exceed 12 inches (in any dimension).

F. Compaction

1. The fill materials which are not having 5% by weight greater than 1-inch sieve OR not having 60% by weight greater than No: 4 sieve should be compacted to at least 85% of Modified Proctor density at -4% to +2% of optimum moisture content.

G. At the end of each day, the exposed surface of the subgrade shall be protected from adverse weather conditions.

H. Any surface which is smooth shall be scarified prior to placement of a subsequent lift.

I. The SUBCONTRACTOR shall be responsible for preparing the materials for the fill placement, including but not limited to, soil amendment and in-place drying or wetting of the soil necessary to achieve the density and moisture content requirements during placement of the fill.

J. Fill materials placed along slopes should be benched into the existing slopes as shown on the construction drawings.

3.04 FIELD QUALITY CONTROL

A. Survey:

1. After completion of construction of general earth fill, the SUBCONTRACTOR shall verify all lines and grades.

B. Pre-Construction Testing:

1. Previous testing and evaluations of the proposed fill materials may be used to evaluate borrow areas.

2. The minimum frequency of tests required for general earth fill materials: Modified Proctor (ASTM D1557) one per type of material, Grain-size distribution (ASTM D422) one per type of material.

C. Conformance Testing:

None Required.

D. Construction Testing.

1. Field density tests of soil fill will not be required when one of the following conditions are encountered:

a) The material contains more than 5 percent plus 1 inch sieve size particles.

b) The material contains more than 60 percent plus No. 4 particles.

When the amount of coarse particles obviously exceeds the above criteria, the basis of determination of compaction shall be visual inspection.

When the material contains substantial quantities of soil passing No. 4 sieve, a field sieve analysis should be performed and the results recorded on or attached to the density test report (applies to mixtures of New Albany Shale with other soils).

Report the basis for waiving the test on the density report form.

2. Questions concerning the accuracy of any single test shall be addressed by retesting in the same general location.

3. Rework lifts that fail to meet density or moisture testing. Rework includes:

a. Defining rework area(s).
b. Discing
c. Moisture conditioning
d. Compacting
e. Retesting

Rework area that fail retesting shall be reworked until it meets the specification or failing material removed and replaced at no cost to OWNER.

4. During construction, the SUBCONTRACTOR shall observe and document the items outlined

in the QA Plan.

5. If during construction material differs from previously tested materials, then different material shall be considered unqualified and additional laboratory testing shall be performed to identify characteristics of the different material.

* * * END OF SECTION * * *

SECTION 02270
EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. Work shall include providing, installing and maintaining sediment control measures for use during construction and during post construction while vegetative cover is being established.

B. Definitions

1. Erosion is the washing away of soil.
2. Sediment is soil that has already been eroded.
3. Erosion control is the prevention or minimization of erosion.
4. Sediment control is the trapping of suspended soil particles.

1.02 MEASUREMENT AND PAYMENT

(Not Used)

1.03 SUBMITTALS

A. Description of sediment control method that will be used.

B. Silt fencing sediment control product literature data on geotextile fabric and manufacturer's installation data.

1.04 TRANSPORTATION, HANDLING, AND STORAGE

A. During shipment and storage, silt fencing fabric (geotextile) shall be wrapped in relatively impermeable and opaque protective covers.

B. Handling, storage, and care of silt fence, and straw bales on site is responsibility of SUBCONTRACTOR prior to, during, and after their installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Silt Fence

1. Silt fencing shall consist of geotextile fabric secured to four (4) foot long, 1-1/2 inch by 1-1/2 inch hardwood posts on 8-foot centers.

2. The geotextile fabric shall consist of a 2-foot wide non-woven polypropylene material that meet the following average roll values:

Property/Unit	M.A.R. Value[1]	Test Method
Grab Strength, lbs.	100	ASTM D 4632
Burst Strength, psi	200	ASTM D 3786
Apparent Opening Size (AOS) U.S. Standard Sieve	50-140	ASTM D 4751
Ultraviolet Resistance, %	90	ASTM D 4355
Water Flow Rate, gpm/sf	10	ASTM D 4491

[1]Minimum Average Roll Values are based on a 95% confidence level.

B. Straw Bales

NOT USED

PART 3 EXECUTION

3.01 PERFORMANCE

A. Silt Fencing

1. Silt fencing shall be installed as detailed on project drawings.

2. Install with the posts to the downstream direction and the fabric to the upstream direction. The fabric shall be anchored below grade approximately 6 inches. Replace and compact soil in anchor trench to restore to original grade.

B. Straw Bales

NOT USED

3.02 MAINTENANCE

A. The SUBCONTRACTOR shall inspect all erosion control devices immediately after each rainfall and at least daily during prolonged rainfall.

B. Excessive sediment deposits shall be removed as needed.

C. Replace damaged silt fencing as long as sediment control is required.

* * * END OF SECTION * * *

SECTION 02426
DEWATERING AND LATERAL PIPELINE SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Dewatering and lateral pipeline materials and construction requirements within proposed landfill phase are as follows.

1. Install perforated dewatering and lateral pipe (with three holes per linear foot of pipe each holes evenly spaced around the ciorcomfrence of the pipe), perforated and non-perforated cleanout risers. The limits of waste were determined and the pipelines will be installed according to the plans and details. Where the waste is not consistent with documented limits, field modifications to the pipe installation may be necessary.

2. Install dewatering sump piping and incidentals such as valve box risers.

1.02 RELATED SECTIONS

A. Section 02221 - Trenching, Backfilling, and Compacting

1.03 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications for leachate collection system and groundwater interception system components

1.04 DELIVERY, STORAGE, AND HANDLING

A. SUBCONTRACTOR will arrange for delivery and unloading of materials on-site.

PART 2 PRODUCTS

2.01 DEWATERING AND LATERAL PIPING

A. Poly Vinyl Chloride (PVC)

1. Collection Piping: Schedule 80, perforated of appropriate diamter

2. Perforations: 5/8-in. diameter holes at locations approved by the Superintendent (three holes per linear foot of pipe with each hole evenly spaced around the circonfrences of the pipe)

3. Cleanout Risers: 6-in. diameter, Schedule 80, non-perforated pipe and perforated pipe (as shown on the drawings) with hinged blind flange cover plate or cap and locking mechanism.

4. Welding Solvents: ASTM D2564.

5. Fittings: ASTM D2464 or D2467 for Schedule 80 PVC fittings.

6. Physical properties of pipe and fittings shall conform to Section 15078.

7. May substitute high density polyethylene (HDPE) SDR-11 pipe for the PVC pipe, see Section 2.01B. Though PVC has a higher flow capacity, HDPE is preferred as it is safer to install where trech sideslopes are unstable.

B. High Density Polyethylene (HDPE) Pipe

1. Collection Piping: 6-in. diameter, SDR-11, perforated.

2. Perforations: 5/8-in. diameter holes at locations approved by the Superintendent (three holes per linear foot of pipe with each hole evenly spaced around the circonfrences of the pipe).

3. Cleanout Risers: 6-in. diameter, SDR-11 non-perforated and perforated pipe (as shown on the drawings) with hinged blind flange cover plate or cap and locking mechanism.

4 Butt Fusion Welding: In accordance with pipe manufacturer's requirements.

5. Fittings: SDR-11.

6. Physical properties of pipe and fittings shall conform to Section 15079.

2.02 GRANULAR MATERIALS

A. Coarse Aggregate for Bedding Collection Pipe

1. Physical properties of coarse aggregate material shall conform to Section 02221.

2. Gradation requirements as determined by ASTM D422.

B. SUBCONTRACTOR will prepare lab analysis and separate samples for conformance testing before and during placement.

2.03 MISCELLANEOUS MATERIALS

A. Metallic Marking Tape:

1. Permanent, bright-colored, continuously printed, metallic warning tape compounded for direct burial service not less than 6-in. wide by 4 mils thick.

2. Imprinted "Caution - Buried Utility Service Below"

PART 3 EXECUTION

3.01 PIPING INSTALLATION

A. Leachate Collection and Groundwater Interception Pipe

1. Lay pipe on granular or soil bedding. Orient pipe perforations down if not continous.

2. Place drainage material on both sides of pipe to provide uniform lateral support.

3. Continue placing drainage material to minimum 24-in. thickness above the top of collection pipe (see detail drawings).

4. Pipe joints shall be tight and true and welded in accordance with manufacturer's recommendations.

5. Direct burial trenching method is acceptable with approval.

B. After placing pipe and granular soil to provide uniform lateral support, leave top of pipe exposed to allow record survey information to be recorded by others.

* * * END OF SECTION * * *

SECTION 02433
GAS AND LEACHATE EXTRACTION/ WELLS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Drilling of bore holes.
2. Field measurements/observations during drilling.
3. Laboratory testing of materials.
4. Well installation.
5. Cleanup.
6. Well abandonment.

B. Payment for Well Construction:

(Not Used)

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. C136 REV A-84 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
2. C702-87 - Standard Practice for Reducing Field Samples of Aggregate to Testing Size.
3. D1557-91 - Standard Test Method of Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54 kg) Rammer and 18-in. (457 mm) Drop.
4. D2487-92 - Standard Test Method for Classification of Soils for Engineering Purposes.
5. D2488-90 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
6. D2922-91 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. D4318-84 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

A. Final boring logs for each well.

B. Construction diagrams for each well.

C. Plan drawings showing well locations and depths to be submitted for MDEQ review prior to installation

1.04 QUALITY ASSURANCE

A. Work shall be supervised by professional experienced in installation of gas wells.

1.05 PROJECT/SITE CONDITIONS

A. Obstructions are sometimes encountered when drilling in a landfill, many of which can be drilled through. SUBCONTRACTOR expected to make reasonable effort to drill through obstructions.

PART 2 PRODUCTS

2.01 PIPE

A. Gas Wells:

1. Well Pipe: 2-in to 3-in dia. non-perforated HDPE SDR-17 or. non-perforated Schedule 80 PVC.
2. Well Screen: 8-in. dia perforated Schedule 80 PVC pipe with end slip cap. Cut slots to dimensions shown on Drawings.
3. Well Coupling: Join perforated and non-perforated well sections by PVC coupling. Use galvanized carbon steel lag bolts with coupling.

B. Leachate Wells:

1. Well Pipe: 4-in. dia non-perforated Schedule 80 PVC.
2. Well Screen: 6-in. dia Schedule 80 PVC. ~~Cut slots to dimensions shown on Drawings~~. Cement PVC slip cap to bottom of screen. Install manufactured well screen. Field-cut slots not acceptable.
3. Or as accepted by the CONSTRUCTION MANAGER.

2.02 AGGREGATE

A. General backfill material shall consist of unwashed bank-run sand or sand and gravel mixture.

2.03 SOIL BACKFILL

A. Soil backfill will meet the requirements of Section 02247.

B. SUBCONTRACTOR will obtain soil backfill material from on-site sources.

2.04 BENTONITE

A. Manufacturers:

1. Baroid.
2. American Colloid.
3. Or equal.

B. Bentonite Pellets: Use pellets in bore holes in slurry mix. Provide water for slurry mix. Graded Bentonite (hole plug or equal): 1/4 to 3/8 in. size. Hydrate in maximum 12-in. lifts.

PART 3 EXECUTION

3.01 PREPARATION

A. SUBCONTRACTOR will survey installation locations prior to beginning Work.

B. Record offset distance from survey stake to final location of bore hole. Offset locations shall be approved prior to drilling.

D. Provide equipment necessary to move drill rig if wet weather conditions encountered.

3.02 SPOILS DISPOSAL

A. Excavated Refuse Disposal:

1. On-Site: Dispose of drilling spoils on-site.

3.03 DRILLING

A. Field Measurements/Observations:

1. Record depth measurements to nearest 1/10th ft on boring logs.
2. Perform gas leachate temperature measurements near bottom of completed well and record on boring logs. Maintain temperature recorder in well for minimum of 30 min. Gas Leachate temperature not acceptable.
3. Record general description of refuse at 5-ft intervals on boring logs (i.e., none, slight, moderate, high).
4. Record moisture level of refuse at 5-ft intervals on boring logs (i.e., dry, moist, wet).

B. Well Depths: Well excavation shall extend to depths equal to bottom of adjacent waste grades. Do not drill into existing clay liner at bottom of landfill site. SUBCONTRACTOR will verify existing grade elevation prior to drilling. Advance drilling equipment with care; note drill torque, pressure, and depth when within 10 ft of expected base of landfill.

3.04 INSTALLATION

A. Solvent weld pipe sections and install galvanized carbon steel lag bolts, or HDPE pipe but fuse welding if depth requires it.

B. Install well piping as single continuous unit.

1. Install piping to minimize flexural stress to unit.

C. Screen Section Backfill:

1. Measure depth to bottom of well.
2. Backfill with filter pack.
3. Extend filter pack 2 ft above screen, as shown on Drawings.
4. Place intermediate filter directly above filter pack.

D. General Backfill:

1. Place general backfill on intermediate filter to approximately 3 ft below ground surface.

E. Bentonite Seal:

1. Place 4-ft bentonite seal directly on general backfill.

2. Use graded bentonite in bore holes. Provide water for hydration.

F. Surface Clay Seal:

1. SUBCONTRACTOR responsible for transport from on-site stockpile to well location.
2. Place clay on general backfill to approximately 1 ft above existing ground surface.
3. Compact clay in 1-ft lifts to 90% of maximum dry density obtained by Modified Proctor (ASTM D1557). Perform 1 Proctor test for each clay material type used. Hand-compact surface clay seal to minimize surface water infiltration.
4. Slope clay surface away from well pipe.

3.05 LABORATORY TESTING

A. Well Backfill Materials:

1. Perform minimum of 4 laboratory grain size distribution tests on representative samples of filter pack and intermediate filter materials.
2. Clay Backfill: Clay soil used for capping clay shall meet requirements of Article 2.03. Obtain minimum of 2 samples for laboratory testing. Test parameters as listed in Article 2.03.

B. SUBCONTRACTOR will provide laboratory testing on clay backfill.

C. SUBCONTRACTOR responsible for laboratory testing, unless otherwise specified.

3.06 CLEANUP

A. Dispose of debris and spoils resulting from drilling operations specified on-site disposal area in accordance with local and state codes.

B. Seeding of disturbed areas is SUBCONTRACTOR responsibility.

C. Repair ruts in landfill cover, caused by SUBCONTRACTOR'S equipment, greater than 5 in. deep to condition and density equal to or exceeding that which existed prior to construction.

3.07 WELL ABANDONMENT

A. Abandoned wells are to be cut off at the ground surface in a safe and effective manner.

B. The cut off standpipe and associated appurtenances are to be disposed off in accordance with applicable regulations.

C. The exposed well pipe is to backfilled with grout or other appropriate material to completely seal the exposed pipe.

D. The grouted pipe end is to be covered with a minimum 12 inches of general fill soil.

E. The location of the abandoned well is to be recorded on applicable project drawings and documentation.

* * * END OF SECTION * * *

Appendix D
Performance Monitoring Plan

Performance Monitoring Plan
(Revision #7)

for the

South Macomb Disposal Authority
Landfills 9 and 9A

By
Petro Environmental Technologies, Inc.

February 2002

Macomb County Landfill
Performance Monitoring Plan
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Addenda (to be submitted separately):

I. Monitoring Well Installation Plan
II. Piezometer Installation Plan
III. Field Sampling Plan
IV. Well Abandonment and Plugging Plan

1. Introduction

This Performance Monitoring Plan (PMP) for the Macomb County Landfill Properties 9 and 9A is designed to evaluate the effectiveness of the site's Remedial Action Plan (RAP). "Property" means the property of Landfills 9 an 9A located south of 24 Mile Road, west of Card Road, and north of the McBride Drain and legally described in Appendix A of the Consent Decree except as modified by written agreement between SDMA and MDEQ. The PMP is considered as part of the RAP and together will ensure that the properties are remediated in accordance with the applicable regulations and court decisions.

This PMP is specific to the monitoring of the remedial action measures. Engineering and construction of the remedial systems are discussed in the RAP. The main focus of this PMP is the evaluation measures needed to assess the effectiveness of the remedial efforts. Within the time frame of the remediation system's operation the following PMP goals will be achieved:

(1) Reaching and maintaining generic residential criteria in groundwater,
(2) Within four years of system start up reach and maintain hydraulic control of the groundwater plume that exceeds the health-based residential criteria, and
(3) Within four years of system start up reach and maintain chemical containment of groundwater plume that exceeds the health based residential criteria.

The final remediation goal is to achieve and maintain generic residential standards in the groundwater at all points in the aquifer beyond the property. Upon achievement of such a goal, it is anticipated the site will be deleted from the National Priorities List (NPL).

2. Summary

The PMP will be incorporated into the RAP that meets the requirements of Sections 18, 20a and 20b of Part 201 of NREPA. Any disputes involving the PMP will be resolved in accordance with Section XVI (Dispute Resolution) of the Consent Decree. SMDA will perform the following tasks as part of its PMP for the Macomb County Landfill Properties 9 and 9A. These tasks include the following:

1. Installation of monitoring wells as required.

2. Sampling of groundwater from the monitoring wells to determine their appropriateness for background use.

3. Monitor the geographic extent of the aesthetic exceedance response from household groundwater well data.

4. Sample and analyze water from monitoring wells to assess current conditions and assess

the effectiveness of the RAP in achieving chemical containment.

5. Measure groundwater elevations within the monitoring wells to assess the effectiveness of the RAP in achieving hydraulic control and dewatering.

6. Assess the overall performance of the remedial systems in achieving steady state and completion of the dewatering phase.

7. Notify MDEQ of excessive leachate/groundwater elevation conditions.

8. Notify MDEQ of excessive chemical monitoring conditions.

9. Perform periodic reviews of the remedial systems performance and make modifications to these systems as necessary.

10. Maintain and operate all pumps, pipes, appurtenances, mechanical systems, electrical controls and electrical power systems for the duration of the remediation effort.

11. Achieve and maintain capture of the contaminant plumes.

3. Aesthetic Exceedance in Groundwater

The following shall apply with respect to any Part 201 aesthetic exceedance that exists in the groundwater within one (1) mile of the boundaries of the Property:

3.1 Background Monitoring Wells Locations and Evaluation

Three wells have been installed and contribute background information. New wells may be installed within one mile of the boundaries of the Properties to provide additional background information. The locations of the new background wells are subject to MDEQ approval.

Each well will be sampled using a sampling methodology and analysis which complies with the methodologies prescribed by Part 201 of the NREPA, Part 201 Rules and guidance provided by the MDEQ on detection limits and analytical methods. The samples will be analyzed for iron, manganese, chloride, diethyl ether, barium, arsenic and general chemistry by a MDEQ approved lab. A split sample will be provided to MDEQ, if requested.

Upon completion of the sampling and analysis of these wells, an evaluation will be performed to determine the appropriateness of the wells for background use. The data and evaluation will be submitted to MDEQ for review and approval. If the data clearly demonstrate that the wells are likely impacted by a source of contamination they should not be used for the determination of background concentrations. If the data indicate that any contaminant plume that emanates from

Property 9 or Property 9A is being influenced by upgradient contamination, further evaluation may be necessary to determine if the wells are appropriate for background concentrations for the Properties. Some background will be determined and used and, if necessary, MDEQ shall designate one or more alternate locations to install well(s), which will be evaluated as provided herein. This will be done until the parties agree that three true background wells exist.

3.2 Establishing Background Parameters

The background concentration of each parameter sampled and analyzed for purposes of remediating the Properties shall be calculated using the average of the concentration of each parameter sampled and analyzed from these three wells and by using a statistical method agreed to by the MDEQ. Sampling may be performed for other constituents, including those with health-based standards, which will become background for each of those additional contaminants when the average concentration is calculated using the same methodology.

3.3 Geographical Extent of Aesthetic Response

The geographical extent of the health-based exceedance is indicated in the following report: "Supplemental Plume Delineation Report", CRA, dated June 2000, Reference No. 11413(21). The aesthetic response actions contained in the PMP apply to all areas within a mile of the Property.

By March 31, 2002, SMDA shall determine whether the groundwater in any residential well that is located within one mile of a boundary of the site being used for household use exceeds the higher of: the standards for aesthetics for manganese, iron, chloride, diethyl ether, barium, arsenic, general chemistry, total dissolved solid (TDS) and other parameters designated by the MDEQ; or the background for any such parameter as determined pursuant to applicable provisions of this PMP.

If an aesthetic exceedance exists at any such residence and the residence in question is not part of a subdivision, within 45 days of the above determination, SMDA shall offer the owner of the residence the choice of installation of a water softener at SMDA's expense or payment to the owner of the residence the equivalent of the cost of a water softener to be used towards hook up to municipal water, if municipal water is available.

If the residence is part of a subdivision and if Macomb Township has adopted and is enforcing a water ordinance described in Section 3.4, then SMDA will have no further obligation to address aesthetic exceedance criteria in the groundwater at that residence. The ordinance must be enforced in order to remain a valid institutional control pursuant to Part 201.

If, however, Macomb Township has not adopted such an ordinance or the residence is for some reason not subject to such an ordinance, then SMDA shall make the offer of either the water softener or the equivalent cost described above, regardless of whether the residence is part of a subdivision.

SMDA will not be required to take action if it is demonstrated to the MDEQ's satisfaction that the detected contamination is not attributable to the Facility. Any dispute will be resolved in accordance with the Consent Order.

3.4 Exceptions for New residential Areas

SMDA may request Macomb Township to adopt and enforce a township ordinance acceptable to the MDEQ pursuant to which any subdivision that exists or is established within 1 mile of the boundaries of Properties 9 and 9A must hook all existing and future residences within the subdivision to municipal water.

4. Capture of Contaminant Plumes

The SMDA shall "capture" the contaminant plumes emanating beyond the lateral boundaries of the Properties by demonstrating both hydraulic control and chemical containment.

4.1 Hydraulic Control

Hydraulic control shall be demonstrated through the use of groundwater contour maps and profiles showing the horizontal and vertical direction of groundwater flow and horizontal and vertical hydraulic gradients. Hydraulic control will be considered to extend to the point where the hydraulic gradients are toward the Property or toward a component of the extraction system (i.e. the divide between inward and outward gradients).

4.2 Chemical Containment

Chemical containment (or chemical capture) is defined as the stabilization and/or reduction of the plume that extends beyond the boundaries of the Property, which exceeds the higher of Part 201 residential health-based drinking water criteria as contained in the January 29, 1999 update of Part 201 Generic Cleanup Criteria Tables of the August 31, 1998 MDEQ Environmental Response Division Memorandum #18 as amended by the October 2, 1998 Update or background as determined pursuant to the Consent Decree (refer to Appendix C). Chemical capture will be considered to exist if the chemical concentrations of the groundwater in the sentinel wells remain below the higher of Part 201 residential health-based drinking water criteria or background and if the chemical concentrations in all of the monitoring wells do not change in a way that indicates that the plume is expanding.

4.3 Dewatering

Dewatering is defined as the process of achieving a zone of hydraulic control expanding away from the individual collection components of the and remedy toward the required zone of capture (i.e.

Part 201 residential health-based plume or background) and decreasing water elevations in the zone of capture towards achieving a steady state dewatered condition within the boundaries of the Properties. Dewatering phase is defined to comprise the time until achievement of steady state conditions or four (4) years from startup, whichever is sooner. Completion of dewatering is defined as the attainment of long-term equilibrium conditions where water levels are drawn down such that the maximum extent of capture is achieved.

Following 90 days after start up of the Groundwater/Leachate Collection System and during the dewatering phase (i.e. prior to steady state conditions) SMDA shall demonstrate that dewatering is occurring. Capture of the health-based plume beyond the boundaries of the Property shall be attained within 4 years of the startup of the groundwater/leachate collection system. Once completion of dewatering is achieved, SMDA shall demonstrate that: Capture of the health-based plume beyond the boundaries of the Property is maintained until such time as concentrations in groundwater beyond the boundaries of the properties are below the higher of Part 201 residential health–based drinking water criteria or background and; The collection trenches are effective in eliminating the continued loss of leachate to the aquifer beyond the boundaries of the Properties. This demonstration may provide extra confidence in the overall system and allow for reductions in monitoring of the aquifer and support any proposals involving natural attenuation or other remedy proposals.

5. Monitoring Wells

Extraction and monitoring well locations, both existing and proposed are shown on plan sheet #8. Appendix A identifies a preliminary monitoring well network for Aquifers 1, 2, and 3 has been currently agreed to by SMDA and MDEQ based on the currently understood remedy and conditions at the Facility. Groundwater samples will be obtained and analyzed, and water levels measured in each type of well in accordance with Appendix A of this PMP.

5.1 Monitoring Wells Installation

SMDA will install up to six (6) transducers in wells to be selected by MDEQ. SMDA will monitor the water levels in the six (6) wells on an on going basis at no less than daily intervals during implementation of the PMP or until MDEQ agrees that such monitoring can be reduced or stopped on one or more such wells. Additional wells designated for long term monitoring will be installed (594R, 9706 and 9707). An additional well will be installed beyond MW-210R to define the extent of the plume in that area.

5.2 East Side of Site 9

After completion of dewatering, the monitoring system must be able to demonstrate to the MDEQ's satisfaction that the leachate collection system is pulling contaminants off the bottom of aquifer 2 on the east side of the Property, where this is required to control the off-site migration of leachate.

To demonstrate this condition, additional piezometers must be positioned in a line perpendicular to the leachate collection trench on the east side of the Property. The number and location of these additional wells or piezometer clusters shall be subject to MDEQ approval and sufficient to demonstrate capture.

The measured static water elevations, when mapped in cross section, must show decreasing head levels from the base of the aquifer to the collection trench as in Appendix B. The profile of static water elevations will be presented in both tabular and graphical format. At the discretion of the MDEQ, tabular format may be used exclusively.

The measured static water elevations, when mapped in cross section, must show decreasing head levels from the base of the aquifer to the collection trench as in Attachment C. The profile set forth in Attachment C (of the Consent Decree) and the associated contours will only need to be demonstrated initially by SMDA after completion of dewatering. The intent of Attachment C is to provide an example oh how MDEQ would like SMDA graphically to present capture in that area. SMDA may therefore present flow and gradients in tabular form. Tabular form presentation pursuant to Section V.D.4 (of the Consent Decree) is acceptable with respect to flow and gradients in all areas throughout the monitoring period. If this condition is not met, notification and response actions as outlined in the following section will be necessary. The final performance monitoring network will be subject to MDEQ review and approval.

6. Leachate/Groundwater Notification Conditions

The following sections list those conditions involving leachate and groundwater elevation that will require notification to MDEQ:

6.1 Notification During Start-Up Period

The general trends in leachate/groundwater elevations will be observed and documented during the initial 90-day startup period in appropriate wells, piezometers and drains. The response mechanisms described below will not apply during the first 90-days because it is not expected that hydraulic or chemical containment will be attained. SMDA will also provide MDEQ with monthly summaries of the dewatering phase during the initial 90-day period. Three summaries shall be submitted within 15 days after the end of the month being reported. An initial review of the hydraulic monitoring data will be completed within 3 weeks of each monitoring event performed after the first 90 days.

6.2 Notification Triggers

Based on the initial review, the following leachate/groundwater elevation conditions require action SMDA by and notification to MDEQ:

(a) During the dewatering phase, the leachate/groundwater elevations (corrected for climatic effects as necessary) indicate that the zone of hydraulic control is not increasing away from the individual collection components when comparing at least two consecutive monitoring intervals; or
(b) After the dewatering phase (i.e. steady state conditions), the leachate/groundwater elevations (corrected for climatic effects as necessary) do not demonstrate hydraulic control of the delineated extent of groundwater contamination above the higher of health-based standards or background.

6.3 Required Actions

The following actions will be taken by SMDA if any of the above conditions occur: SMDA will notify the MDEQ within one week of evaluating the data collected during the monitoring event for which the above condition occurs. If the trends or fluctuations in leachate/groundwater elevations cannot be explained by climatic conditions or hydrogeologic effects observed in wells outside the area to be dewatered, the leachate/groundwater levels in the area of concern will be remeasured within two weeks of above notification.

The MDEQ will be notified of the results within one week of the follow-up monitoring event. If the elevations have declined, measurement of leachate groundwater elevations will continue at biweekly intervals for one month during the monthly monitoring phase and at 6-week intervals for one quarter during the quarterly monitoring phase.

If the hydraulic monitoring does not demonstrate that dewatering is occurring at a rate that will result in capture within four (4) years of startup of the leachate/groundwater collection system, SMDA will increase pumping or leachate collection rates in the affected area within 2 weeks of the time water levels were remeasured to correct the situation. The results of these actions will be forwarded to MDEQ within 8 weeks of the increase in pumping or leachate collection rates.

If increased pumping or leachate collection is not practical or does not cause the water elevation to decline, SMDA will submit a corrective action plan to the MDEQ within 10 weeks of identifying the situation. Construction of the corrective actions will be implemented within 6 months of identifying the condition. SMDA may petition the MDEQ to request an extension if major modifications to the system are required or weather conditions do not permit timely construction. The concept that increased pumping and/or collection "is not practical" shall mean that the method of collection, treatment or disposal of leachate and groundwater, which SMDA is using at the time, cannot handle the increased volume of liquids.

7. Chemical Monitoring Notification Conditions

The following lists those conditions involving chemical monitoring that will require notification to MDEQ:

7.1 Conditions Requiring Action

The following leachate/groundwater quality conditions require action by SMDA and notification to MDEQ: The chemical concentration in any of the sentinel monitoring wells increases above the Part 201 residential health-based drinking water criteria or background as established pursuant to Section 3 of this PMP, whichever is higher; or: The chemical concentration in any of the monitoring wells increases in a way that indicates that the plume may be expanding.

7.2 Required Actions during Dewatering

SMDA will take the following actions if any of the above chemical monitoring conditions occur during the dewatering phase: SMDA will notify the MDEQ of the condition within 1 week of evaluating the results. Evaluation of the results will occur within 2 weeks of receipt of the results. The well will be resampled within 3 weeks of the above notification. If the chemical concentration in the follow-up sample is below the Part 201 residential health-based criteria or background, whichever is higher, and does not indicate the plume may be expanding, the monitoring well will continue to be sampled during the regularly scheduled water quality monitoring events. If the chemical concentration in the follow-up sample from a sentinel well does not meet the Part 201 residential health-based criteria or background, whichever is higher, a new sentinel well will be installed downgradient of the impacted sentinel well to monitor the expansion of the plume. Any such wells shall be installed within 3 months of receipt of the results unless an extension of this time is agreed to by the MDEQ.

The limits of the plume will be monitored and revised during the dewatering phase to provide a basis to evaluate the effects of the remedy on the plume when steady-state conditions have been attained. The new location(s) will be proposed by SMDA and be subject to review and approval by the MDEQ.

7.3 Required Action after Dewatering

SMDA will take the following actions if any of the above chemical monitoring conditions occur after the dewatering phase (i.e. steady-state conditions): SMDA will notify the MDEQ of the condition within 1 week of evaluating the results. Evaluation of the results must occur within two weeks of receipt of the results. The well will be resampled within 3 weeks the above notification. If the chemical concentration in the follow-up sample meets the Part 201 residential health-based criteria or background, whichever is higher, the monitoring well will continue to be sampled during the scheduled water quality monitoring events.

If the chemical concentration in the follow-up sample does not meet the Part 201 residential health-based criteria or is above background, whichever is higher: SMDA will notify the MDEQ of the corrective actions that will be taken within 1 week of this determination. SMDA will increase pumping or leachate collection rates if necessary in the affected area within 2 weeks of this determination to correct the situation. The well will be resampled within 8 weeks of increasing the

pumping or leachate collection rates. The results of these actions will be forwarded to MDEQ within 1 week of evaluating the analytical results of this last resample.

If increased pumping or leachate collection rates is not practical or does not cause the water quality to improve and/or if SMDA is unable to demonstrate hydraulic capture, SMDA will submit a corrective action plan to the MDEQ within 12 weeks of identifying the situation. The corrective actions will be implemented within 6 months of identifying the condition. SMDA may petition the MDEQ to request an extension if major modifications to the system are required or weather conditions do not permit timely construction.

8. Periodic Review

The leachate/groundwater extraction and monitoring systems will be reviewed periodically during and following the 90-day startup phase of the remedial action to determine if the locations and performance of the extraction and monitoring systems are adequate. Monthly reviews will be conducted during the start up phase, and reported to MDEQ in the monthly progress reports. Thereafter this issue will be addressed with the MDEQ on an annual basis in the annual monitoring report, to be submitted annually within 30 days of the anniversary of the effective date of the Consent Decree, until 1 year after equilibrium conditions are attained. During the reviews, wells proposed to be abandoned will be identified.

9. Modification

The PMP will be modified, as necessary, based on the Final Design, additional investigations (including the Supplemental Plume Delineation Work Plan, potable well inventory, hydraulic monitoring, etc.) as well as initial system operational data. Any revisions to the PMP will result in a similar level of cost and effort as currently proposed in Appendix A, provided no new information becomes available that significantly changes MDEQ's or SMDA's current understanding of the Facility conditions and/or the adequacy of the Conceptual Remedy. SMDA will submit any such modifications to the MDEQ for review and approval. Any disputes will be resolved in accordance with Section XVI of the Consent Decree.

10. Pumping System

SMDA shall start up the groundwater/leachate collection pumping system within September 7, 2002 unless a longer time is agreed to by SMDA and the MDEQ.

SMDA shall achieve capture, as defined above of the contaminant plumes that exceed the Part 201 health based standards or background, whichever is higher, beyond the boundaries of the Properties within four (4) years of the startup of the groundwater/leachate collection pumping system.

10.1 Failure to Achieve Capture

If capture is not achieved within 4 years of the startup of the leachate/groundwater collection system, or by the completion of the dewatering phase, SMDA will: immediately increase pumping

and leachate collection rates, as practical, until a corrective action plan is implemented; and submit to the MDEQ a corrective action plan including an amendment to the RAP within 10 days of the end of the four years or within 10 weeks of completion of the dewatering phase, whichever occurs first. The corrective action plan should include an evaluation of additional groundwater extraction wells and leachate collection trenches, as necessary, to obtain capture.

The corrective actions will be implemented within 6 months of identifying the condition, unless a longer time is agreed to by SMDA and MDEQ. Any disputes concerning the proposed corrective action plan or the amendments to the RAP shall be resolved in accordance with Section XVI of the Consent Decree.

10.2 Alternate Remedies

If, at any time after startup of the groundwater/leachate collection system, SMDA concludes that contaminated groundwater in one or more areas is not likely to be captured by the existing system or, if after completion of the dewatering phase, there are certain areas of the plume where the monitoring does not conclusively show hydraulic control or chemical containment, SMDA may propose an alternate remedy which may include natural attenuation. This proposed alternative remedy will be submitted to MDEQ for approval as a resubmittal of the RAP and PMP.

The burden shall be on SMDA to clearly delineate the extent of such areas, to adequately demonstrate that chemical containment has been achieved in the area(s), and to demonstrate that the collection system is preventing any continued loading of contaminated leachate to the aquifer in the area(s).

In the event that SMDA submits such a proposal, the proposal shall include adequate deed restrictions or institutional controls and fully comply with a "limited" or site-specific category cleanup pursuant to Part 201, including Sections 20118, 20120a and 20120b. Unless and until the MDEQ approves of such a proposal, SMDA shall fully comply with all notifications and responses contained in the Consent Decree and in the approved PMP. Any disputes concerning the proposed alternative remedy shall be resolved in accordance with Section XVI of the Consent Decree.

10.3 Demonstration of Capture

Once capture of the health-based plume has been achieved, SMDA shall demonstrate that capture of the plume beyond the boundaries of the Properties is maintained until such time as concentrations in groundwater at the boundary of the Properties are below Part 201 residential health-based drinking water criteria or background, whichever is higher. Capture/containment at the boundaries of the Properties and property owned by SMDA will need to be maintained in perpetuity or until it is demonstrated to MDEQ's satisfaction that all leachate/groundwater within the Site boundaries and under land owned by SMDA meets all applicable standards or at or below background, whichever is higher.

11. Verification of Remediation

At the start of groundwater monitoring, SMDA will perform baseline sampling in accordance with tables 1,2 and 3 of Appendix A of this PMP. The information from this initial baseline sampling and analysis will be used to confirm the extent of the contaminant plume defined in the CRA supplemental Plume Delineation Report of June 2000. If the plume(s) are not completely defined, additional wells will be installed to define the extent of contamination above the residential health-based criteria. If necessary, the contaminant plume will be redrawn for each aquifer. Based on the Supplemental Plume Delineation Report, additional monitoring wells will be needed northeast of MW-201R and possibly MW-117R.

12. Well Closure

Once the extent of the contaminant plume within each aquifer has been confirmed, SMDA will sample and analyze for metals, VOCS and general chemistry, consistent with Appendix A. After the first year of monitoring an assessment will be performed to determined which general chemistry parameters to continue analyzing. Any time after the first two years of monitoring, SMDA may petition the MDEQ to reduce the number of parameters analyzed and/or the frequency of monitoring. When a monitoring well no longer shows any parameters in excess of standards and if the well is no longer needed to demonstrate chemical containment, SMDA may petition the MDEQ to cease chemical monitoring at that well. Chemical monitoring will only cease after MDEQ approval for such a change to the PMP.

Appendix A – Groundwater Monitoring Well Summaries

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	Status	Location	Water Level Monitoring (Quarterly)	Water Level Monitoring (Continuous)	Water Quality Monitoring [4] (Baseline)	Water Quality Monitoring [4] (Quarterly)	Water Quality Monitoring [4] (Annual)
MW-006	E	N9	X		X		
MW-008	E	NW9	X[2]		X		X
MW-009	E	N9	X[2]				
MW-104	E	C9	X[2]		X		
MW-108	E	E9	X[2]		X	X	X
MW-110S	E	E9	X[2]		X		
MW-216	E	S9/9A	X[2]				
MW-503-1	E	SE9			X		X
MW-505	E	W9/E9A	X[2]				
MW-510	E	N9	X				
MW-511-1-1	E	N9	X		X		X
MW-512-1-1	E	N9	X		X		
MW-514	E	N9	X		X		X
MW-515	E	NW9	X		X	X	X
MW-517	E	W9	X[3]		X		
MW-518	E	S9/9A	X		X		X
MW-520	E	W9/N9A	X[2]		X	X	X
MW-521	E	W9/N9A	X[2]		X		
MW-530-2-1	E	E9		X[1]			
MW-531	E	N9	X		X		
MW-535-1-1	E	N9	X		X		X[1]
MW-535-1-2	E	N9	X		X		X[1]
MW-549	E	W9	X[2]				
MW-551	E	E9					
MW-565-15	E	C9A	X[2]				

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [4]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-571-21	E	C9		X[4]			
MW-590-11	E	N9	X		X		
MW-591-9	E	N9			X		
MW-592-16.5	E	N9			X		
LP-01	N	9A	X[3]				
LP-02	N	9A	X[3]				
LP-03	N	9A	X[3]				
LP-04	N	9A	X[3]				
LP-05	N	9A	X[3]				
LP-06	N	9A	X[3]				
LP-07	N	9A	X[3]				
LP-08	N	9A	X[3]				
LP-09	N	9A	X[3]				
LP-10	N	9A	X[3]				
LP-11	N	9A	X[3]				
LP-12	N	9A	X[3]				
LP-13	N	9	X[3]				
LP-14	N	9	X[3]				
PZ-98-01	N	NW9A	X[3]				
PZ-98-02	N	W9A	X[3]				
PZ-98-03	N	S9A	X[3]				
PZ3	E	S9A	X				
PZ4	E	S9A	X[3]				
PZ5	E	S9A	X[3]				

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [4]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
PZ6	E	S9A	X				
9701[1]	N	N9A	X[2]		X		
9702[1]	N	N9A	X[2]		X		
9703[1]	N	N9A	X[2]		X		
9704[1]	N	N9A	X[2]		X		
9705[1]	N	W9	X		X	X	X
9706[1]	N	N9	X		X	X	X
9707[1]	N	N9			X		X
9714	N	S9A	X		X		X[5]
9715[1]	N	N9A	X		X		
9716[1]	N	N9A	X		X		

Note:

[1] - Dependent on the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

[3] - After the first year only sample depth with highest contaminant level

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals. Data will be downloaded each quarter.

[5] - After initial baseline sample, determine if annual monitoring is required

[6] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include ~~TCL VOCs and TAL Metals~~. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells. OK

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-003	E	N9	X[2]				
MW-007	E	NE9	X		X		
MW-007D	E	NE9	X		X		X[6]
MW-103	E	C9	X				
MW-106	E	S9	X[2]				
MW-107	E	E9	X	X[4]			
MW-108-34	E	NE9	X[2]				
MW-110	E	E9	X[2]		X		
MW-111	E	N9	X[2]		X		
MW-112	E	N9	X		X		
MW-113	E	N9A	X[2]		X		
MW-114	E	SE9A	X[2]		X		
MW-115	E	C9A	X[2]		X		X
MW-116	E	W9	X		X		X
MW-117	E	NE9	X		X[5]		
MW-118	E	E9	X[2]		X		X
MW-206	E	NW9A	X				
MW-211	E	N9	X		X		
MW-218	E	C9A	X[2]				
MW-219	E	C9A	X[2]				
MW-401	E	S9A	X[2]				
MW-509-2	E	NW9	X		X		
MW-511-2-1	E	N9	X		X		X[1]
MW-511-2-2	E	N9	X		X		X[1]
MW-512-2-1	E	N9	X		X		X
MW-512-2-2	E	N9	X				

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-526-2-1	E	NE9	X[2]		X		X[1]
MW-526-2-2	E	NE9	X[2]		X		X[1]
MW-526-2-3	E	NE9	X[2]		X		X[1]
MW-527	E	NE9	X		X		X
MW-528	E	W9	X		X		X
MW-529-2-1	E	S9A	X		X		
MW-529-2-2	E	S9A	X[2]		X		
MW-530-2-1	E	E9	X[2]		X		
MW-530-2-2	E	E9	X[2]				
MW-530-2-3	E	E9	X[2]				
MW-538-2-1	E	NW9	X		X		
MW-539-2-1	E	E9	X[2]		X		X[1]
MW-539-2-2	E	E9	X[2]		X		X[1]
MW-540-2-1	E	E9	X		X		X
MW-542-2-1	E	W9	X		X		
MW-542-2-2	E	W9	X		X		
MW-543-2-1	E	NW9A	X[2]		X		X[1]
MW-543-2-2	E	NW9A	X[2]		X		X[1]
MW-550	E	E9	X		X		
MW-551	E	E9	X				
MW-556-23	E	C9A	X				
MW-557	E	W9/E9A	X[2]		X[3]		
MW-558-22	E	C9A	X		X		
MW-565-23	E	C9A	X[2]				
MW-571-43	E	C9	X[2]		X		
MW-575-36	E	C9A	X[2]				

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [7]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-576-24	E	S9	X[3]				
MW-578-26	E	C9	X				
MW-578-36	E	C9		X[4]			
MW-581-32	E	SE9	X		X		
MW-582-19	E	S9	X		X		X
MW-594-25	E	E9	X				
MW-594-35[1]	N	E9	X		X	X	X
8834	E	SW9A	X				
8836	E	W9A	X				
9708-2[1]	N	E9	X		X	X	X
9709-2[1]	N	SE9	X		X	X	X
MW-201R[1]	N	NE9	X		X	X	X
MW-117-R[1]	N	NE9	X		X	X	X

Note:

[1] - Dependent on the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

[3] - After the first year only sample depth with highest contaminant level

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals.. Data will be downloaded each quarter.

[5] - Sample during initial baseline event only

[6] - After the first year, determine need for further sampling

[7] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS, nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include TCL VOCs and TAL Metals. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells.

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-100	E	C9	X				
MW-101	E	S9	X[2]				
MW-105	E	S9A	X				
MW-109	E	NE9	X[2]				
MW-202	E	NE9	X				
MW-205	E	NW9A	X[2]				
MW-210	E	NW9	X				
MW-212	E	N9	X				
MW-500-2-1	E	S9A	X[2]	X[1]			
MW-500-2-2	E	S9A	X[2]		X	X	X
MW-501-2-1	E	S9A	X		X		X[1]
MW-501-2-2	E	S9A	X[2]		X		X[1]
MW-501-2-3	E	S9A	X[2]		X		X[1]
MW-501-2-4	E	S9A	X[2]		X		X[1]
MW-501-3-1	E	S9A	X		X		
MW-502	E	SE9A	X		X		
MW-503-2-1	E	SE9	X		X		X[1]
MW-503-2-2	E	SE9	X		X		X[1]
MW-503-2-3	E	SE9	X		X		X[1]
MW-504-2-1	E	SE9	X		X		X[1]

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [1]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-504-2-2	E	SE9	X		X		X[3]
MW-509-3-2	E	NW9	X[2]				
MW-511-3	E	N9	X				
MW-512-3	E	N9	X				
MW-529-2-1	E	S9A	X[2]		X		
MW-529-2-2	E	S9A	X[2]		X		
MW-529-3	E	S9A	X[2]		X		
MW-530-3	E	E9					
MW-538-3	E	N9	X				
MW-539-3-2	E	E9	X		X		X
MW-540-3-1	E	E9	X		X	X[3]	X
MW-540-3-2	E	E9	X		X	X[3]	X
MW-542-3	E	W9	X[2]				
MW-546-2-1	E	S9	X		X		
MW-550	E	E9	X				
MW-552-68	E	NE9A	X				
MW-554-53	E	NW9A	X		X		X
MW-557-59	E	E9A	X				
MW-558-56	E	W9A	X				
MW-567-50	E	SE9A	X[2]				

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-567-8	E	SE9A	X[2]				
MW-571-68	E	C9		X[1]			
MW-572-33	E	S9A	X[2]		X		
MW-572-44	E	S9A	X[2]				
MW-577-61	E	C9A	X		X		
MW-578-68	E	C9	X				
MW-579-62	E	C9	X				
MW-580-45	E	S9	X[2]				
MW-581-52	E	S9	X				
MW-582-41	E	S9	X				
9708-3[1]	N	E9	X		X	X	X
9709-3[1]	N	SE9	X		X	X	X
9711	N	S9A	X		X	X	X
9712	N	S9A	X		X	X	X
MW-598-R-2[1]	N	SE9	X		X	X[5]	X
MW-598-R-3[1]	N	E9	X		X	X[5]	X
S-16-3 or RS-16-4	E	S9A			X		X[6]

Note:

[1] - Dependent to the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [7]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*

[3] - After the first year only sample depth with highest contaminant level.

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals. Data will be downloaded each quarter.

[5] - After initial baseline event determine one well to be sampled from MW-540-3-1, MW-540-3-2, MW-598-R2, and MW598-R3 quarterly. Sample the rest annually

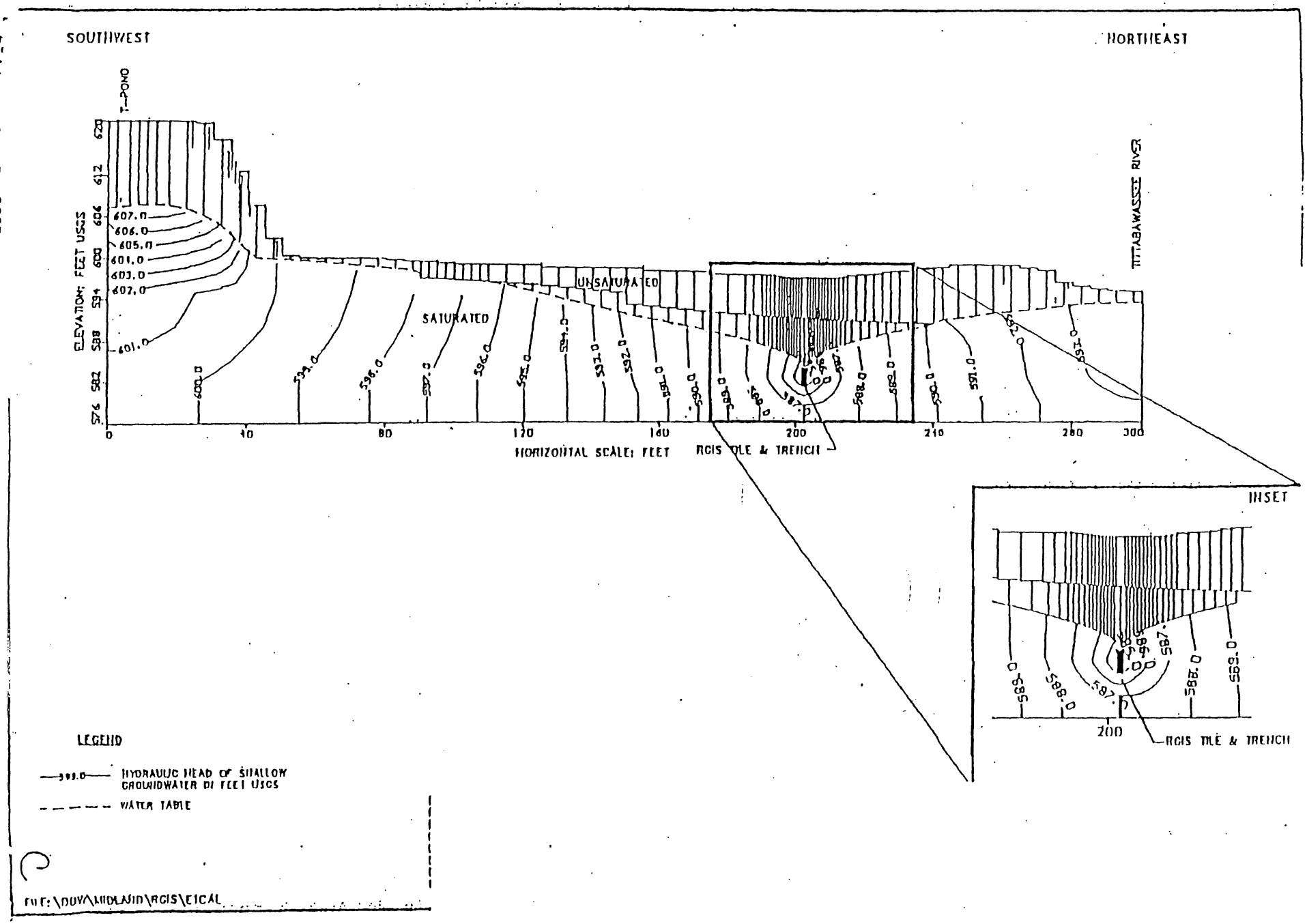
[6] - Sample one Decock irrigation well annually during irrigation season (well to be determined prior to initial baseline event).

[7] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS, nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include TCL VOCs and TAL Metals. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells.

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

Appendix B – Figure (Attachment C for 7/9/99 Agreement)


SOUTHWEST
NORTHEAST
T-POND
ELEVATION, FEET USGS
620
612
606
600
594
588
582
576
607.0
606.0
605.0
604.0
603.0
602.0
601.0
SATURATED
UNSATURATED
TITTABAWASSEE RIVER
0
40
80
120
160
200
240
280
300
HORIZONTAL SCALE: FEET
RGIS TILE & TRENCH
INSET
585.0
586.0
587.0
588.0
589.0
200
RGIS TILE & TRENCH
LEGEND
HYDRAULIC HEAD OF SHALLOW GROUNDWATER IN FEET USGS
WATER TABLE
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Appendix C – Part 201 Generic Cleanup Criteria Tables

DEQ

Environmental Response Division

GROUNDWATER: RESIDENTIAL AND INDUSTRIAL-C PART 201 GENERIC CLEANUP CRITERIA AND SCREE

Developed under the authority of the NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT, 199

Groundwater criteria were calculated using currently available chemical-specific data and U.S. Environmental change for the next annual revision of the criteria tables. All criteria are expressed in units of parts per billion (ppb; for example, 2 x 106 is reported as 2.0E+6. For comparison to the criteria, groundwater samples should be rep contaminant plume. Samples should be collected using a low flow protocol that minimizes turbidity caused by dist the samples should be conducted (see Op Memos #18 for details). Please refer to Op Memo #6 for recom

Guidesheet Number		#1	#2	#3	#4	#
	Chemical Abstract Service Number	Residential & Commercial I Drinking Water Criteria	Industrial & Commercial II, III & IV Drinking Water Criteria	Groundwater Surface Water Interface Criteria	Residential & Commercial I Groundwater Volatilization to Indoor Air Inhalation Criteria	Indus Com II, III Groun Volatili to Ind Inhal Crit
PHYSICAL PARAMETERS						
Dissolved oxygen (DO)		NA	NA	{AE}	NA	N
Phosphorus		NA	NA	{AE}	NA	N
Total dissolved solids (TDS)		5.0E+5 {E}	5.0E+5 {E}	{AE}	NA	N
HAZARDOUS SUBSTANCES						
BTEX + MTBE						
Benzene {I}	71432	5.0 {A}	5.0 {A}	200 {X}	5,600	36,
Ethylbenzene {I}	100414	74 {E}	74 {E}	18	1.7E+5 {S}	1.7E
Methyl-tert-butyl ether (MTBE)	1634044	40 {E}	40 {E}	730 {X}	4.7E+7 {S}	4.7E
Toluene {I}	108883	790 {E}	790 {E}	140	5.3E+5 {S}	5.3E
Xylenes {I}	1330207	280 {E}	280 {E}	35	1.9E+5 {S}	1.9E
VOLATILES						
Acetone {I}	67641	730	2,100	1,700	1.0E+9 {D,S}	1.0E+
Acrolein {I}	107028	120	330	NA	2,100	4,2
Acrylonitrile {I}	107131	2.6	11	4.9 {X}	34,000	1.9
Benzyl chloride	100447	7.7	32	NA	12,000	77,
Bromobenzene {I}	108861	18	50	NA	1.8E+5	3.9
Bromodichloromethane	75274	100 {A,W}	100 {A,W}	ID	4,800	38,
Bromoform	75252	100 {A,W}	100 {A,W}	ID	4.8E+5	3.1E
Bromomethane	74839	10	29	35	4,000	9,0
n-Butanol {I}	71363	950	2,700	NA	NLV	N
2-Butanone (MEK) {I}	78933	13,000	38,000	2,200	2.4E+8 {S}	2.4E
n-Butyl acetate	123864	550	1,600	NA	6.7E+6 {S}	6.7E
t-Butyl alcohol	75650	3,900	11,000	NA	1.0E+9 {D,S}	1.0E+
n-Butylbenzene	104518	80	230	NA	ID	I
sec-Butylbenzene	135988	80	230	NA	ID	I
tert-Butylbenzene {I}	98066	80	230	NA	ID	I
Carbon disulfide {I,R}	75150	800	2,300	ID	2.5E+5	5.5

Carbon tetrachloride	56235	5.0 {A}	5.0 {A}	45 {X}	370	2,4
Chlorobenzene {I}	108907	100 {A}	100 {A}	47	2.1E+5	4.7E
1-Chloro-1,1-difluoroethane	75683	15,000	44,000	NA	3.9E+6 {S}	3.9E
Chloroethane	75003	430	1,700	ID	5.7E+6 {S}	5.7E
2-Chloroethyl vinyl ether	110758	ID	ID	NA	ID	I
Chloroform	67663	100 {A,W}	100 {A,W}	170 {X}	28,000	1.8
Chloromethane {I}	74873	260	1,100	ID	8,600	52,
o-Chlorotoluene {I}	95498	150	420	NA	3.7E+5 {S}	3.7E
Dibromochloromethane	124481	100 {A,W}	100 {A,W}	ID	15,000	1.1
Dibromochloropropane	96128	0.2 {A}	0.2 {A}	NA	1,200 {S}	1,20
Dibromomethane	74953	80	230	NA	ID	I
Dichlorodifluoromethane	75718	1,700	4,800	ID	2.2E+5	3.0E
1,1-Dichloroethane	75343	880	2,500	ID	1.0E+6	2.3
1,2-Dichloroethane {I}	107062	5.0 {A}	5.0 {A}	360 {X}	9,600	59,
1,1-Dichloroethylene {I}	75354	7.0 {A}	7.0 {A}	65 {X}	200	1,3
cis-1,2-Dichloroethylene	156592	70 {A}	70 {A}	ID	96,000	2.2
trans-1,2-Dichloroethylene	156605	100 {A}	100 {A}	ID	85,000	2.0
1,2-Dichloropropane {I}	78875	5.0 {A}	5.0 {A}	290 {X}	16,000	36,
1,3-Dichloropropene	542756	21	63	NA	2.0	1
Diethyl ether	60297	10 {E,M}	10 {E,M}	ID	6.1E+7 {S}	6.1E
Diisopropyl ether	108203	30	86	NA	ID	I
Dimethylformamide {I}	68122	700	2,000	NA	NLV	N
Dimethylsulfoxide	67685	2.2E+5	6.3E+5	1.9E+5	NLV	N
1,4-Dioxane {I}	123911	85	350	2,800 {X}	NLV	N
Epichlorohydrin {I}	106898	5.0 {M}	6.0	NA	3.2E+5	6.3
Ethanol {I}	64175	1.9E+6	3.8E+6	IP	NLV	N
Ethyl acetate {I}	141786	6,600	19,000	NA	6.4E+7 {S}	6.4E
Ethylene dibromide	106934	1.0 {A,M}	1.0 {A,M}	1.0 {M}	2,400	15,
n-Heptane	142825	2,700 {S}	2,700 {S}	NA	2,700 {S}	2,70
n-Hexane	110543	3,000	8,600	NA	12,000 {S}	12,00
2-Hexanone	591786	1,000	2,900	NA	4.2E+6	8.8
Isobutyl alcohol {I}	78831	2,300	6,700	NA	7.6E+7 {S}	7.6E
Isopropyl alcohol {I}	67630	470	1,300	NA	NLV	N
Isopropyl benzene	98828	800	2,300	ID	56,000 {S}	56,00
Methane	74828	ID	ID	ID	{K}	{
Methanol	67561	3,700	10,000	480	2.5E+6	6.0
4-Methyl-2-pentanone (MIBK) {I}	108101	1,800	5,200	ID	2.0E+7 {S}	2.0E
Methylene chloride	75092	5.0 {A}	5.0 {A}	940 {X}	2.2E+5	1.4
Pentane	109660	ID	ID	NA	38,000 {S}	38,00
2-Pentene {I}	109682	ID	ID	NA	ID	I
Propyl alcohol {I}	71238	1,400	4,000	NA	NLV	N
n-Propylbenzene {I}	103651	80	230	ID	ID	I
Styrene	100425	100 {A}	100 {A}	80	1.7E+5	3.1E
1,1,1,2-Tetrachloroethane	630206	77	320	NA	15,000	96,
1,1,2,2-Tetrachloroethane	79345	8.5	35	78 {X}	12,000	77,
Tetrachloroethylene	127184	5.0 {A}	5.0 {A}	45 {X}	25,000	1.7
Tetrahydrofuran	109999	95	270	11,000 {X}	6.9E+6	1.6
1,1,1-Trichloroethane	71556	200 {A}	200 {A}	200	6.6E+5	1.3E
1,1,2-Trichloroethane	79005	5.0 {A}	5.0 {A}	330 {X}	17,000	1.1
Trichloroethylene	79016	5.0 {A}	5.0 {A}	200 {X}	15,000	97,
Trichlorofluoromethane	75694	2,600	7,300	NA	1.1E+6 {S}	1.1E
1,2,3-Trichloropropane	96184	42	120	NA	ID	I
1,1,2-Trichloro-1,2,2-trifluoroethane	76131	1.7E+5 {S}	1.7E+5 {S}	NA	1.7E+5 {S}	1.7E

Triethanolamine	102716	3,700	10,000	NA	NLV	N
2,2,4-Trimethyl pentane	540841	ID	ID	NA	ID	I
2,4,4-Trimethyl-2-pentene {I}	107404	ID	ID	NA	ID	I
1,2,4-Trimethylbenzene {I}	95636	63 {E}	63 {E}	ID	56,000 {S}	56,00
1,3,5-Trimethylbenzene {I}	108678	72 {E}	72 {E}	ID	61,000 {S}	61,00
Vinyl acetate {I}	108054	640	1,800	NA	4.1E+6	8.9
Vinyl chloride	75014	2.0 {A}	2.0 {A}	15	110	6
INORGANICS						
Aluminum {B}	7429905	50 {V}	50 {V}	NA	NLV	N
Antimony	7440360	6.0 {A}	6.0 {A}	ID	NLV	N
Arsenic {B}	7440382	50 {A}	50 {A}	150 {X}	NLV	N
Barium	7440393	2,000 {A}	2,000 {A}	{G,X}	NLV	N
Beryllium	7440417	4.0 {A}	4.0 {A}	{G}	NLV	N
Boron {B}	7440428	500 {F}	500 {F}	1,900	NLV	N
Cadmium {B}	7440439	5.0 {A}	5.0 {A}	{G,X}	NLV	N
Chromium (III) {B,H}	16065831	100 {A}	100 {A}	{G,X}	NLV	N
Chromium (VI)	18540299	100 {A}	100 {A}	11	NLV	N
Cobalt	7440484	40	100	100	NLV	N
Copper	7440508	1,000 {E}	1,000 {E}	{G}	NLV	N
Iron {B}	7439896	300 {E}	300 {E}	NA	NLV	N
Lead	7439921	4.0 {L}	4.0 {L}	{G,X}	NLV	N
Lithium {B}	7439932	170	350	25	NLV	N
Magnesium {B}	7439954	4.0E+5	1.1E+6	NA	NLV	N
Manganese {B}	7439965	50 {E}	50 {E}	{G,X}	NLV	N
Mercury (Inorganic)	7439976	2.0 {A}	2.0 {A}	1.3E-3 {Z}	NLV	N
Molybdenum {B}	7439987	37	100	800 {X}	NLV	N
Nickel {B}	7440020	100 {A}	100 {A}	{G}	NLV	N
Selenium {B}	7782492	50 {A}	50 {A}	5.0	NLV	N
Silver {B}	7440224	34	98	0.2 {M}	NLV	N
Sodium	17341252	1.2E+5	3.5E+5	NA	NLV	N
Strontium {B}	7440246	4,600	13,000	760	NLV	N
Thallium {B}	7440280	2.0 {A}	2.0 {A}	3.7 {X}	NLV	N
Vanadium	7440622	4.5	62	12	NLV	N
White phosphorus {R}	12185103	0.11	0.31	NA	NLV	N
Zinc {B}	7440666	2,400	5,000 {E}	{G}	NLV	N
PAHs						
Acenaphthene	83329	1,300	3,800	19	4,200 {S}	4,20
Acenaphthylene	208968	52	150	ID	3,900 {S}	3,90
Anthracene	120127	43 {S}	43 {S}	ID	43 {S}	43
Benzo(a)anthracene {Q}	56553	2.1	8.5	NA	NLV	N
Benzo(b)fluoranthene {Q}	205992	2.0 {M}	2.0 {M}	ID	NLV	N
Benzo(k)fluoranthene {Q}	207089	5.0 {M}	5.0 {M}	NA	NLV	N
Benzo(g,h,i)perylene	191242	5.0 {M}	5.0 {M}	NA	NLV	N
Benzo(a)pyrene {Q}	50328	5.0 {A,M}	5.0 {A,M}	ID	NLV	N
beta-Chloronaphthalene	91587	1,800	5,200	NA	ID	I
Chrysene {Q}	218019	5.0 {M}	5.0 {M}	ID	ID	I
Dibenzo(a,h)anthracene {Q}	53703	5.0 {M}	5.0 {M}	ID	NLV	N
Dibenzofuran	132649	ID	ID	4.0	ID	I
Fluoranthene	206440	210 {S}	210 {S}	1.6	210 {S}	210
Fluorene	86737	880	2,000 {S}	12	2,000 {S}	2,00
Indeno(1,2,3-cd)pyrene {Q}	193395	5.0 {M}	5.0 {M}	ID	NLV	N
2-Methylnaphthalene	91576	260	750	ID	ID	I

Naphthalene	91203	520	1,500	13	31,000 {S}	31,00
Phenanthrene	85018	52	150	5.0 {M}	1,000 {S}	1,00
Pyrene	129000	140 {S}	140 {S}	ID	140 {S}	140
SEMIVOLATILES						
Acetonitrile	75058	140	400	NA	2.4E+7	4.5
Acetophenone	98862	1,500	4,400	NA	6.1E+6 {S}	6.1E
Acrylamide	79061	0.3	1.2	NA	NLV	N
Acrylic acid	79107	3,900	11,000	NA	1.2E+7	2.8
Aniline	62533	53	220	20 {M}	NLV	N
Azobenzene	103333	23	94	NA	6,400 {S}	6,40
Benzidine	92875	0.3 {M}	0.3 {M}	ID	NLV	N
Benzoic acid	65850	32,000	92,000	NA	NLV	N
Benzyl alcohol	100516	10,000	29,000	NA	NLV	N
bis(2-Chloroethoxy)ethane	112265	ID	ID	NA	NLV	N
bis(2-Chloroethyl)ether {I}	111444	2.0	8.3	NA	38,000	2.1
Camphene {I}	79925	ID	ID	NA	ID	I
Caprolactam	105602	5,800	17,000	NA	NLV	N
Carbazole	86748	85	350	10 {M}	NLV	N
Decabromodiphenyl ether	1163195	30 {S}	30 {S}	NA	30 {S}	30
Di(2-ethylhexyl) adipate	103231	400 {A}	400 {A}	NA	NLV	N
Diacetone alcohol {I}	123422	ID	ID	NA	NLV	N
1,2-Dichlorobenzene	95501	600 {A}	600 {A}	16	1.6E+5 {S}	1.6E
1,3-Dichlorobenzene	541731	6.6	19	38	ID	I
1,4-Dichlorobenzene	106467	75 {A}	75 {A}	13	16,000	74,00
3,3'-Dichlorobenzidine	91941	1.1	4.3	0.3 {M,X}	NLV	N
2,6-Dichloro-4-nitroaniline	99309	2,200	6,300	NA	NLV	N
Diisopropylamine {I}	108189	5.6	16	NA	ID	I
Dimethyl phthalate	131113	73,000	2.1E+5	NA	NLV	N
N,N-Dimethylacetamide	127195	180	520	4,100 {X}	NLV	N
N,N-Dimethylaniline	121697	16	46	NA	2.4E+5	1.3E
2,4-Dinitrotoluene	121142	7.7	32	NA	NLV	N
1-Formylpiperidine	2591868	80	230	NA	ID	I
Gentian violet	548629	15	63	NA	NLV	N
Hexabromobenzene	87821	10 {M}	10 {M}	ID	ID	I
Hexachlorobenzene (C-66)	118741	1.0 {A}	1.0 {A}	ID	440	3,0
Hexachlorobutadiene (C-46)	87683	15	42	0.053	1,600	3,20
alpha-Hexachlorocyclohexane	319846	0.43	1.7	NA	2,000 {S}	2,00
beta-Hexachlorocyclohexane	319857	0.88	3.6	NA	NLV	N
Hexachlorocyclopentadiene (C-56)	77474	50 {A}	50 {A}	ID	ID	I
Hexachloroethane	67721	7.3	21	6.7 {X}	27,000	50,00
Isophorone	78591	770	3,100	570 {X}	NLV	N
2-Methoxyethanol {I}	109864	7.3	21	NA	NLV	N
N-Methyl-morpholine {I}	109024	20	56	NA	NLV	N
Methylcyclopentane {I}	96377	ID	ID	NA	ID	I
4,4'-Methylene-bis-2-chloroaniline (MBOCA)	101144	1.1	4.5	NA	NLV	N
Nitrobenzene {I}	98953	3.4	9.6	180 {X}	2.1E+6 {S}	2.1E
n-Nitroso-di-n-propylamine	621647	5.0 {M}	5.0 {M}	NA	NLV	N
N-Nitrosodiphenylamine	86306	270	1,100	NA	NLV	N
Oxo-hexyl acetate	88230357	73	210	NA	ID	I
Pentachlorobenzene	608935	6.1	17	NA	ID	I
Pentachloronitrobenzene	82688	32 {S}	32 {S}	NA	32 {S}	32
Piperidine	110894	3.2	9.2	NA	NLV	N

Propionic acid	79094	12,000	35,000	ID	NLV	N
Pyridine {I}	110861	7.3	21	NA	5,500	12,
1,2,4,5-Tetrachlorobenzene	95943	1,300 {S}	1,300 {S}	2.9 {X}	ID	I
p-Toluidine	106490	15	62	NA	NLV	N
Tributylamine	102829	10	29	ID	14,000	75,00
1,2,4-Trichlorobenzene	120821	70 {A}	70 {A}	30	3.0E+5 {S}	3.0E
Triphenyl phosphate	115866	1,200	1,400 {S}	NA	NLV	N
tris(2,3-Dibromopropyl)phosphate	126727	0.71	2.9	NA	4,700 {S}	4,70
PCBs						
Polychlorinated biphenyls (PCBs) {J,T}	1336363	0.5 {A}	0.5 {A}	0.2 {M}	45 {S}	45
PHTHALATES						
bis(2-Ethylhexyl)phthalate	117817	6.0 {A}	6.0 {A}	32	NLV	N
Butyl benzyl phthalate	85687	1,200	2,700 {S}	14 {X}	NLV	N
Di-n-butyl phthalate	84742	880	2,500	9.7	NLV	N
Di-n-octyl phthalate	117840	130	380	ID	NLV	N
Dicyclohexyl phthalate	84617	ID	ID	NA	ID	I
Diethyl phthalate	84662	5,500	16,000	NA	NLV	N
Phthalic acid	88993	14,000	40,000	NA	NLV	N
Phthalic anhydride	85449	15,000	44,000	NA	NLV	N
PESTICIDES						
Alachlor	15972608	2.0 {A}	2.0 {A}	11 {X}	NLV	N
Aldrin	309002	0.098	0.4	NA	180 {S}	180
Atrazine	1912249	3.0 {A}	3.0 {A}	7.3 {X}	NLV	N
Chlordane {J}	57749	2.0 {A}	2.0 {A}	IP	56 {S}	56
Chlorpyrifos	2921882	22	63	NA	2.9	6.
Cyanazine	21725462	10 {M}	10 {M}	56 {X}	NLV	N
Dacthal	1861321	73	210	NA	NLV	N
4-4'-DDD	72548	9.1	37	NA	NLV	N
4-4'-DDE	72559	4.3	15	NA	ID	I
4-4'-DDT	50293	3.6	10	0.02 {M}	NLV	N
Diazinon	333415	1.3	3.8	NA	NLV	N
Dichlorovos	62737	1.6	6.7	NA	NLV	N
Dieldrin	60571	0.11	0.43	0.02 {M}	200 {S}	200
Dinoseb	88857	7.0 {A}	7.0 {A}	NA	ID	I
Diuron	330541	31	90	NA	NLV	N
Endosulfan {J}	115297	1.7	4.8	NA	ID	I
Endothall	145733	100 {A}	100 {A}	NA	NLV	N
Endrin	72208	2.0 {A}	2.0 {A}	IP	NLV	N
Heptachlor	76448	0.4 {A}	0.4 {A}	NA	180 {S}	180
Heptachlor epoxide	1024573	0.2 {A}	0.2 {A}	NA	NLV	N
Lindane	58899	0.2 {A}	0.2 {A}	0.027	ID	I
Methoxychlor	72435	40 {A}	40 {A}	NA	ID	I
Methyl parathion	298000	1.8	5.2	NA	NLV	N
Metolachlor	51218452	240	990	NA	NLV	N
Mirex	2385855	0.02 {M}	0.02 {M}	NA	NA	N
Pendimethalin	40487421	280 {S}	280 {S}	NA	NLV	N
Prometon	1610180	160	460	NA	NLV	N
Propachlor	1918167	95	270	NA	NLV	N
Propazine	139402	200	560	NA	NLV	N
Simazine	122349	4.0 {A}	4.0 {A}	NA	NLV	N
Tebuthiuron	34014181	510	1,500	NA	NLV	N
Toxaphene	8001352	3.0 {A}	3.0 {A}	1.0 {M}	NLV	N

Triallate	2303175	95	270	NA	ID	I
PESTICIDES-HERBICIDES						
Aldicarb	116063	3.0 {A}	3.0 {A}	NA	NLV	N
Aldicarb sulfoxide	1646873	4.0 {A}	4.0 {A}	NA	NLV	N
Aldicarb sulfone	1646884	2.0 {A}	2.0 {A}	NA	NLV	N
Carbaryl	63252	700	2,000	NA	ID	I
Carbofuran	1563662	40 {A}	40 {A}	NA	NLV	N
Dalapon	75990	200 {A}	200 {A}	NA	NLV	N
2,4-Dichlorophenoxyacetic acid	94757	70 {A}	70 {A}	220	NLV	N
Diquat	85007	20 {A}	20 {A}	NA	NLV	N
Glyphosate	1071836	700 {A}	700 {A}	NA	NLV	N
2-Methyl-4-chlorophenoxyacetic acid	94746	7.3	21	NA	NLV	N
Oxamyl	23135220	200 {A}	200 {A}	NA	NLV	N
Picloram	1918021	500 {A}	500 {A}	NA	NLV	N
Silvex (2,4,5-TP)	93721	50 {A}	50 {A}	NA	NLV	N
Trifluralin	1582098	37	110	NA	ID	I
DIOXINS						
2,3,7,8-Tetrabromodibenzo-p-dioxin {O}	50585416	{O}	{O}	{O}	NLV	N
2,3,7,8-Tetrachlorodibenzo-p-dioxin {O}	1746016	3.0E-5 {A}	3.0E-5 {A}	1.0E-5 {M}	NLV	N
PHENOLS						
4-Chloro-3-methylphenol	59507	150	420	NA	NLV	N
2-Chlorophenol	95578	45	130	22	ID	I
2,4-Dichlorophenol	120832	73	210	19	NLV	N
2,4-Dimethylphenol	105679	370	1,000	380	NLV	N
2,6-Dimethylphenol	576261	4.4	13	NA	NLV	N
3,4-Dimethylphenol	95658	10	29	NA	NLV	N
2-Methyl-4,6-dinitrophenol	534521	20 {M}	20 {M}	NA	NLV	N
Methylphenols (J)	1319773	370	1,000	71	NLV	N
2-Nitrophenol	88755	20	58	ID	NLV	N
Pentachlorophenol	87865	1.0 {A}	1.0 {A}	{G,X}	NLV	N
Phenol	108952	4,400	13,000	210	NLV	N
2,4,5-Trichlorophenol	95954	730	2,100	NA	NLV	N
2,4,6-Trichlorophenol	88062	120	470	4.4	NLV	N
3-Trifluoromethyl-4-nitrophenol	88302	4,500	13,000	NA	NLV	N
MISCELLANEOUS						
Ammonia	7664417	10,000 {N}	10,000 {N}	{AC}	3.2E+6	7.2
Asbestos {AB}	1332214	7.0E+6 f/mL {A}	7.0E+6 f/mL {A}	NA	NLV	N
Chloride	16887006	2.5E+5 {E}	2.5E+5 {E}	1.25E+5 {X}	NLV	N
Cyanide {R}	57125	200 {A}	200 {A}	20 {M}	NLV	N
Fluorine (soluble fluoride) {B}	7782414	2,000 {E}	2,000 {E}	NA	NLV	N
Nitrate {B,N}	14797558	10,000 {A,N}	10,000 {A,N}	NA	NLV	N
Nitrite {B,N}	14797650	1,000 {A,N}	1,000 {A,N}	NA	NLV	N
Phosphorus (total)	7723140	63,000	2.4E+5	NA	NLV	N
Sulfate	14808798	2.5E+5 {E}	2.5E+5 {E}	NA	NLV	N
Urea	57136	ID {N}	ID {N}	NA	NLV	N
PBBs						
Polybrominated biphenyls {J}	67774327	0.032	0.09	IP	NLV	N
GLYCOLS						
Diethylene glycol monobutyl ether	112345	88	250	NA	NLV	N

Ethylene glycol	107211	15,000	42,000	1.9E+5 {X}	NLV	N
Ethylene glycol monobutyl ether	111762	3,700	10,000	NA	2.9E+6	6.5
Propylene glycol	57556	1.5E+5	4.2E+5	NA	NLV	N
Triethylene glycol	112276	10,000 {M}	12,000	NA	NLV	N
CARBONYLS						
Acetaldehyde {I}	75070	950	2,700	NA	1.1E+6	2.3
Cyclohexanone	108941	33,000	94,000	NA	1,400	3,3
Formaldehyde	50000	1,300	3,800	120	63,000	3.6
LOW MOLECULAR WEIGHT ACID						
Acetic acid	64197	18,000 {M}	18,000 {M}	18,000 {M}	NLV	N
Formic acid {I,U}	64186	18,000 {M}	29,000	ID	7.7E+6	1.5

Appendix D
Performance Monitoring Plan

Performance Monitoring Plan
(Revision #7)

for the

South Macomb Disposal Authority
Landfills 9 and 9A

By
Petro Environmental Technologies, Inc.

February 2002

Macomb County Landfill
Performance Monitoring Plan
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Addenda (to be submitted separately):

I. Monitoring Well Installation Plan
II. Piezometer Installation Plan
III. Field Sampling Plan
IV. Well Abandonment and Plugging Plan

1. Introduction

This Performance Monitoring Plan (PMP) for the Macomb County Landfill Properties 9 and 9A is designed to evaluate the effectiveness of the site's Remedial Action Plan (RAP). "Property" means the property of Landfills 9 an 9A located south of 24 Mile Road, west of Card Road, and north of the McBride Drain and legally described in Appendix A of the Consent Decree except as modified by written agreement between SDMA and MDEQ. The PMP is considered as part of the RAP and together will ensure that the properties are remediated in accordance with the applicable regulations and court decisions.

This PMP is specific to the monitoring of the remedial action measures. Engineering and construction of the remedial systems are discussed in the RAP. The main focus of this PMP is the evaluation measures needed to assess the effectiveness of the remedial efforts. Within the time frame of the remediation system's operation the following PMP goals will be achieved:

(1) Reaching and maintaining generic residential criteria in groundwater,
(2) Within four years of system start up reach and maintain hydraulic control of the groundwater plume that exceeds the health-based residential criteria, and
(3) Within four years of system start up reach and maintain chemical containment of groundwater plume that exceeds the health based residential criteria.

The final remediation goal is to achieve and maintain generic residential standards in the groundwater at all points in the aquifer beyond the property. Upon achievement of such a goal, it is anticipated the site will be deleted from the National Priorities List (NPL).

2. Summary

The PMP will be incorporated into the RAP that meets the requirements of Sections 18, 20a and 20b of Part 201 of NREPA. Any disputes involving the PMP will be resolved in accordance with Section XVI (Dispute Resolution) of the Consent Decree. SMDA will perform the following tasks as part of its PMP for the Macomb County Landfill Properties 9 and 9A. These tasks include the following:

1. Installation of monitoring wells as required.

2. Sampling of groundwater from the monitoring wells to determine their appropriateness for background use.

3. Monitor the geographic extent of the aesthetic exceedance response from household groundwater well data.

4. Sample and analyze water from monitoring wells to assess current conditions and assess

the effectiveness of the RAP in achieving chemical containment.

5. Measure groundwater elevations within the monitoring wells to assess the effectiveness of the RAP in achieving hydraulic control and dewatering.

6. Assess the overall performance of the remedial systems in achieving steady state and completion of the dewatering phase.

7. Notify MDEQ of excessive leachate/groundwater elevation conditions.

8. Notify MDEQ of excessive chemical monitoring conditions.

9. Perform periodic reviews of the remedial systems performance and make modifications to these systems as necessary.

10. Maintain and operate all pumps, pipes, appurtenances, mechanical systems, electrical controls and electrical power systems for the duration of the remediation effort.

11. Achieve and maintain capture of the contaminant plumes.

3. Aesthetic Exceedance in Groundwater

The following shall apply with respect to any Part 201 aesthetic exceedance that exists in the groundwater within one (1) mile of the boundaries of the Property:

3.1 Background Monitoring Wells Locations and Evaluation

Three wells have been installed and contribute background information. New wells may be installed within one mile of the boundaries of the Properties to provide additional background information. The locations of the new background wells are subject to MDEQ approval.

Each well will be sampled using a sampling methodology and analysis which complies with the methodologies prescribed by Part 201 of the NREPA, Part 201 Rules and guidance provided by the MDEQ on detection limits and analytical methods. The samples will be analyzed for iron, manganese, chloride, diethyl ether, barium, arsenic and general chemistry by a MDEQ approved lab. A split sample will be provided to MDEQ, if requested.

Upon completion of the sampling and analysis of these wells, an evaluation will be performed to determine the appropriateness of the wells for background use. The data and evaluation will be submitted to MDEQ for review and approval. If the data clearly demonstrate that the wells are likely impacted by a source of contamination they should not be used for the determination of background concentrations. If the data indicate that any contaminant plume that emanates from

Property 9 or Property 9A is being influenced by upgradient contamination, further evaluation may be necessary to determine if the wells are appropriate for background concentrations for the Properties. Some background will be determined and used and, if necessary, MDEQ shall designate one or more alternate locations to install well(s), which will be evaluated as provided herein. This will be done until the parties agree that three true background wells exist.

3.2 Establishing Background Parameters

The background concentration of each parameter sampled and analyzed for purposes of remediating the Properties shall be calculated using the average of the concentration of each parameter sampled and analyzed from these three wells and by using a statistical method agreed to by the MDEQ. Sampling may be performed for other constituents, including those with health-based standards, which will become background for each of those additional contaminants when the average concentration is calculated using the same methodology.

3.3 Geographical Extent of Aesthetic Response

The geographical extent of the health-based exceedance is indicated in the following report: "Supplemental Plume Delineation Report", CRA, dated June 2000, Reference No. 11413(21). The aesthetic response actions contained in the PMP apply to all areas within a mile of the Property.

By March 31, 2002, SMDA shall determine whether the groundwater in any residential well that is located within one mile of a boundary of the site being used for household use exceeds the higher of: the standards for aesthetics for manganese, iron, chloride, diethyl ether, barium, arsenic, general chemistry, total dissolved solid (TDS) and other parameters designated by the MDEQ; or the background for any such parameter as determined pursuant to applicable provisions of this PMP.

If an aesthetic exceedance exists at any such residence and the residence in question is not part of a subdivision, within 45 days of the above determination, SMDA shall offer the owner of the residence the choice of installation of a water softener at SMDA's expense or payment to the owner of the residence the equivalent of the cost of a water softener to be used towards hook up to municipal water, if municipal water is available.

If the residence is part of a subdivision and if Macomb Township has adopted and is enforcing a water ordinance described in Section 3.4, then SMDA will have no further obligation to address aesthetic exceedance criteria in the groundwater at that residence. The ordinance must be enforced in order to remain a valid institutional control pursuant to Part 201.

If, however, Macomb Township has not adopted such an ordinance or the residence is for some reason not subject to such an ordinance, then SMDA shall make the offer of either the water softener or the equivalent cost described above, regardless of whether the residence is part of a subdivision.

SMDA will not be required to take action if it is demonstrated to the MDEQ's satisfaction that the detected contamination is not attributable to the Facility. Any dispute will be resolved in accordance with the Consent Order.

3.4 Exceptions for New residential Areas

SMDA may request Macomb Township to adopt and enforce a township ordinance acceptable to the MDEQ pursuant to which any subdivision that exists or is established within 1 mile of the boundaries of Properties 9 and 9A must hook all existing and future residences within the subdivision to municipal water.

4. Capture of Contaminant Plumes

The SMDA shall "capture" the contaminant plumes emanating beyond the lateral boundaries of the Properties by demonstrating both hydraulic control and chemical containment.

4.1 Hydraulic Control

Hydraulic control shall be demonstrated through the use of groundwater contour maps and profiles showing the horizontal and vertical direction of groundwater flow and horizontal and vertical hydraulic gradients. Hydraulic control will be considered to extend to the point where the hydraulic gradients are toward the Property or toward a component of the extraction system (i.e. the divide between inward and outward gradients).

4.2 Chemical Containment

Chemical containment (or chemical capture) is defined as the stabilization and/or reduction of the plume that extends beyond the boundaries of the Property, which exceeds the higher of Part 201 residential health-based drinking water criteria as contained in the January 29, 1999 update of Part 201 Generic Cleanup Criteria Tables of the August 31, 1998 MDEQ Environmental Response Division Memorandum #18 as amended by the October 2, 1998 Update or background as determined pursuant to the Consent Decree (refer to Appendix C). Chemical capture will be considered to exist if the chemical concentrations of the groundwater in the sentinel wells remain below the higher of Part 201 residential health-based drinking water criteria or background and if the chemical concentrations in all of the monitoring wells do not change in a way that indicates that the plume is expanding.

4.3 Dewatering

Dewatering is defined as the process of achieving a zone of hydraulic control expanding away from the individual collection components of the and remedy toward the required zone of capture (i.e.

Part 201 residential health-based plume or background) and decreasing water elevations in the zone of capture towards achieving a steady state dewatered condition within the boundaries of the Properties. Dewatering phase is defined to comprise the time until achievement of steady state conditions or four (4) years from startup, whichever is sooner. Completion of dewatering is defined as the attainment of long-term equilibrium conditions where water levels are drawn down such that the maximum extent of capture is achieved.

Following 90 days after start up of the Groundwater/Leachate Collection System and during the dewatering phase (i.e. prior to steady state conditions) SMDA shall demonstrate that dewatering is occurring. Capture of the health-based plume beyond the boundaries of the Property shall be attained within 4 years of the startup of the groundwater/leachate collection system. Once completion of dewatering is achieved, SMDA shall demonstrate that: Capture of the health-based plume beyond the boundaries of the Property is maintained until such time as concentrations in groundwater beyond the boundaries of the properties are below the higher of Part 201 residential health–based drinking water criteria or background and; The collection trenches are effective in eliminating the continued loss of leachate to the aquifer beyond the boundaries of the Properties. This demonstration may provide extra confidence in the overall system and allow for reductions in monitoring of the aquifer and support any proposals involving natural attenuation or other remedy proposals.

5. Monitoring Wells

Extraction and monitoring well locations, both existing and proposed are shown on plan sheet #8. Appendix A identifies a preliminary monitoring well network for Aquifers 1, 2, and 3 has been currently agreed to by SMDA and MDEQ based on the currently understood remedy and conditions at the Facility. Groundwater samples will be obtained and analyzed, and water levels measured in each type of well in accordance with Appendix A of this PMP.

5.1 Monitoring Wells Installation

SMDA will install up to six (6) transducers in wells to be selected by MDEQ. SMDA will monitor the water levels in the six (6) wells on an on going basis at no less than daily intervals during implementation of the PMP or until MDEQ agrees that such monitoring can be reduced or stopped on one or more such wells. Additional wells designated for long term monitoring will be installed (594R, 9706 and 9707). An additional well will be installed beyond MW-210R to define the extent of the plume in that area.

5.2 East Side of Site 9

After completion of dewatering, the monitoring system must be able to demonstrate to the MDEQ's satisfaction that the leachate collection system is pulling contaminants off the bottom of aquifer 2 on the east side of the Property, where this is required to control the off-site migration of leachate.

To demonstrate this condition, additional piezometers must be positioned in a line perpendicular to the leachate collection trench on the east side of the Property. The number and location of these additional wells or piezometer clusters shall be subject to MDEQ approval and sufficient to demonstrate capture.

The measured static water elevations, when mapped in cross section, must show decreasing head levels from the base of the aquifer to the collection trench as in Appendix B. The profile of static water elevations will be presented in both tabular and graphical format. At the discretion of the MDEQ, tabular format may be used exclusively.

The measured static water elevations, when mapped in cross section, must show decreasing head levels from the base of the aquifer to the collection trench as in Attachment C. The profile set forth in Attachment C (of the Consent Decree) and the associated contours will only need to be demonstrated initially by SMDA after completion of dewatering. The intent of Attachment C is to provide an example oh how MDEQ would like SMDA graphically to present capture in that area. SMDA may therefore present flow and gradients in tabular form. Tabular form presentation pursuant to Section V.D.4 (of the Consent Decree) is acceptable with respect to flow and gradients in all areas throughout the monitoring period. If this condition is not met, notification and response actions as outlined in the following section will be necessary. The final performance monitoring network will be subject to MDEQ review and approval.

6. Leachate/Groundwater Notification Conditions

The following sections list those conditions involving leachate and groundwater elevation that will require notification to MDEQ:

6.1 Notification During Start-Up Period

The general trends in leachate/groundwater elevations will be observed and documented during the initial 90-day startup period in appropriate wells, piezometers and drains. The response mechanisms described below will not apply during the first 90-days because it is not expected that hydraulic or chemical containment will be attained. SMDA will also provide MDEQ with monthly summaries of the dewatering phase during the initial 90-day period. Three summaries shall be submitted within 15 days after the end of the month being reported. An initial review of the hydraulic monitoring data will be completed within 3 weeks of each monitoring event performed after the first 90 days.

6.2 Notification Triggers

Based on the initial review, the following leachate/groundwater elevation conditions require action SMDA by and notification to MDEQ:

(a) During the dewatering phase, the leachate/groundwater elevations (corrected for climatic effects as necessary) indicate that the zone of hydraulic control is not increasing away from the individual collection components when comparing at least two consecutive monitoring intervals; or
(b) After the dewatering phase (i.e. steady state conditions), the leachate/groundwater elevations (corrected for climatic effects as necessary) do not demonstrate hydraulic control of the delineated extent of groundwater contamination above the higher of health-based standards or background.

6.3 Required Actions

The following actions will be taken by SMDA if any of the above conditions occur: SMDA will notify the MDEQ within one week of evaluating the data collected during the monitoring event for which the above condition occurs. If the trends or fluctuations in leachate/groundwater elevations cannot be explained by climatic conditions or hydrogeologic effects observed in wells outside the area to be dewatered, the leachate/groundwater levels in the area of concern will be remeasured within two weeks of above notification.

The MDEQ will be notified of the results within one week of the follow-up monitoring event. If the elevations have declined, measurement of leachate groundwater elevations will continue at biweekly intervals for one month during the monthly monitoring phase and at 6-week intervals for one quarter during the quarterly monitoring phase.

If the hydraulic monitoring does not demonstrate that dewatering is occurring at a rate that will result in capture within four (4) years of startup of the leachate/groundwater collection system, SMDA will increase pumping or leachate collection rates in the affected area within 2 weeks of the time water levels were remeasured to correct the situation. The results of these actions will be forwarded to MDEQ within 8 weeks of the increase in pumping or leachate collection rates.

If increased pumping or leachate collection is not practical or does not cause the water elevation to decline, SMDA will submit a corrective action plan to the MDEQ within 10 weeks of identifying the situation. Construction of the corrective actions will be implemented within 6 months of identifying the condition. SMDA may petition the MDEQ to request an extension if major modifications to the system are required or weather conditions do not permit timely construction. The concept that increased pumping and/or collection "is not practical" shall mean that the method of collection, treatment or disposal of leachate and groundwater, which SMDA is using at the time, cannot handle the increased volume of liquids.

7. Chemical Monitoring Notification Conditions

The following lists those conditions involving chemical monitoring that will require notification to MDEQ:

7.1 Conditions Requiring Action

The following leachate/groundwater quality conditions require action by SMDA and notification to MDEQ: The chemical concentration in any of the sentinel monitoring wells increases above the Part 201 residential health-based drinking water criteria or background as established pursuant to Section 3 of this PMP, whichever is higher; or: The chemical concentration in any of the monitoring wells increases in a way that indicates that the plume may be expanding.

7.2 Required Actions during Dewatering

SMDA will take the following actions if any of the above chemical monitoring conditions occur during the dewatering phase: SMDA will notify the MDEQ of the condition within 1 week of evaluating the results. Evaluation of the results will occur within 2 weeks of receipt of the results. The well will be resampled within 3 weeks of the above notification. If the chemical concentration in the follow-up sample is below the Part 201 residential health-based criteria or background, whichever is higher, and does not indicate the plume may be expanding, the monitoring well will continue to be sampled during the regularly scheduled water quality monitoring events. If the chemical concentration in the follow-up sample from a sentinel well does not meet the Part 201 residential health-based criteria or background, whichever is higher, a new sentinel well will be installed downgradient of the impacted sentinel well to monitor the expansion of the plume. Any such wells shall be installed within 3 months of receipt of the results unless an extension of this time is agreed to by the MDEQ.

The limits of the plume will be monitored and revised during the dewatering phase to provide a basis to evaluate the effects of the remedy on the plume when steady-state conditions have been attained. The new location(s) will be proposed by SMDA and be subject to review and approval by the MDEQ.

7.3 Required Action after Dewatering

SMDA will take the following actions if any of the above chemical monitoring conditions occur after the dewatering phase (i.e. steady-state conditions): SMDA will notify the MDEQ of the condition within 1 week of evaluating the results. Evaluation of the results must occur within two weeks of receipt of the results. The well will be resampled within 3 weeks the above notification. If the chemical concentration in the follow-up sample meets the Part 201 residential health-based criteria or background, whichever is higher, the monitoring well will continue to be sampled during the scheduled water quality monitoring events.

If the chemical concentration in the follow-up sample does not meet the Part 201 residential health-based criteria or is above background, whichever is higher: SMDA will notify the MDEQ of the corrective actions that will be taken within 1 week of this determination. SMDA will increase pumping or leachate collection rates if necessary in the affected area within 2 weeks of this determination to correct the situation. The well will be resampled within 8 weeks of increasing the

pumping or leachate collection rates. The results of these actions will be forwarded to MDEQ within 1 week of evaluating the analytical results of this last resample.

If increased pumping or leachate collection rates is not practical or does not cause the water quality to improve and/or if SMDA is unable to demonstrate hydraulic capture, SMDA will submit a corrective action plan to the MDEQ within 12 weeks of identifying the situation. The corrective actions will be implemented within 6 months of identifying the condition. SMDA may petition the MDEQ to request an extension if major modifications to the system are required or weather conditions do not permit timely construction.

8. Periodic Review

The leachate/groundwater extraction and monitoring systems will be reviewed periodically during and following the 90-day startup phase of the remedial action to determine if the locations and performance of the extraction and monitoring systems are adequate. Monthly reviews will be conducted during the start up phase, and reported to MDEQ in the monthly progress reports. Thereafter this issue will be addressed with the MDEQ on an annual basis in the annual monitoring report, to be submitted annually within 30 days of the anniversary of the effective date of the Consent Decree, until 1 year after equilibrium conditions are attained. During the reviews, wells proposed to be abandoned will be identified.

9. Modification

The PMP will be modified, as necessary, based on the Final Design, additional investigations (including the Supplemental Plume Delineation Work Plan, potable well inventory, hydraulic monitoring, etc.) as well as initial system operational data. Any revisions to the PMP will result in a similar level of cost and effort as currently proposed in Appendix A, provided no new information becomes available that significantly changes MDEQ's or SMDA's current understanding of the Facility conditions and/or the adequacy of the Conceptual Remedy. SMDA will submit any such modifications to the MDEQ for review and approval. Any disputes will be resolved in accordance with Section XVI of the Consent Decree.

10. Pumping System

SMDA shall start up the groundwater/leachate collection pumping system within September 7, 2002 unless a longer time is agreed to by SMDA and the MDEQ.

SMDA shall achieve capture, as defined above of the contaminant plumes that exceed the Part 201 health based standards or background, whichever is higher, beyond the boundaries of the Properties within four (4) years of the startup of the groundwater/leachate collection pumping system.

10.1 Failure to Achieve Capture

If capture is not achieved within 4 years of the startup of the leachate/groundwater collection system, or by the completion of the dewatering phase, SMDA will: immediately increase pumping

and leachate collection rates, as practical, until a corrective action plan is implemented; and submit to the MDEQ a corrective action plan including an amendment to the RAP within 10 days of the end of the four years or within 10 weeks of completion of the dewatering phase, whichever occurs first. The corrective action plan should include an evaluation of additional groundwater extraction wells and leachate collection trenches, as necessary, to obtain capture.

The corrective actions will be implemented within 6 months of identifying the condition, unless a longer time is agreed to by SMDA and MDEQ. Any disputes concerning the proposed corrective action plan or the amendments to the RAP shall be resolved in accordance with Section XVI of the Consent Decree.

10.2 Alternate Remedies

If, at any time after startup of the groundwater/leachate collection system, SMDA concludes that contaminated groundwater in one or more areas is not likely to be captured by the existing system or, if after completion of the dewatering phase, there are certain areas of the plume where the monitoring does not conclusively show hydraulic control or chemical containment, SMDA may propose an alternate remedy which may include natural attenuation. This proposed alternative remedy will be submitted to MDEQ for approval as a resubmittal of the RAP and PMP.

The burden shall be on SMDA to clearly delineate the extent of such areas, to adequately demonstrate that chemical containment has been achieved in the area(s), and to demonstrate that the collection system is preventing any continued loading of contaminated leachate to the aquifer in the area(s).

In the event that SMDA submits such a proposal, the proposal shall include adequate deed restrictions or institutional controls and fully comply with a "limited" or site-specific category cleanup pursuant to Part 201, including Sections 20118, 20120a and 20120b. Unless and until the MDEQ approves of such a proposal, SMDA shall fully comply with all notifications and responses contained in the Consent Decree and in the approved PMP. Any disputes concerning the proposed alternative remedy shall be resolved in accordance with Section XVI of the Consent Decree.

10.3 Demonstration of Capture

Once capture of the health-based plume has been achieved, SMDA shall demonstrate that capture of the plume beyond the boundaries of the Properties is maintained until such time as concentrations in groundwater at the boundary of the Properties are below Part 201 residential health-based drinking water criteria or background, whichever is higher. Capture/containment at the boundaries of the Properties and property owned by SMDA will need to be maintained in perpetuity or until it is demonstrated to MDEQ's satisfaction that all leachate/groundwater within the Site boundaries and under land owned by SMDA meets all applicable standards or at or below background, whichever is higher.

11. Verification of Remediation

At the start of groundwater monitoring, SMDA will perform baseline sampling in accordance with tables 1,2 and 3 of Appendix A of this PMP. The information from this initial baseline sampling and analysis will be used to confirm the extent of the contaminant plume defined in the CRA supplemental Plume Delineation Report of June 2000. If the plume(s) are not completely defined, additional wells will be installed to define the extent of contamination above the residential health-based criteria. If necessary, the contaminant plume will be redrawn for each aquifer. Based on the Supplemental Plume Delineation Report, additional monitoring wells will be needed northeast of MW-201R and possibly MW-117R.

12. Well Closure

Once the extent of the contaminant plume within each aquifer has been confirmed, SMDA will sample and analyze for metals, VOCS and general chemistry, consistent with Appendix A. After the first year of monitoring an assessment will be performed to determined which general chemistry parameters to continue analyzing. Any time after the first two years of monitoring, SMDA may petition the MDEQ to reduce the number of parameters analyzed and/or the frequency of monitoring. When a monitoring well no longer shows any parameters in excess of standards and if the well is no longer needed to demonstrate chemical containment, SMDA may petition the MDEQ to cease chemical monitoring at that well. Chemical monitoring will only cease after MDEQ approval for such a change to the PMP.

Appendix A – Groundwater Monitoring Well Summaries

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	Status	Location	Water Level Monitoring (Quarterly)	Water Level Monitoring (Continuous)	Water Quality Monitoring [4] (Baseline)	Water Quality Monitoring [4] (Quarterly)	Water Quality Monitoring [4] (Annual)
MW-006	E	N9	X		X		
MW-008	E	NW9	X[2]		X		X
MW-009	E	N9	X[2]				
MW-104	E	C9	X[2]		X		
MW-108	E	E9	X[2]		X	X	X
MW-110S	E	E9	X[2]		X		
MW-216	E	S9/9A	X[2]				
MW-503-1	E	SE9			X		X
MW-505	E	W9/E9A	X[2]				
MW-510	E	N9	X				
MW-511-1-1	E	N9	X		X		X
MW-512-1-1	E	N9	X		X		
MW-514	E	N9	X		X		X
MW-515	E	NW9	X		X	X	X
MW-517	E	W9	X[3]		X		
MW-518	E	S9/9A	X		X		X
MW-520	E	W9/N9A	X[2]		X	X	X
MW-521	E	W9/N9A	X[2]		X		
MW-530-2-1	E	E9		X[1]			
MW-531	E	N9	X		X		
MW-535-1-1	E	N9	X		X		X[1]
MW-535-1-2	E	N9	X		X		X[1]
MW-549	E	W9	X[2]				
MW-551	E	E9					
MW-565-15	E	C9A	X[2]				

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [4]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-571-21	E	C9		X[4]			
MW-590-11	E	N9	X		X		
MW-591-9	E	N9			X		
MW-592-16.5	E	N9			X		
LP-01	N	9A	X[3]				
LP-02	N	9A	X[3]				
LP-03	N	9A	X[3]				
LP-04	N	9A	X[3]				
LP-05	N	9A	X[3]				
LP-06	N	9A	X[3]				
LP-07	N	9A	X[3]				
LP-08	N	9A	X[3]				
LP-09	N	9A	X[3]				
LP-10	N	9A	X[3]				
LP-11	N	9A	X[3]				
LP-12	N	9A	X[3]				
LP-13	N	9	X[3]				
LP-14	N	9	X[3]				
PZ-98-01	N	NW9A	X[3]				
PZ-98-02	N	W9A	X[3]				
PZ-98-03	N	S9A	X[3]				
PZ3	E	S9A	X				
PZ4	E	S9A	X[3]				
PZ5	E	S9A	X[3]				

TABLE 1

AQUIFER 1 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [4]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
PZ6	E	S9A	X				
9701[1]	N	N9A	X[2]		X		
9702[1]	N	N9A	X[2]		X		
9703[1]	N	N9A	X[2]		X		
9704[1]	N	N9A	X[2]		X		
9705[1]	N	W9	X		X	X	X
9706[1]	N	N9	X		X	X	X
9707[1]	N	N9			X		X
9714	N	S9A	X		X		X[5]
9715[1]	N	N9A	X		X		
9716[1]	N	N9A	X		X		

Note:

[1] - Dependent on the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

[3] - After the first year only sample depth with highest contaminant level

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals. Data will be downloaded each quarter.

[5] - After initial baseline sample, determine if annual monitoring is required

[6] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include ~~TCL VOCs and TAL Metals~~. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells. OK

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-003	E	N9	X[2]				
MW-007	E	NE9	X		X		
MW-007D	E	NE9	X		X		X[6]
MW-103	E	C9	X				
MW-106	E	S9	X[2]				
MW-107	E	E9	X	X[4]			
MW-108-34	E	NE9	X[2]				
MW-110	E	E9	X[2]		X		
MW-111	E	N9	X[2]		X		
MW-112	E	N9	X		X		
MW-113	E	N9A	X[2]		X		
MW-114	E	SE9A	X[2]		X		
MW-115	E	C9A	X[2]		X		X
MW-116	E	W9	X		X		X
MW-117	E	NE9	X		X[5]		
MW-118	E	E9	X[2]		X		X
MW-206	E	NW9A	X				
MW-211	E	N9	X		X		
MW-218	E	C9A	X[2]				
MW-219	E	C9A	X[2]				
MW-401	E	S9A	X[2]				
MW-509-2	E	NW9	X		X		
MW-511-2-1	E	N9	X		X		X[1]
MW-511-2-2	E	N9	X		X		X[1]
MW-512-2-1	E	N9	X		X		X
MW-512-2-2	E	N9	X				

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-526-2-1	E	NE9	X[2]		X		X[1]
MW-526-2-2	E	NE9	X[2]		X		X[1]
MW-526-2-3	E	NE9	X[2]		X		X[1]
MW-527	E	NE9	X		X		X
MW-528	E	W9	X		X		X
MW-529-2-1	E	S9A	X		X		
MW-529-2-2	E	S9A	X[2]		X		
MW-530-2-1	E	E9	X[2]		X		
MW-530-2-2	E	E9	X[2]				
MW-530-2-3	E	E9	X[2]				
MW-538-2-1	E	NW9	X		X		
MW-539-2-1	E	E9	X[2]		X		X[1]
MW-539-2-2	E	E9	X[2]		X		X[1]
MW-540-2-1	E	E9	X		X		X
MW-542-2-1	E	W9	X		X		
MW-542-2-2	E	W9	X		X		
MW-543-2-1	E	NW9A	X[2]		X		X[1]
MW-543-2-2	E	NW9A	X[2]		X		X[1]
MW-550	E	E9	X		X		
MW-551	E	E9	X				
MW-556-23	E	C9A	X				
MW-557	E	W9/E9A	X[2]		X[3]		
MW-558-22	E	C9A	X		X		
MW-565-23	E	C9A	X[2]				
MW-571-43	E	C9	X[2]		X		
MW-575-36	E	C9A	X[2]				

TABLE 2

AQUIFER 2 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [7]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-576-24	E	S9	X[3]				
MW-578-26	E	C9	X				
MW-578-36	E	C9		X[4]			
MW-581-32	E	SE9	X		X		
MW-582-19	E	S9	X		X		X
MW-594-25	E	E9	X				
MW-594-35[1]	N	E9	X		X	X	X
8834	E	SW9A	X				
8836	E	W9A	X				
9708-2[1]	N	E9	X		X	X	X
9709-2[1]	N	SE9	X		X	X	X
MW-201R[1]	N	NE9	X		X	X	X
MW-117-R[1]	N	NE9	X		X	X	X

Note:

[1] - Dependent on the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

[3] - After the first year only sample depth with highest contaminant level

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals.. Data will be downloaded each quarter.

[5] - Sample during initial baseline event only

[6] - After the first year, determine need for further sampling

[7] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS, nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include TCL VOCs and TAL Metals. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells.

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-100	E	C9	X				
MW-101	E	S9	X[2]				
MW-105	E	S9A	X				
MW-109	E	NE9	X[2]				
MW-202	E	NE9	X				
MW-205	E	NW9A	X[2]				
MW-210	E	NW9	X				
MW-212	E	N9	X				
MW-500-2-1	E	S9A	X[2]	X[1]			
MW-500-2-2	E	S9A	X[2]		X	X	X
MW-501-2-1	E	S9A	X		X		X[1]
MW-501-2-2	E	S9A	X[2]		X		X[1]
MW-501-2-3	E	S9A	X[2]		X		X[1]
MW-501-2-4	E	S9A	X[2]		X		X[1]
MW-501-3-1	E	S9A	X		X		
MW-502	E	SE9A	X		X		
MW-503-2-1	E	SE9	X		X		X[1]
MW-503-2-2	E	SE9	X		X		X[1]
MW-503-2-3	E	SE9	X		X		X[1]
MW-504-2-1	E	SE9	X		X		X[1]

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [1]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-504-2-2	E	SE9	X		X		X[3]
MW-509-3-2	E	NW9	X[2]				
MW-511-3	E	N9	X				
MW-512-3	E	N9	X				
MW-529-2-1	E	S9A	X[2]		X		
MW-529-2-2	E	S9A	X[2]		X		
MW-529-3	E	S9A	X[2]		X		
MW-530-3	E	E9					
MW-538-3	E	N9	X				
MW-539-3-2	E	E9	X		X		X
MW-540-3-1	E	E9	X		X	X[3]	X
MW-540-3-2	E	E9	X		X	X[3]	X
MW-542-3	E	W9	X[2]				
MW-546-2-1	E	S9	X		X		
MW-550	E	E9	X				
MW-552-68	E	NE9A	X				
MW-554-53	E	NW9A	X		X		X
MW-557-59	E	E9A	X				
MW-558-56	E	W9A	X				
MW-567-50	E	SE9A	X[2]				

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [2]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*
MW-567-8	E	SE9A	X[2]				
MW-571-68	E	C9		X[1]			
MW-572-33	E	S9A	X[2]		X		
MW-572-44	E	S9A	X[2]				
MW-577-61	E	C9A	X		X		
MW-578-68	E	C9	X				
MW-579-62	E	C9	X				
MW-580-45	E	S9	X[2]				
MW-581-52	E	S9	X				
MW-582-41	E	S9	X				
9708-3[1]	N	E9	X		X	X	X
9709-3[1]	N	SE9	X		X	X	X
9711	N	S9A	X		X	X	X
9712	N	S9A	X		X	X	X
MW-598-R-2[1]	N	SE9	X		X	X[5]	X
MW-598-R-3[1]	N	E9	X		X	X[5]	X
S-16-3 or RS-16-4	E	S9A			X		X[6]

Note:

[1] - Dependent to the Supplemental Plume Delineation results.

[2] - Water levels to be monitored weekly for the first 4 weeks and monthly for the next 5 months.

TABLE 3

AQUIFER 3 MONITORING SUMMARY
SMDA SITES 9 AND 9A
MACOMB COUNTY, MICHIGAN

Well I.D.	*Status*	*Location*	*Water Level Monitoring*		*Water Quality Monitoring* [7]		
			(Quarterly)	*(Continuous)*	*(Baseline)*	*(Quarterly)*	*(Annual)*

[3] - After the first year only sample depth with highest contaminant level.

[4] - Continuous water level monitoring will be performed using electronic transducers programmed to record at daily intervals. Data will be downloaded each quarter.

[5] - After initial baseline event determine one well to be sampled from MW-540-3-1, MW-540-3-2, MW-598-R2, and MW598-R3 quarterly. Sample the rest annually

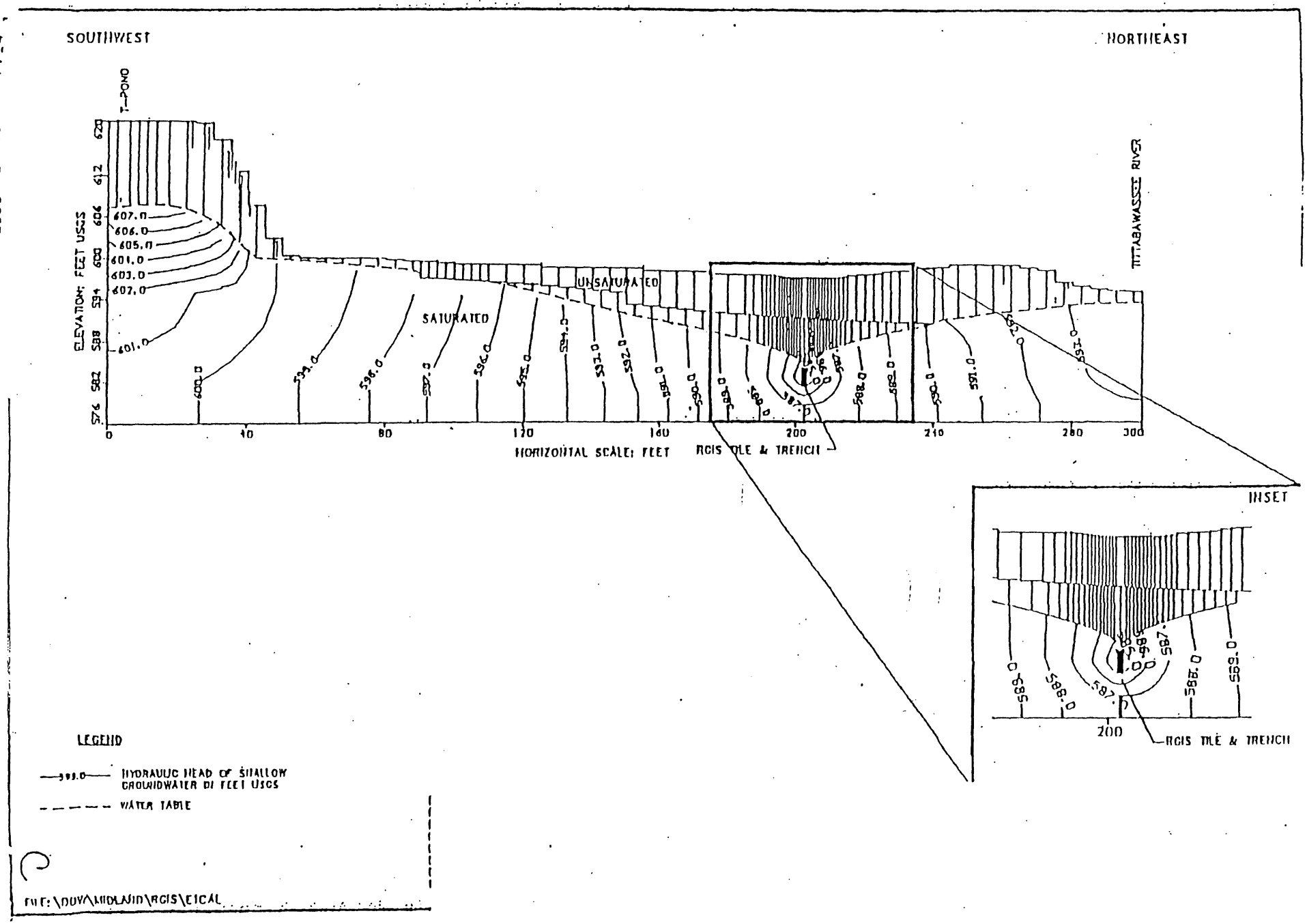
[6] - Sample one Decock irrigation well annually during irrigation season (well to be determined prior to initial baseline event).

[7] - The initial Baseline monitoring and Quarterly monitoring for the first year will include TCL VOCs, TAL metals, and general chemistry (sodium, potassium, magnesium, calcium, bicarbonate, carbonate, chloride, sulfate, BOD, COD, TDS, nitrates, and ammonia). Regular Baseline, Annual, and Quarterly monitoring shall include TCL VOCs and TAL Metals. After the first year, an assessment will be performed to determine which general chemistry parameters to continue analyzing for during future events and on which wells.

Status- E=existing well, N=new well to be installed

Location-location of well with respect to Sites 9 or 9A (N=north, S =south, E=east, W=west, C=central)

Appendix B – Figure (Attachment C for 7/9/99 Agreement)


SOUTHWEST
NORTHEAST
T-POND
ELEVATION, FEET USGS
620
612
606
600
594
588
582
576
607.0
606.0
605.0
604.0
603.0
602.0
601.0
SATURATED
UNSATURATED
TITTABAWASSEE RIVER
0
40
80
120
160
200
240
280
300
HORIZONTAL SCALE: FEET
RGIS TILE & TRENCH
INSET
585.0
586.0
587.0
588.0
589.0
200
RGIS TILE & TRENCH
LEGEND
HYDRAULIC HEAD OF SHALLOW GROUNDWATER IN FEET USGS
WATER TABLE
FILE:\DOW\MIDLAND\RGIS\EICAL

Appendix C – Part 201 Generic Cleanup Criteria Tables

DEQ

Environmental Response Division

GROUNDWATER: RESIDENTIAL AND INDUSTRIAL-C PART 201 GENERIC CLEANUP CRITERIA AND SCREE

Developed under the authority of the NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT, 199

Groundwater criteria were calculated using currently available chemical-specific data and U.S. Environmental change for the next annual revision of the criteria tables. All criteria are expressed in units of parts per billion (ppb; for example, 2 x 106 is reported as 2.0E+6. For comparison to the criteria, groundwater samples should be rep contaminant plume. Samples should be collected using a low flow protocol that minimizes turbidity caused by dist the samples should be conducted (see Op Memos #18 for details). Please refer to Op Memo #6 for recom

Guidesheet Number		#1	#2	#3	#4	#
	Chemical Abstract Service Number	Residential & Commercial I Drinking Water Criteria	Industrial & Commercial II, III & IV Drinking Water Criteria	Groundwater Surface Water Interface Criteria	Residential & Commercial I Groundwater Volatilization to Indoor Air Inhalation Criteria	Indus Com II, III Groun Volatili to Ind Inhal Crit
PHYSICAL PARAMETERS						
Dissolved oxygen (DO)		NA	NA	{AE}	NA	N
Phosphorus		NA	NA	{AE}	NA	N
Total dissolved solids (TDS)		5.0E+5 {E}	5.0E+5 {E}	{AE}	NA	N
HAZARDOUS SUBSTANCES						
BTEX + MTBE						
Benzene {I}	71432	5.0 {A}	5.0 {A}	200 {X}	5,600	36,
Ethylbenzene {I}	100414	74 {E}	74 {E}	18	1.7E+5 {S}	1.7E
Methyl-tert-butyl ether (MTBE)	1634044	40 {E}	40 {E}	730 {X}	4.7E+7 {S}	4.7E
Toluene {I}	108883	790 {E}	790 {E}	140	5.3E+5 {S}	5.3E
Xylenes {I}	1330207	280 {E}	280 {E}	35	1.9E+5 {S}	1.9E
VOLATILES						
Acetone {I}	67641	730	2,100	1,700	1.0E+9 {D,S}	1.0E+
Acrolein {I}	107028	120	330	NA	2,100	4,2
Acrylonitrile {I}	107131	2.6	11	4.9 {X}	34,000	1.9
Benzyl chloride	100447	7.7	32	NA	12,000	77,
Bromobenzene {I}	108861	18	50	NA	1.8E+5	3.9
Bromodichloromethane	75274	100 {A,W}	100 {A,W}	ID	4,800	38,
Bromoform	75252	100 {A,W}	100 {A,W}	ID	4.8E+5	3.1E
Bromomethane	74839	10	29	35	4,000	9,0
n-Butanol {I}	71363	950	2,700	NA	NLV	N
2-Butanone (MEK) {I}	78933	13,000	38,000	2,200	2.4E+8 {S}	2.4E
n-Butyl acetate	123864	550	1,600	NA	6.7E+6 {S}	6.7E
t-Butyl alcohol	75650	3,900	11,000	NA	1.0E+9 {D,S}	1.0E+
n-Butylbenzene	104518	80	230	NA	ID	I
sec-Butylbenzene	135988	80	230	NA	ID	I
tert-Butylbenzene {I}	98066	80	230	NA	ID	I
Carbon disulfide {I,R}	75150	800	2,300	ID	2.5E+5	5.5

Carbon tetrachloride	56235	5.0 {A}	5.0 {A}	45 {X}	370	2,4
Chlorobenzene {I}	108907	100 {A}	100 {A}	47	2.1E+5	4.7E
1-Chloro-1,1-difluoroethane	75683	15,000	44,000	NA	3.9E+6 {S}	3.9E
Chloroethane	75003	430	1,700	ID	5.7E+6 {S}	5.7E
2-Chloroethyl vinyl ether	110758	ID	ID	NA	ID	I
Chloroform	67663	100 {A,W}	100 {A,W}	170 {X}	28,000	1.8
Chloromethane {I}	74873	260	1,100	ID	8,600	52,
o-Chlorotoluene {I}	95498	150	420	NA	3.7E+5 {S}	3.7E
Dibromochloromethane	124481	100 {A,W}	100 {A,W}	ID	15,000	1.1
Dibromochloropropane	96128	0.2 {A}	0.2 {A}	NA	1,200 {S}	1,20
Dibromomethane	74953	80	230	NA	ID	I
Dichlorodifluoromethane	75718	1,700	4,800	ID	2.2E+5	3.0E
1,1-Dichloroethane	75343	880	2,500	ID	1.0E+6	2.3
1,2-Dichloroethane {I}	107062	5.0 {A}	5.0 {A}	360 {X}	9,600	59,
1,1-Dichloroethylene {I}	75354	7.0 {A}	7.0 {A}	65 {X}	200	1,3
cis-1,2-Dichloroethylene	156592	70 {A}	70 {A}	ID	96,000	2.2
trans-1,2-Dichloroethylene	156605	100 {A}	100 {A}	ID	85,000	2.0
1,2-Dichloropropane {I}	78875	5.0 {A}	5.0 {A}	290 {X}	16,000	36,
1,3-Dichloropropene	542756	21	63	NA	2.0	1
Diethyl ether	60297	10 {E,M}	10 {E,M}	ID	6.1E+7 {S}	6.1E
Diisopropyl ether	108203	30	86	NA	ID	I
Dimethylformamide {I}	68122	700	2,000	NA	NLV	N
Dimethylsulfoxide	67685	2.2E+5	6.3E+5	1.9E+5	NLV	N
1,4-Dioxane {I}	123911	85	350	2,800 {X}	NLV	N
Epichlorohydrin {I}	106898	5.0 {M}	6.0	NA	3.2E+5	6.3
Ethanol {I}	64175	1.9E+6	3.8E+6	IP	NLV	N
Ethyl acetate {I}	141786	6,600	19,000	NA	6.4E+7 {S}	6.4E
Ethylene dibromide	106934	1.0 {A,M}	1.0 {A,M}	1.0 {M}	2,400	15,
n-Heptane	142825	2,700 {S}	2,700 {S}	NA	2,700 {S}	2,70
n-Hexane	110543	3,000	8,600	NA	12,000 {S}	12,00
2-Hexanone	591786	1,000	2,900	NA	4.2E+6	8.8
Isobutyl alcohol {I}	78831	2,300	6,700	NA	7.6E+7 {S}	7.6E
Isopropyl alcohol {I}	67630	470	1,300	NA	NLV	N
Isopropyl benzene	98828	800	2,300	ID	56,000 {S}	56,00
Methane	74828	ID	ID	ID	{K}	{
Methanol	67561	3,700	10,000	480	2.5E+6	6.0
4-Methyl-2-pentanone (MIBK) {I}	108101	1,800	5,200	ID	2.0E+7 {S}	2.0E
Methylene chloride	75092	5.0 {A}	5.0 {A}	940 {X}	2.2E+5	1.4
Pentane	109660	ID	ID	NA	38,000 {S}	38,00
2-Pentene {I}	109682	ID	ID	NA	ID	I
Propyl alcohol {I}	71238	1,400	4,000	NA	NLV	N
n-Propylbenzene {I}	103651	80	230	ID	ID	I
Styrene	100425	100 {A}	100 {A}	80	1.7E+5	3.1E
1,1,1,2-Tetrachloroethane	630206	77	320	NA	15,000	96,
1,1,2,2-Tetrachloroethane	79345	8.5	35	78 {X}	12,000	77,
Tetrachloroethylene	127184	5.0 {A}	5.0 {A}	45 {X}	25,000	1.7
Tetrahydrofuran	109999	95	270	11,000 {X}	6.9E+6	1.6
1,1,1-Trichloroethane	71556	200 {A}	200 {A}	200	6.6E+5	1.3E
1,1,2-Trichloroethane	79005	5.0 {A}	5.0 {A}	330 {X}	17,000	1.1
Trichloroethylene	79016	5.0 {A}	5.0 {A}	200 {X}	15,000	97,
Trichlorofluoromethane	75694	2,600	7,300	NA	1.1E+6 {S}	1.1E
1,2,3-Trichloropropane	96184	42	120	NA	ID	I
1,1,2-Trichloro-1,2,2-trifluoroethane	76131	1.7E+5 {S}	1.7E+5 {S}	NA	1.7E+5 {S}	1.7E

Triethanolamine	102716	3,700	10,000	NA	NLV	N
2,2,4-Trimethyl pentane	540841	ID	ID	NA	ID	I
2,4,4-Trimethyl-2-pentene {I}	107404	ID	ID	NA	ID	I
1,2,4-Trimethylbenzene {I}	95636	63 {E}	63 {E}	ID	56,000 {S}	56,00
1,3,5-Trimethylbenzene {I}	108678	72 {E}	72 {E}	ID	61,000 {S}	61,00
Vinyl acetate {I}	108054	640	1,800	NA	4.1E+6	8.9
Vinyl chloride	75014	2.0 {A}	2.0 {A}	15	110	6
INORGANICS						
Aluminum {B}	7429905	50 {V}	50 {V}	NA	NLV	N
Antimony	7440360	6.0 {A}	6.0 {A}	ID	NLV	N
Arsenic {B}	7440382	50 {A}	50 {A}	150 {X}	NLV	N
Barium	7440393	2,000 {A}	2,000 {A}	{G,X}	NLV	N
Beryllium	7440417	4.0 {A}	4.0 {A}	{G}	NLV	N
Boron {B}	7440428	500 {F}	500 {F}	1,900	NLV	N
Cadmium {B}	7440439	5.0 {A}	5.0 {A}	{G,X}	NLV	N
Chromium (III) {B,H}	16065831	100 {A}	100 {A}	{G,X}	NLV	N
Chromium (VI)	18540299	100 {A}	100 {A}	11	NLV	N
Cobalt	7440484	40	100	100	NLV	N
Copper	7440508	1,000 {E}	1,000 {E}	{G}	NLV	N
Iron {B}	7439896	300 {E}	300 {E}	NA	NLV	N
Lead	7439921	4.0 {L}	4.0 {L}	{G,X}	NLV	N
Lithium {B}	7439932	170	350	25	NLV	N
Magnesium {B}	7439954	4.0E+5	1.1E+6	NA	NLV	N
Manganese {B}	7439965	50 {E}	50 {E}	{G,X}	NLV	N
Mercury (Inorganic)	7439976	2.0 {A}	2.0 {A}	1.3E-3 {Z}	NLV	N
Molybdenum {B}	7439987	37	100	800 {X}	NLV	N
Nickel {B}	7440020	100 {A}	100 {A}	{G}	NLV	N
Selenium {B}	7782492	50 {A}	50 {A}	5.0	NLV	N
Silver {B}	7440224	34	98	0.2 {M}	NLV	N
Sodium	17341252	1.2E+5	3.5E+5	NA	NLV	N
Strontium {B}	7440246	4,600	13,000	760	NLV	N
Thallium {B}	7440280	2.0 {A}	2.0 {A}	3.7 {X}	NLV	N
Vanadium	7440622	4.5	62	12	NLV	N
White phosphorus {R}	12185103	0.11	0.31	NA	NLV	N
Zinc {B}	7440666	2,400	5,000 {E}	{G}	NLV	N
PAHs						
Acenaphthene	83329	1,300	3,800	19	4,200 {S}	4,20
Acenaphthylene	208968	52	150	ID	3,900 {S}	3,90
Anthracene	120127	43 {S}	43 {S}	ID	43 {S}	43
Benzo(a)anthracene {Q}	56553	2.1	8.5	NA	NLV	N
Benzo(b)fluoranthene {Q}	205992	2.0 {M}	2.0 {M}	ID	NLV	N
Benzo(k)fluoranthene {Q}	207089	5.0 {M}	5.0 {M}	NA	NLV	N
Benzo(g,h,i)perylene	191242	5.0 {M}	5.0 {M}	NA	NLV	N
Benzo(a)pyrene {Q}	50328	5.0 {A,M}	5.0 {A,M}	ID	NLV	N
beta-Chloronaphthalene	91587	1,800	5,200	NA	ID	I
Chrysene {Q}	218019	5.0 {M}	5.0 {M}	ID	ID	I
Dibenzo(a,h)anthracene {Q}	53703	5.0 {M}	5.0 {M}	ID	NLV	N
Dibenzofuran	132649	ID	ID	4.0	ID	I
Fluoranthene	206440	210 {S}	210 {S}	1.6	210 {S}	210
Fluorene	86737	880	2,000 {S}	12	2,000 {S}	2,00
Indeno(1,2,3-cd)pyrene {Q}	193395	5.0 {M}	5.0 {M}	ID	NLV	N
2-Methylnaphthalene	91576	260	750	ID	ID	I

Naphthalene	91203	520	1,500	13	31,000 {S}	31,00
Phenanthrene	85018	52	150	5.0 {M}	1,000 {S}	1,00
Pyrene	129000	140 {S}	140 {S}	ID	140 {S}	140
SEMIVOLATILES						
Acetonitrile	75058	140	400	NA	2.4E+7	4.5
Acetophenone	98862	1,500	4,400	NA	6.1E+6 {S}	6.1E
Acrylamide	79061	0.3	1.2	NA	NLV	N
Acrylic acid	79107	3,900	11,000	NA	1.2E+7	2.8
Aniline	62533	53	220	20 {M}	NLV	N
Azobenzene	103333	23	94	NA	6,400 {S}	6,40
Benzidine	92875	0.3 {M}	0.3 {M}	ID	NLV	N
Benzoic acid	65850	32,000	92,000	NA	NLV	N
Benzyl alcohol	100516	10,000	29,000	NA	NLV	N
bis(2-Chloroethoxy)ethane	112265	ID	ID	NA	NLV	N
bis(2-Chloroethyl)ether {I}	111444	2.0	8.3	NA	38,000	2.1
Camphene {I}	79925	ID	ID	NA	ID	I
Caprolactam	105602	5,800	17,000	NA	NLV	N
Carbazole	86748	85	350	10 {M}	NLV	N
Decabromodiphenyl ether	1163195	30 {S}	30 {S}	NA	30 {S}	30
Di(2-ethylhexyl) adipate	103231	400 {A}	400 {A}	NA	NLV	N
Diacetone alcohol {I}	123422	ID	ID	NA	NLV	N
1,2-Dichlorobenzene	95501	600 {A}	600 {A}	16	1.6E+5 {S}	1.6E
1,3-Dichlorobenzene	541731	6.6	19	38	ID	I
1,4-Dichlorobenzene	106467	75 {A}	75 {A}	13	16,000	74,00
3,3'-Dichlorobenzidine	91941	1.1	4.3	0.3 {M,X}	NLV	N
2,6-Dichloro-4-nitroaniline	99309	2,200	6,300	NA	NLV	N
Diisopropylamine {I}	108189	5.6	16	NA	ID	I
Dimethyl phthalate	131113	73,000	2.1E+5	NA	NLV	N
N,N-Dimethylacetamide	127195	180	520	4,100 {X}	NLV	N
N,N-Dimethylaniline	121697	16	46	NA	2.4E+5	1.3E
2,4-Dinitrotoluene	121142	7.7	32	NA	NLV	N
1-Formylpiperidine	2591868	80	230	NA	ID	I
Gentian violet	548629	15	63	NA	NLV	N
Hexabromobenzene	87821	10 {M}	10 {M}	ID	ID	I
Hexachlorobenzene (C-66)	118741	1.0 {A}	1.0 {A}	ID	440	3,0
Hexachlorobutadiene (C-46)	87683	15	42	0.053	1,600	3,20
alpha-Hexachlorocyclohexane	319846	0.43	1.7	NA	2,000 {S}	2,00
beta-Hexachlorocyclohexane	319857	0.88	3.6	NA	NLV	N
Hexachlorocyclopentadiene (C-56)	77474	50 {A}	50 {A}	ID	ID	I
Hexachloroethane	67721	7.3	21	6.7 {X}	27,000	50,00
Isophorone	78591	770	3,100	570 {X}	NLV	N
2-Methoxyethanol {I}	109864	7.3	21	NA	NLV	N
N-Methyl-morpholine {I}	109024	20	56	NA	NLV	N
Methylcyclopentane {I}	96377	ID	ID	NA	ID	I
4,4'-Methylene-bis-2-chloroaniline (MBOCA)	101144	1.1	4.5	NA	NLV	N
Nitrobenzene {I}	98953	3.4	9.6	180 {X}	2.1E+6 {S}	2.1E
n-Nitroso-di-n-propylamine	621647	5.0 {M}	5.0 {M}	NA	NLV	N
N-Nitrosodiphenylamine	86306	270	1,100	NA	NLV	N
Oxo-hexyl acetate	88230357	73	210	NA	ID	I
Pentachlorobenzene	608935	6.1	17	NA	ID	I
Pentachloronitrobenzene	82688	32 {S}	32 {S}	NA	32 {S}	32
Piperidine	110894	3.2	9.2	NA	NLV	N

Propionic acid	79094	12,000	35,000	ID	NLV	N
Pyridine {I}	110861	7.3	21	NA	5,500	12,
1,2,4,5-Tetrachlorobenzene	95943	1,300 {S}	1,300 {S}	2.9 {X}	ID	I
p-Toluidine	106490	15	62	NA	NLV	N
Tributylamine	102829	10	29	ID	14,000	75,00
1,2,4-Trichlorobenzene	120821	70 {A}	70 {A}	30	3.0E+5 {S}	3.0E
Triphenyl phosphate	115866	1,200	1,400 {S}	NA	NLV	N
tris(2,3-Dibromopropyl)phosphate	126727	0.71	2.9	NA	4,700 {S}	4,70
PCBs						
Polychlorinated biphenyls (PCBs) {J,T}	1336363	0.5 {A}	0.5 {A}	0.2 {M}	45 {S}	45
PHTHALATES						
bis(2-Ethylhexyl)phthalate	117817	6.0 {A}	6.0 {A}	32	NLV	N
Butyl benzyl phthalate	85687	1,200	2,700 {S}	14 {X}	NLV	N
Di-n-butyl phthalate	84742	880	2,500	9.7	NLV	N
Di-n-octyl phthalate	117840	130	380	ID	NLV	N
Dicyclohexyl phthalate	84617	ID	ID	NA	ID	I
Diethyl phthalate	84662	5,500	16,000	NA	NLV	N
Phthalic acid	88993	14,000	40,000	NA	NLV	N
Phthalic anhydride	85449	15,000	44,000	NA	NLV	N
PESTICIDES						
Alachlor	15972608	2.0 {A}	2.0 {A}	11 {X}	NLV	N
Aldrin	309002	0.098	0.4	NA	180 {S}	180
Atrazine	1912249	3.0 {A}	3.0 {A}	7.3 {X}	NLV	N
Chlordane {J}	57749	2.0 {A}	2.0 {A}	IP	56 {S}	56
Chlorpyrifos	2921882	22	63	NA	2.9	6.
Cyanazine	21725462	10 {M}	10 {M}	56 {X}	NLV	N
Dacthal	1861321	73	210	NA	NLV	N
4-4'-DDD	72548	9.1	37	NA	NLV	N
4-4'-DDE	72559	4.3	15	NA	ID	I
4-4'-DDT	50293	3.6	10	0.02 {M}	NLV	N
Diazinon	333415	1.3	3.8	NA	NLV	N
Dichlorovos	62737	1.6	6.7	NA	NLV	N
Dieldrin	60571	0.11	0.43	0.02 {M}	200 {S}	200
Dinoseb	88857	7.0 {A}	7.0 {A}	NA	ID	I
Diuron	330541	31	90	NA	NLV	N
Endosulfan {J}	115297	1.7	4.8	NA	ID	I
Endothall	145733	100 {A}	100 {A}	NA	NLV	N
Endrin	72208	2.0 {A}	2.0 {A}	IP	NLV	N
Heptachlor	76448	0.4 {A}	0.4 {A}	NA	180 {S}	180
Heptachlor epoxide	1024573	0.2 {A}	0.2 {A}	NA	NLV	N
Lindane	58899	0.2 {A}	0.2 {A}	0.027	ID	I
Methoxychlor	72435	40 {A}	40 {A}	NA	ID	I
Methyl parathion	298000	1.8	5.2	NA	NLV	N
Metolachlor	51218452	240	990	NA	NLV	N
Mirex	2385855	0.02 {M}	0.02 {M}	NA	NA	N
Pendimethalin	40487421	280 {S}	280 {S}	NA	NLV	N
Prometon	1610180	160	460	NA	NLV	N
Propachlor	1918167	95	270	NA	NLV	N
Propazine	139402	200	560	NA	NLV	N
Simazine	122349	4.0 {A}	4.0 {A}	NA	NLV	N
Tebuthiuron	34014181	510	1,500	NA	NLV	N
Toxaphene	8001352	3.0 {A}	3.0 {A}	1.0 {M}	NLV	N

Triallate	2303175	95	270	NA	ID	I
PESTICIDES-HERBICIDES						
Aldicarb	116063	3.0 {A}	3.0 {A}	NA	NLV	N
Aldicarb sulfoxide	1646873	4.0 {A}	4.0 {A}	NA	NLV	N
Aldicarb sulfone	1646884	2.0 {A}	2.0 {A}	NA	NLV	N
Carbaryl	63252	700	2,000	NA	ID	I
Carbofuran	1563662	40 {A}	40 {A}	NA	NLV	N
Dalapon	75990	200 {A}	200 {A}	NA	NLV	N
2,4-Dichlorophenoxyacetic acid	94757	70 {A}	70 {A}	220	NLV	N
Diquat	85007	20 {A}	20 {A}	NA	NLV	N
Glyphosate	1071836	700 {A}	700 {A}	NA	NLV	N
2-Methyl-4-chlorophenoxyacetic acid	94746	7.3	21	NA	NLV	N
Oxamyl	23135220	200 {A}	200 {A}	NA	NLV	N
Picloram	1918021	500 {A}	500 {A}	NA	NLV	N
Silvex (2,4,5-TP)	93721	50 {A}	50 {A}	NA	NLV	N
Trifluralin	1582098	37	110	NA	ID	I
DIOXINS						
2,3,7,8-Tetrabromodibenzo-p-dioxin {O}	50585416	{O}	{O}	{O}	NLV	N
2,3,7,8-Tetrachlorodibenzo-p-dioxin {O}	1746016	3.0E-5 {A}	3.0E-5 {A}	1.0E-5 {M}	NLV	N
PHENOLS						
4-Chloro-3-methylphenol	59507	150	420	NA	NLV	N
2-Chlorophenol	95578	45	130	22	ID	I
2,4-Dichlorophenol	120832	73	210	19	NLV	N
2,4-Dimethylphenol	105679	370	1,000	380	NLV	N
2,6-Dimethylphenol	576261	4.4	13	NA	NLV	N
3,4-Dimethylphenol	95658	10	29	NA	NLV	N
2-Methyl-4,6-dinitrophenol	534521	20 {M}	20 {M}	NA	NLV	N
Methylphenols (J)	1319773	370	1,000	71	NLV	N
2-Nitrophenol	88755	20	58	ID	NLV	N
Pentachlorophenol	87865	1.0 {A}	1.0 {A}	{G,X}	NLV	N
Phenol	108952	4,400	13,000	210	NLV	N
2,4,5-Trichlorophenol	95954	730	2,100	NA	NLV	N
2,4,6-Trichlorophenol	88062	120	470	4.4	NLV	N
3-Trifluoromethyl-4-nitrophenol	88302	4,500	13,000	NA	NLV	N
MISCELLANEOUS						
Ammonia	7664417	10,000 {N}	10,000 {N}	{AC}	3.2E+6	7.2
Asbestos {AB}	1332214	7.0E+6 f/mL {A}	7.0E+6 f/mL {A}	NA	NLV	N
Chloride	16887006	2.5E+5 {E}	2.5E+5 {E}	1.25E+5 {X}	NLV	N
Cyanide {R}	57125	200 {A}	200 {A}	20 {M}	NLV	N
Fluorine (soluble fluoride) {B}	7782414	2,000 {E}	2,000 {E}	NA	NLV	N
Nitrate {B,N}	14797558	10,000 {A,N}	10,000 {A,N}	NA	NLV	N
Nitrite {B,N}	14797650	1,000 {A,N}	1,000 {A,N}	NA	NLV	N
Phosphorus (total)	7723140	63,000	2.4E+5	NA	NLV	N
Sulfate	14808798	2.5E+5 {E}	2.5E+5 {E}	NA	NLV	N
Urea	57136	ID {N}	ID {N}	NA	NLV	N
PBBs						
Polybrominated biphenyls {J}	67774327	0.032	0.09	IP	NLV	N
GLYCOLS						
Diethylene glycol monobutyl ether	112345	88	250	NA	NLV	N

Ethylene glycol	107211	15,000	42,000	1.9E+5 {X}	NLV	N
Ethylene glycol monobutyl ether	111762	3,700	10,000	NA	2.9E+6	6.5
Propylene glycol	57556	1.5E+5	4.2E+5	NA	NLV	N
Triethylene glycol	112276	10,000 {M}	12,000	NA	NLV	N
CARBONYLS						
Acetaldehyde {I}	75070	950	2,700	NA	1.1E+6	2.3
Cyclohexanone	108941	33,000	94,000	NA	1,400	3,3
Formaldehyde	50000	1,300	3,800	120	63,000	3.6
LOW MOLECULAR WEIGHT ACID						
Acetic acid	64197	18,000 {M}	18,000 {M}	18,000 {M}	NLV	N
Formic acid {I,U}	64186	18,000 {M}	29,000	ID	7.7E+6	1.5

Appendix E
Contingency Plan

Contingency Plan
(Revision #3)

for

SOUTH MACOMB DISPOSAL AUTHORITY
LANDFILLS 9 AND 9A

By
Petro Environmental Technologies, Inc.

February 2002

SMDA Landfill Site 9 and 9A
Contingency Plan

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1.0 Introduction

This Contingency Plan for the Macomb County Landfill Properties 9 and 9A is intended to augment the Property's Remedial Action Plan (RAP). Should the results of the Performance Monitoring Plan (PMP) indicate that the RAP is not achieving the results required by the PMP within the time frame established by the PMP, applicable provisions of the Contingency Plan will be implemented as required. In addition to ensuring that the provisions of the PMP are met, this Contingency Plan also provides guidelines for the management of unforeseen circumstances such as:

- The encountering of waste during construction
- Existing soil cover that does not meet the design thickness
- The inflow of groundwater into the landfill from a lower aquifer
- Excessive landfill gas

The goals of the PMP that are to be ensured by the Contingency Plan are within the parameters of the regulatory requirements of Part 201 of the NREPA. It is also consistent with the requirements of the "Stipulated Order Accepting and Assuming Jurisdiction over Settlement Agreement", by the Circuit Court for the County Of Macomb, dated July 9, 1999. By providing for additional remediation effort in addition to the RAP, the Contingency Plan will ensure that the legal and regulatory requirements of the PMP are met.

Engineering and construction of the remedial systems are discussed in the RAP. The Contingency Plan provides for additional engineering and construction of remedial systems needed to ensure that the requirements of the PMP are met and that unforeseen events are properly managed. The PMP is specific to the operation, maintenance and monitoring of the remedial action measures. The Contingency Plan does not address safety issues or responses to safety incidents such as fire, explosion or injury. Safety issues are described in the attached Site Health and Safety Plan (HASP).

This Contingency Plan describes adjustment(s) to field operations or system redesigns that will be taken in response to a remediation contingency. Report requirements, documentation, sampling frequencies and other administrative tasks are described in more detail in the PMP.

To the extent that any of the contingencies identified in this plan are not sufficient, or situations arise that are not covered in this Contingency Plan, a Corrective Action Plan (CAP) will be submitted to MDEQ, as necessary, in accordance with Section 5.19 of the Consent Decree.

2.0 Summary

Within the time frame of the remediation system's operation the following PMP goals will be achieved:

- Reaching and maintaining water quality standards in groundwater,
- Certifying hydraulic control of the leachate within the landfill, and
- Confirming chemical containment of the leachate plume.

The final remediation goal is to achieve and maintain generic residential standards in the groundwater at all points in the aquifer beyond the property. Upon achievement of such a goal, it is anticipated the Property will be deleted from the National Priorities List (NPL).

The tasks involved in achieving Property remediation in accordance with the PMP are as follows:

1. Establish background monitoring wells (including new wells) upgradient from the Property. Once background wells are established, perform background sampling to determine appropriate analysis parameters. Should sampling results indicate that a background well has been impacted by the Property, a new background well location will be determined.

2. Determine geographical extent of water quality exceedance in local drinking water wells. Monitor the drinking water wells to determine effectiveness of the RAP on water quality parameters.

3. Install up to six piezometers with transducers to measure groundwater levels east of Property 9 (existing monitoring wells can be used). Measure groundwater head elevations (adjusted for seasonal variations) as required by the PMP in existing wells and new piezometers to determine if hydraulic control has been achieved.

4. Analyze groundwater monitoring well samples as required by the PMP to determine if chemical containment is being achieved.

5. Determine rate of dewatering and estimate time to completion of dewatering and establishment of steady state conditions.

6. Periodically review and adjust RAP systems while operating and maintaining the system components.

7. Achieve and maintain capture of the contaminant plumes.

3.0 Waste Encountered during Construction

The RAP is designed to minimize the potential for encountering waste during construction operations. Trenching for the groundwater interceptors and the leachate collectors is to occur outside the limits of waste. Excavation and regrading should be confined to the existing final cover soil layer. However, should construction activities such as excavation, trenching and regrading result in the exposure or removal of deposited waste, the following will occur:

1. Excavated waste will be stockpiled immediately adjacent to the working area. If necessary the waste stockpile will be covered with a temporary tarp, soil or spray emulsion at the end of the workday.

2. Exposed waste will be kept undisturbed as much as possible. If necessary the exposed waste will be covered with a temporary tarp, soil or spray emulsion at the end of the workday.

3. Both stockpiled and exposed waste will be protected so as to prevent leachate run-off discharges into surrounding areas.

4. As much as possible, stockpiled waste will be back filled into its original location. Should other back fill material displace the waste volume in its original location, the excess waste will be deposited on-site after stripping of cover to ensure waste to waste contact, and grades will be reconfigured to allow placement of waste and to ensure that a minimum 24-inch final cover soil layer is constructed over the deposited waste.

5. Should significant quantities of waste be exposed, the incident will be reported to MDEQ.

6. Should the exposed waste contain significant quantities of potential airborne particulates, the frequency of air monitoring will be increased to daily until the waste is no longer exposed.

4.0 Insufficient Final Cover Thickness

We will check all areas in an approximate 200-foot grid. The RAP's designed property regrading will result in both cut and fill operations confined primarily to this existing final soil cover layer. As construction progresses, completed areas will be checked at a 200-foot grid interval using hand excavation or other acceptable means to ensure that a minimum 24 inches of existing final cover soil remains.

Should additional cover soil be required, it will be constructed in controlled compacted lifts in accordance with the RAP. The additional cover soil will be of sufficient thickness to ensure that a minimum total thickness (existing plus additional) of 24 inches is achieved.

5.0 Groundwater Inflow due to Static Pressure Head

HELP model analyses performed for the RAP (refer to Attachment III) shows a significant reduction in leachate head (greater than 2 feet accounting for seasonal fluctuations), generation rates and percolation into lower aquifers once the remediation systems have achieved steady state. Available hydrogeological information suggests that Aquifer 2 underlying the landfill may contain groundwater subject to significant static pressure heads. Once the remediation effort has drawn down the amount of leachate within the landfill to negligible head elevations, it is possible that this underlying groundwater could flow upwards into the landfill.

Should measurements of leachate head elevations show an increase in water levels within the landfill after an initial decrease in leachate head levels, a groundwater extraction well will be installed at the highest point of the groundwater mound. This extraction well will extend down through the landfill into Aquifer 2 so as to ensure that the resultant draw down curve maintains isolation between the landfill bottom and groundwater. The status of this groundwater and its subsequent pretreatment and disposal methods will be determined based on the results of field analyses.

6.0 Short Circuiting of the Groundwater Interceptor

The groundwater interceptors to be installed along the western, northern and northeastern boundaries of Property9 and along the northern and western boundaries of Property9A may be augmented by an impermeable geomembrane barrier. This geomembrane is to be installed between the groundwater interceptor and the landfill waste and will be keyed into an underlying soil layer of relatively low permeability. It is intended to isolate the groundwater interceptor from landfill leachate.

However, available hyrogeological information suggests that a significant leachate mound exists at the northern limits of the boundary between Site's 9 and 9A. Therefore, until dewatering is completed and steady state achieved within the landfill, there is the potential for leachate driven by the head built-up in the mound to migrate under the geomembrane and into the groundwater interceptor.

Should this occur, as determined by higher than anticipated levels of contaminants in the groundwater samples (as determined by established statistical methods), an additional leachate extraction well will be installed at this location just inside the limits of waste. The location and depth of the leachate extraction well will be determined by field conditions. The status of this leachate and its subsequent pretreatment and disposal methods will be determined based on the results of field analyses.

7.0 Operational Contingency

Typical leachate and groundwater extraction rates will be set at approximately 50% to 70% of the maximum allowable total discharge (approximately 194,000 gallons per day according to the Macomb County Engineer's sewer discharge limits) for all permitted

means of leachate and groundwater pretreatment and disposal (sanitary sewer, surface water, and other). This will ensure that discharge capacity is available should increased leachate and groundwater extraction rates by required to achieve water quality standards, hydraulic control or chemical containment.

8.0 Landfill Gas Contingency

Though both landfills are well past their peak gas production stages, enough landfill gas (LFG) may still be generating at both Properties to require a management system. LFG monitoring will assess the need for a landfill gas management system. Should LFG monitoring indicate that LFG migration is a problem, a LFG management system will be installed after the construction of the final cover soil layer. The primary focus of this management system will be to prevent the off-property migration of landfill gas into surrounding properties.

The monitoring plan and contingencies triggers will ensure compliance with the Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended rules, in particular R 299.4433, Type II landfill operation; explosive gas control and monitoring. In accordance with this rule, the concentration of methane gas generated by the facility will not be more than 25 percent of the lower explosive limit for methane in facility structures, and not more than the lower explosive limit at or beyond the facility property boundary. 10 percent of the lower explosive limit at the property boundary will be the action level that triggers a landfill gas contingency. The time frames for responding to landfill gas contingencies will conform to those listed in Rule R 299.4433:

- Immediately take all steps necessary to ensure protection of human health.
- Immediately notify the director.
- Within seven days, place records of the recorded methane levels in the operating record.
- Within sixty days, implement a remediation plan.

9.0 Air Quality and Odor Contingency

SMDA will perform construction dust control. The equipment available to limit dust production include:

- Water wagons
- Water trucks
- And/or sprinkler systems

The site supervisor and Health Safety Officer (HSO) will document visual observations and direct dust suppression efforts. The site supervisor and HSO have the authority to shut down operations if dust becomes a concern.

If uncovering the waste causes odors that violate Rule 901 of Air Quality rules, then SMDA shall immediately control the emissions using clean fill or foam. SMDA shall have available on site, the equipment for foam cover or clean fill for this purpose.

Appendix F
Sanitary Sewer Discharge Permit Application

LAW OFFICES
SEIBERT AND DLOSKI
PROFESSIONAL LIMITED LIABILITY COMPANY
202 VICANT BUILDING
59 NORTH WALNUT STREET
MOUNT CLEMENS, MICHIGAN 48043

ROBERT J. SEIBERT
LAWRENCE W. DLOSKI
CHRISTINE D. ANDERSON
COLLEEN P. O'CONNOR

TELEPHONE
(810) 469-3800
FACSIMILE
(810) 469-2443

COPY

October 11, 2001

Roger K. Timm
Dykema Gossett
400 Renaissance Center
Detroit, Michigan 48243-1668

Re: Bielat, et al v SMDA, et al

Dear Mr. Timm,

Enclosed please find a true copy of the Stipulated Order Regarding Deep Injection Well Remediation for Sites 9 and 9A, regarding the above-referenced matter.

Best regards,

SEIBERT AND DLOSKI
Professional Limited Liability Company

Lawrence W. Dloski
LWD/smr
Encl.
cc: Macomb Township
Mark Mather
David Kline

RECEIVED
OCT 15 2001

STATE OF MICHIGAN

IN THE CIRCUIT COURT FOR THE COUNTY OF MACOMB

EDWARD BIELAT, et al.,

Plaintiffs,

-vs-

No. 84-612-AA
Consolidated with
Case No. 85-3476-AA

SOUTH MACOMB DISPOSAL AUTHORITY,
a Michigan municipal entity,

HON: MICHAEL D. SCHWARTZ

Defendant.
_____/

STIPULATED ORDER REGARDING
DEEP INJECTION WELL REMEDIATION
FOR SITES 9 AND 9A

Pursuant to the Stipulation set forth below, IT IS ORDERED:

1. For so long as Macomb Township ("Township") has in effect a sanitary sewer that allows Petro Environmental Technologies, Inc. ("Petro"), the South Macomb Disposal Authority ("SMDA") and/or the agents and/or successors of either to discharge into the Township's sewer system collected leachate and groundwater from the vicinity of Sites 9 and 9A, at a maximum discharge rate of 0.2 CFS, unless the discharge occurs during non-peak hours that can be monitored by the Township, no Deep Injection Well ("DIW") will be installed or utilized as part of the remediation of Sites 9 and 9A; nor will Petro, SMDA, or the agents or successors of either seek to install or utilize a DIW on either Site 9 or Site 9A or on any property owned or controlled by either of them, located in Macomb Township.

2. Petro, SMDA, and/or the agents and/or successors of either shall abide by DWSD and Township's effluent limit criteria or the Township shall have the right to discontinue the sanitary sewer connection until such time as the effluent limits can be met.

3. Petro, SMDA and/or the agents and/or successors of either shall obtain all necessary reviews, approvals and permits from the Township for connection to the Township's sanitary sewer and any structure(s) proposed for remediation of Sites 9 and 9A.

4. The provision of this order shall be included in the restrictive covenants for SMDA Sites 9 and 9A and filed with the Macomb County Register of Deeds.

5. This order does not resolve all issues between the parties.

ANTONIO P. VIVIANO

IN THE ABS. OF THE HONORABLE

MICHAEL D. SCHWARTZ

Circuit Court Judge

OCT 11 2001

A TRUE COPY

CARMELLA SABAUGH, COUNTY CLERK

By Jeanne Schott Court Clerk

STIPULATION

Macomb Township, South Macomb Disposal Authority and Petro Environmental Technologies, Inc. stipulate to the entry of the above Stipulated Order Regarding Deep Well Remediation for Sites 9 and 9A.

MACOMB TOWNSHIP

By: John D. Brennan

Its: Township Supervisor

Dated: October 10, 2001

SOUTH MACOMB DISPOSAL AUTHORITY

By: Roger K. Timm

Its: Attorney

Dated: October 10, 2001

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.

By: _____

Its: Sec. Treas

Dated: Oct. 10, 2001

DET01\ 282879.1
ID\ RKT

Macomb County
Public Works Commissioner
Anthony V. Marrocco

RECEIVED
NOV 10 2001

November 6, 2001

Mr. Daniel P. Duffy, P.E.
Petro Environmental Technologies
7851 Palace Drive
Cincinnati, OH 45249

RE: Macomb Township Landfill: South Macomb Disposal Authority
DWSD Industrial Discharge Permit
Approval by Macomb County Wastewater Disposal District (MCWWDD)

Dear Mr. Duffy:

This office has received your letter dated 10/25/01 and approval by the MCWWDD is hereby given based upon letters received and your DWSD permit application. Specific conditions for this approval include:

1. No discharge when rain is predicted or occurring until the Garfield Interceptor is completed. Current schedule is October, 2002.

2. Maximum rate of discharge of 0.2 cfs (90 gals/min) between 5:00 a.m. and 9:00 p.m. – Day

3. Maximum rate of discharge of 0.5 cfs (225 gals/min) between 9:00 p.m. and 5:00 a.m. – Night

4. Estimated rate of discharge after 2 to 3 years (by 1/04) of 0.0015 cfs (.09 gals/min or 1,000 gals/day).

This office reserves the right to impose other restrictions, via our contract with Macomb Township, if this discharge becomes deleterious to the MCWWDD interceptors.

Office Location: 115 S. Groesbeck • Mt. Clemens, Michigan (2 Miles North of Metro Parkway) • Phone: 810-469-5325 • Fax: 810-469-5933
Mailing Address: P.O. Box 806 • Mt. Clemens, Michigan 48046-0806
Engineering Phone: 810-469-5910 • Fax: 810-469-7693 • Soil Erosion Phone: 810-469-5327 • Fax: 810-307-8264

Also, regarding item 1, it is your responsibility to monitor weather conditions. Enclosed is information for the National Weather Service for your consideration.

Sincerely,

Kenneth Bonin, P.E.
Chief Engineer

Enclosure

cc: Thomas Eapen, DWSD Industrial Discharge
Dave Koss, Macomb Township Sewer & Water Superintendent

KB/lb-MCWWDDDuffy.let

overture

How FAST do you want your credit decision?

Pick YOUR Speed

1 minute

Search

NATIONAL+WEATHER SERVICE Search

You searched for **NATIONAL+WEATHER SERVICE**.

Search Tips

Computing
Education & Career
Entertainment
Finance
Health
Homelife
Reference
Shopping
Travel

RECEIVED NOV 0 6 2001 OFFICE OF PUBLIC WORKS

Special Note: Overture is placing public service links at the top of the listings at NO cost to the charities.

Quick Hit™ Result: The official site for **National Weather Bureau**

1. **Weather Equipment from WeatherTools**
   Weather Stations and equipment from Davis, Peet Bros and Oregon Scientific. Weather Instruments and P.C. weather software.
   www.weathertools.com (Cost to advertiser: $0.02)

2. **Freeality Free Local Weather on Task Bar**
   Link to free download - local temperature on your task bar. Free local and U.S. forecasts. Complete news and weather site.
   www.freeality.com (Cost to advertiser: $0.01)

3. **Weather Alert Radios, Information Links**
   Weather warning radios and instruments for hurricane, tornado, and other severe weather automatic alert and forecasting systems with links to most government weather sites.
   www.hurricane-eye.com (Cost to advertiser: $0.01)

4. **Interactive Weather Information Network**
   NEW ANIMATION-->Try out the new ANIMATED IWIN - (High Speed Users) Active Warnings: Flood, Special Marine, Non PrecipitationThis page will "REFRESH" itself every 60 seconds to keep you up to dateCheck out our stats page! Active Warnings: Flood Alaska
   iwin.nws.noaa.gov

5. **National Oceanic & Atmospheric Administration**
   Highlights the NOAA program information, the environmental data services, and the library for students, teachers and researchers.
   www.noaa.gov

6. **National Weather Service - San Francisco Bay Area**
   National Weather Service forecasts and warnings for the San Francisco Bay Area and California Central Coast
   www.nws.mbay.net

7. **National Weather Service Forecast Office Los Angeles/Oxnard**
   Click on an area to get the current forecast as well as a listing of current observations, watches, warnings and advisories in that area. Zones that are colored in indicate areas where a current warning, advisory, or other state
   www.nwsla.noaa.gov

8. **NWS Internet Weather Source**
   Government Internet Service Home page. The starting point for official governemnt weather forecasts, warning, and meteorological products for forecasting the weather.
   weather.noaa.gov weather.noaa.gov

Weather Source

United States Weather

U.S. and State Maps - Graphical selection (uses javascript)

- or -

Select a state Go! - Text selection (WebTV Users, please use this option)

Weather conditions for the past 24 hours, forecasts, watches, and warnings for the United States.

Marine Weather

Marine forecasts and outlooks for U.S. Coastal areas and Great Lakes. Offshore and high seas forecasts for the Atlantic, Pacific, and Gulf of Mexico.

Radar Graphics

Local and National radar products from the U.S. National Weather Service, including the latest images and animations for your area.

Weather Maps

Facsimile (fax) charts produced by the U.S. National Weather Service.

International Weather Conditions

Weather conditions for the past 24 hours world-wide.

Aviation Weather

Current conditions in METAR code form. Forecasts in TAF code form. Access to observations produced during the previous 24 hours.

Michigan Weather

Go to another state Go!

Forecasts, watches, warnings, and the most recently observed weather conditions for locations throughout Michigan are available here. Select from the lists below to get weather information for an area or location.

Current weather conditions

Select a location

Go!

Forecasts, watches and warnings

Select a county or area Go!

Select a city Go!

Go to another state

Select a state Go!

Source

Current Weather Conditions

Selfridge Air National Guard Base, MI, United States

(KMTC) 42-37N 082-50W

Conditions at Nov 05, 2001 - 08:56 AM EST
2001.11.05 1356 UTC

Wind from the NW (320 degrees) at 10 MPH (9 KT)
Visibility 10 mile(s)
Sky conditions mostly cloudy
Temperature 39 F (4 C)
Dew Point 30 F (-1 C)
Relative Humidity 69%
Pressure (altimeter) 30.37 in. Hg (1028 hPa)
ob KMTC 051356Z 32009KT 10SM FEW035 BKN150 04/M01 A3037 RMK SLP291 8/570 9/260

24 Hour Summary

	Time EST (UTC)	Temperature F (C)	Dew Point F (C)	Pressure Inches (hPa)	Wind MPH	Weather
Latest	9 AM (14) Nov 05	39 (4)	30 (-1)	30.37 (1028)	NW 10	
	8 AM (13) Nov 05	33 (1)	28 (-2)	30.35 (1027)	WNW 8	
	7 AM (12) Nov 05	32 (0)	26 (-3)	30.34 (1027)	WNW 8	
	6 AM (11) Nov 05	32 (0)	26 (-3)	30.33 (1027)	WNW 6	
	5 AM (10) Nov 05	32 (0)	26 (-3)	30.32 (1026)	W 8	
	4 AM (9) Nov 05	33 (1)	26 (-3)	30.31 (1026)	W 6	
	3 AM (8) Nov 05	33 (1)	26 (-3)	30.29 (1025)	NW 6	
	2 AM (7) Nov 05	35 (2)	26 (-3)	30.29 (1025)	NW 8	
	1 AM (6) Nov 05	37 (3)	26 (-3)	30.29 (1025)	WNW 8	
	Midnight (5) Nov 05	39 (4)	26 (-3)	30.29 (1025)	NNW 11	
	11 PM (4) Nov 04	42 (6)	28 (-2)	30.27 (1025)	NNW 13	
	10 PM (3) Nov 04	42 (6)	28 (-2)	30.25 (1024)	NW 12	
	9 PM (2) Nov 04	46 (8)	26 (-3)	30.25 (1024)	NW 13	
	8 PM (1) Nov 04	48 (9)	23 (-5)	30.23 (1023)	NW 12	
	7 PM (0) Nov 04	44 (7)	26 (-3)	30.21 (1023)	WNW 8	
	6 PM (23) Nov 04	50 (10)	23 (-5)	30.19 (1022)	NW 10	
	5 PM (22) Nov 04	50 (10)	26 (-3)	30.17 (1021)	WNW 12	
	4 PM (21) Nov 04	55 (13)	26 (-3)	30.16 (1021)	NNW 13	
	3 PM (20) Nov 04	57 (14)	24 (-4)	30.14 (1020)	NNW 16	
	2 PM (19) Nov 04	59 (15)	28 (-2)	30.13 (1020)	NW 14	
	1 PM (18) Nov 04	59 (15)	30 (-1)	30.12 (1019)	WNW 10	
	Noon (17) Nov 04	59 (15)	35 (2)	30.14 (1020)	NW 11	

PETRO
environmental
technologies

April 20, 2001

Ms. Delores Sanders-Hunter
City of Detroit
Water and Sewerage Department
Industrial Waste Control Division
303 S. Livernois Avenue
Detroit, Michigan 48209

Letter #007

RE: Macomb County Landfill Sites 9 and 9A
Industrial Discharge Permit Application

Dear Ms. Sanders-Hunter,

This letter is in response to your fax of January 19, 2001 listing the remaining documentation required for the issuance of an Industrial Discharge Permit for the leachate extracted from the Macomb County Landfill Sites 9 and 9A. Since receipt of your fax, Petro Environmental has made an exhaustive study of potential pretreatment technologies for reducing BOD to below 10,000 ppm. This documentation is provided as described below with each item in your list followed by applicable information:

- *Proposed water discharges (leachate) estimate (gpd)*

As described in our letter to you dated April 4, 2001 and our letter to Mr. Thomas Eapon of the Detroit MSD dated April 6, 2001, the proposed leachate discharge rate has been revised to 400,000 gpd. Though "Section F" of our initial permit application described this flow as continuous, field conditions may make this difficult to achieve. Batch discharges are possible.

- *Description of proposed pretreatment system*

As described in our letter of January 25, 2001, the only leachate constituent that needs to be addressed by a pretreatment system is the elevated BOD. There are no other constituents of concern in the leachate, and BOD is the sole parameter that has to be reduced prior to discharge. BOD must be below 10,000 ppm to allow discharge to the sanitary sewer.

Petro Environmental has had additional laboratory tests performed on grab samples of the leachate and contaminated groundwater to determine their individual and composite BOD levels. The four grab samples are from the areas that will contribute to the remediation water collection system. The results are as follows:

7851 Palace Drive • Cincinnati, Ohio 45249 • 513.489.6789 • Fax 489.7208
8200 Seville Road • Lodi, Ohio 44254 • 330.948.1494 • Fax 948.1933

	BOD_5
Groundwater Sample #1	*ND*
Groundwater Sample #2	*ND*
Groundwater Sample #3	*ND*
Leachate Sample	*21,800-ppm*
Composite Sample	*7,660-ppm*

The composite sample consisted of equal parts of the four grab samples (three parts groundwater to one part leachate). This composite models the anticipated flows to the sanitary sewer (see Attachment I, BOD Test Results). Based on the composite results, we will be able to directly discharge the remediation water.

The pretreatment system will consist of a portable fract tank with a minimum capacity of 12,000 gallons. The tank will be equipped with a floater switch system. The first floater switch will allow collected groundwater to fill the tank to a volume of 9,000 gallons. Once that level has been achieved, the first floater switch will turn off the groundwater flow and start the leachate flow into the tank. Leachate flow will continue until 3,000 gallons of leachate are stored in the tank. These flow volumes will ensure a three parts groundwater to one part leachate composite mixture. At that time a second floater switch will turn off the leachate inflow and begin discharge of the groundwater/leachate mixture to the sanitary sewer. Once the tank is drained, the process begins again with initial groundwater inflow.

- *Proposed sampling location(s) description (diagrams with measurements).*

The fract tank will also be equipped with a sampling port on its discharge line. The tank will be located on-site in the southwest corner of Site 9, immediately adjacent to the sanitary sewer manhole that will receive the composite discharge. The manhole is attached to a 24" sanitary sewer designated as node #B5 on the Broughton North Service District. The sanitary sewer has a rated flow capacity of 4.60 cubic feet per second, or 2,973,000 gpd. It connects to a down gradient sanitary sewer line with a flow capacity of 14.34 cubic feet per second. The proposed 400,000 gpd discharge from the site is equivalent to only 13% of the sewer's flow capacity.

A plan drawing of the site indicating sampling locations is provided in Attachment II, System Plan Drawing.

- *Copy of proposed plant layout (pretreatment) area(s), sewer lines showing connections to the sampling location(s) and the city sewer system*

The plan drawing provided in Attachment II also shows the pretreatment system layout including sewer lines, connections to the sampling locations and the city sewer system.

- *Copy of proposed process flow (leachate) diagram for wastewater*

A process flow diagram is provided in Attachment III, Process Flow Diagram.

- *Xerox copy of the latest waste manifests for solid and liquid waste (1 month of manifests)*

There are no solid wastes removed from the site, only liquid waste (landfill leachate) is hauled form the site to a local wastewater treatment plant. Our permit application submitted on November 9, 2000 included a copy of the liquid waste manifests for August 2000. This was a representative month for leachate extraction and disposal. Manifests for other months are available upon request.

- *How long has leachate been hauled away?*

According to sources at the South Macomb Disposal Authority, leachate extraction and hauling has been performed since 1983.

- *Date the sampling location and pretreatment system will be completed?*

Under the current construction schedule, installation of the leachate collection, pretreatment and discharge systems will begin in May/June 2001. Completion of this effort is expected by September/October 2001.

If you have any questions or comments, please contact us at (513) 489-6789. We are at your convenience and look forward to your response.

Respectfully yours,
Petro Environmental Technologies, Inc.

Daniel P. Duffy, PE

Cc: Mark S. Mather
Mr. Cleveland Clark, Detroit MSD
Ms. Ahlam Kamash, Detroit MSD
Mr. Thomas Eapon, Detroit MSD
File

Attachments:
I BOD Test Results
II System Plan Drawing
III Process Flow Diagram

Appendix G
NPDES Permit Application

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF ENVIRONMENTAL QUALITY

"Better Service for a Better Environment"

HOLLISTER BUILDING, PO BOX 30473, LANSING MI 48909-7973

INTERNET: www.deq.state.mi.us

RUSSELL J. HARDING, Director

REPLY TO:

SURFACE WATER QUALITY DIVISION
KNAPPS CENTRE
PO BOX 30273
LANSING MI 48909-7773

RECEIVED
MAR 26

March 20, 2001

Mr. Mark S. Mather
Petro Environmental Technologies, Inc.
7851 Palace Drive
Cincinnati, Ohio 45249

Dear Mr. Mather:

SUBJECT: National Pollutant Discharge Elimination System (NPDES) Permit No. MI0056430
Macomb Co Landfill-9 & 9A

We have determined the probable water quality-based and treatment technology based limits for the proposed discharge based on the monitoring data you submitted. The probable effluent limits are attached The proposed treatment must be determined before we can proceed because without it the application is incomplete and we cannot process it further without the following information.

Please provide a flow diagram showing the wastewater flow through the facility including all treatment units, processes and bypass piping, and a narrative description of the water flow through the facility from intake to discharge. Show all operations contributing wastewater and the locations of flow meters, chemical feeds and discharge points. The water balance shall show daily average flow rates at intake and discharge points and approximate daily flow rates between treatment units including influent and treatment rates. The line diagram shall include all operations contributing wastewater including storm water runoff. Please send this information to me with a complementary copy to the Southeast Michigan District Office, Department of Environmental Quality (DEQ) of the Surface Water Quality Division (SWQD) located at 38980 Seven Mile Road, Livonia, Michigan 48152-1006.

Sincerely,

Karen Lauterbach

Karen Lauterbach
Permits Section
Surface Water Quality Division
517-373-1326
email: lauterbk@state.mi.us

kl/na
Attachment
cc: Mr. Daniel Duffey, P.E., Petro Environmental Technologies, Inc.
Southeast Michigan District Office, SWQD, DEQ
File

Parameter	Maximum Limits for Quantity or Loading Monthly	Daily	Units	Maximum Limits for Quality or Concentration Monthly	Daily	Units	Frequency of Analysis	Sample Type
Flow	(report)	(report)	MGD	---	---	---	Daily	Report Total Daily Flow
Chlorobenzene	0.012	---	lbs/day	47	---	µg/l	Weekly	Grab
Chloroform	0.025	---	lbs/day	10	---	µg/l	Weekly	Grab
Ethylbenzene	0.045	---	lbs/day	18	---	µg/l	Weekly	Grab
Trichloroethylene	0.013	---	lbs/day	5.0	---	µg/l	Weekly	Grab
Vinyl Chloride	0.013	---	lbs/day	5.0	---	µg/l	Weekly	Grab
Xylene	0.088	---	lbs/day	35	---	µg/l	Weekly	Grab
Total Arsenic	0.38	1.7	lbs/day	150	680	µg/l	Weekly	24-Hr Composite
Total Beryllium	0.035	---	lbs/day	14	---	µg/l	Weekly	24-Hr Composite
Total Cadmium	0.020	0.095	lbs/day	7.8	38	µg/l	Weekly	24-Hr Composite
Total Copper	0.060	0.19	lbs/day	24	77	µg/l	Weekly	24-Hr Composite
Total Lead	0.25	4.3	lbs/day	98	1,700	µg/l	Weekly	24-Hr Composite
Total Nickel	0.45	8.3	lbs/day	180	3,300	µg/l	Weekly	24-Hr Composite
Total Barium	2.3	---	lbs/day	910	---	µg/l	Weekly	24-Hr Composite
Total Manganese	2.4	10	lbs/day	970	4,200	µg/l	Weekly	24-Hr Composite
Total Zinc	1.1	2.8	lbs/day	450	890	µg/l	Weekly	24-Hr Composite
Total Chromium	0.50	---	lbs/day	200	---	µg/l	Weekly	24-Hr Composite
Total Mercury	33×10^{-6}	---	lbs/day	1.3	---	ng/l	Monthly	24-Hr Composite
Total Antimony	(report)	---	lbs/day	(report)	---	µg/l	Monthly	24-Hr Composite
Bromodichloromethane	0.013	---	lbs/day	5.0	---	µg/l	Monthly	Grab
1,1 Dichloroethylene	(report)	---	lbs/day	(report)	---	µg/l	Monthly	Grab
Methyl Ethyl Ketone	0.25	---	lbs/day	100	---	µg/l	Monthly	Grab
Acetone	0.63	---	lbs/day	250	---	µg/l	Monthly	Grab
Dibromochloromethane	0.013	---	lbs/day	5.0	---	µg/l	Monthly	Grab
Toluene	0.013	---	lbs/day	5.0	---	µg/l	Monthly	Grab
Total Cobalt	(report)	---	lbs/day	(report)	---	µg/l	Monthly	24-Hr Composite
Total Suspended Solids	50	75	lbs/day	20	30	mg/l	Weekly	24-Hr Composite

a. Quantification Level for Total Antimony, Bromodichloromethane, 1,1 Dichloroethylene, Methyl Ethyl Ketone, Acetone, Dibromocholromethane, Toluene, and Total Cobalt
The quantification level shall be as follows unless a higher level is appropriate because of sample matrix interference.

Parameter	Quantification Level	Units
Total Antimony	10	µg/l
Chlorobenzene	1.0	µg/l
Chloroform	1.0	µg/l
Ethylbenzene	1.0	µg/l
Tricholorethylene	1.0	µg/l
Vinyl Chloride	1.0	µg/l
Xylene	3.0	µg/l
Bromodichloromethane	5.0	µg/l
1,1 Dichloroethylene	10	µg/l
Methyl Ethyl Ketone	50	µg/l
Acetone	100	µg/l
Dibromochloromethane	5.0	µg/l
Toluene	5.0	µg/l
Total Cobalt	50	µg/l

b. Total Mercury Testing Requirements
The analytical protocol for total mercury shall be in accordance with EPA Method 1631. The quantification level for total mercury shall be 0.5 ng/l, unless a higher level is appropriate because of sample matrix interference. Justification for higher quantification levels shall be submitted to the Southeast Michigan District Supervisor of the Surface Water Quality Division.

The use of clean technique sampling procedures is strongly recommended. Guidance for clean technique sampling is contained in: EPA Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels (Sampling Guidance)*, EPA-821-R96-001, July 1996. Information and data documenting the permittee's sampling and analytical protocols and data acceptability shall be submitted to the Department upon request.

Appendix H
Operations and Maintenance Plan

Operations and Maintenance Plan
(Revision #5)

for

SOUTH MACOMB DISPOSAL AUTHORITY
LANDFILLS 9 AND 9A

By
Petro Environmental Technologies, Inc.

February 2002

SMDA Landfill Sites 9 and 9A
Operations and Maintenance Plan

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1.0 Introduction

The following operations and maintenance plans are presented in outline format to illustrate the main requirements of these plans. These plans cover the operation and maintenance of the following Property remediation systems: final cover and vegetation, surface water run-off management, golf course management, groundwater interception, groundwater monitoring, leachate collection, leachate monitoring, landfill gas management, landfill gas monitoring, Property security and signage, deep injection well and pre-treatment, sanitary sewer discharge and pre-treatment, surface water discharge and pre-treatment.

Various manufacturers' information brochures describing the operation and maintenance requirements of their products are attached for reference. These are preliminary representations only, and the actual products, mechanicals, and fixtures used in the field may differ from those presented.

Updates to the plan will be prepared upon: (1) completion of the additional design elements; (2) completion of construction; (3) when significant modifications are made to the remediation system; and (4) every five years, or as otherwise appropriate. Once the actual components of the system are determined, the manufacturers written information regarding the operation and maintenance for these components will be attached to the plan. The structures, facilities and equipment associated with the NPDES discharge, sanitary sewer discharge, or deep injection well discharge will be operated and maintained in accordance with their respective permits as well as manufacturer's recommendations.

Records of the inspections and maintenance activities will be kept in a file or log book at the facility. A list of inspection and maintenance activities will be finalized and attached to this plan upon final determination of the mechanical components of the systems in question. Sample inspection forms, sample maintenance records and samples of any other records to be kept on-Property will also be finalized at this time in conformance with the requirements of the manufacturer and/or supplier.

During monitoring well activities, if there is a correction measure needed, higher frequency inspections will be implemented. Trespassing inspection will then be performed weekly. Final cover and vegetation inspections will be done monthly.

2.0 Final Cover and Vegetation Maintenance

Staffing required:

- Provide adequate maintenance staff to perform scheduled duties to maintain final cover and vegetation
- Hire a seeding subcontractor as needed to reseed areas of poor vegetation

Soil Erosion Repair and Maintenance:

- Inspect cover soil in September, December, March, May, and July for gullies and erosion. Inspections will also be performed after a 25 year 24 hour rainfall event. This inspection schedule also applies to re-seeding, vegetative stress, tree and bush removal and maintenance of surface water collection channels.
- Place and compact fill soil in eroded areas in accordance with the applicable technical specifications
- Eroded areas are defined as those whose gullies are deeper than 50% of the final cover thickness
- Repairs are to be made, conditions permitting, within two weeks of inspections
- Reseed the areas of replacement fill soil in accordance with the applicable technical specifications
- Utilize temporary erosion controls (such as straw bales or silt fence) until vegetation is reestablished on replacement fill areas
- Vegetative stress requiring the installation of a landfill gas vent is defined as at least 50% dead vegetation over a contiguous area of ¼ acre. Smaller areas may also be considered for gas vent installation.

Seeding and Reseeding:

- Apply seed, fertilizer and mulch in accordance with the applicable technical specifications
- Inspect final cover vegetation in September, December, March, May, and July,
- Designate areas of inadequate vegetative cover
- Small areas to by reseeding by hand
- Large areas to be disced and then reseeded in a the same way as the initial seeding

Vegetative Stress due to Landfill Gas:

- Inspect final cover vegetation in September, December, March, May, and July
- Designate isolated areas of inadequate vegetative cover which are apparently due to methane distress
- Set a gas probe in the center of this distressed area to measure LFG concentrations
- Should LFG samples indicate high concentrations of methane (25% of the lower explosive limit), set a passive gas vent adjacent to the probe. Should such high concentrations of methane be detected near the perimeter of the waste, actions will be taken consistent with the contingency plan.
- Reseed area of vegetative stress

Tree and Brush Removal:

- Inspect final cover quarterly for the first two years, semi-annually for the next two years and annually thereafter for tree saplings and bushes growing on the final cover

- Chop down and remove saplings and bushes growing within the limits of the final cover layer
- Final cover vegetation to be mowed annually

Surface Water Run-Off Collection Channels Maintenance:

- Inspect surface water run-off collection channels quarterly for the first two years, semi-annually for the next two years and annually thereafter
- Anticipate cleaning of surface water run-off collection channels every five years

Sedimentation Control Structures Maintenance:

- Inspect sedimentation structures and ponds annually
- Anticipate cleaning of sedimentation structures and ponds every five years

3.0 Groundwater Interception System Operation and Maintenance

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain and operate the groundwater interception system
- Hire a mechanical, electrical or pumping subcontractor as needed to replace or repair components of the groundwater interception system

Power Supply Operation and Maintenance:

- Inspect the electrical power supply in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on electrical power supply annually
- Anticipate replacement of electrical power connections every five years

Electronic Controls Operation and Maintenance:

- Inspect the electronic controls in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on electrical controls annually
- Anticipate replacement of electrical controls every five years

Pump Operation and Maintenance

- Inspect the leachate extraction pumps in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter

- Anticipate pump replacement for each sump every five years

Interceptor Pipe Cleanout:

- Inspect interceptor pipes in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Jet or flush interceptor pipes as needed to remove obstructions
- Jetting or flushing (or camera inspection) will be performed every four years or when clogging of the pipes results in a reduction of flow rate as indicated by increased head levels in wells adjacent to the pipes that is not accompanied by increased pipe flows.

Maintenance of Force Mains, Valves, Sumps and Other Fixtures:

- Inspect force mains, valves, sumps and other fixtures in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on force mains, valves, sumps and other fixtures semi annually
- Anticipate replacement of force mains, valves, sumps and other fixtures every five years

Groundwater Monitoring Operation and Maintenance

- Perform groundwater monitoring in accordance with the PMP and other permits
- Inspect groundwater monitoring wells annually
- Perform closure of groundwater monitoring wells in accordance with the PMP

4.0 Leachate Collection System Operation and Maintenance

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain and operate the leachate collection system
- Hire a mechanical, electrical or pumping subcontractor as needed to replace or repair components of the leachate collection system

Power Supply Operation and Maintenance:

- Inspect the electrical power supply in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on electrical power supply annually
- Anticipate replacement of electrical power connections every five years

Electronic Controls Operation and Maintenance:

- Inspect the electronic controls in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on electrical controls annually
- Anticipate replacement of electrical controls every five years

Pump Operation and Maintenance

- Inspect the leachate extraction pumps in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Anticipate pump replacement for each sump every five years

Collector Pipe Cleanout:

- Inspect collection pipes in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Jet or flush collection pipes as needed to remove obstructions
- Jetting or flushing (or camera inspection) will be performed every four years or when clogging of the pipes results in a reduction of flow rate as indicated by increased head levels in wells adjacent to the pipes that is not accompanied by increased pipe flows.

Maintenance of Force Mains, Valves, Sumps and Other Fixtures:

- Inspect force mains, valves, sumps and other fixtures in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Perform maintenance on force mains, valves, sumps and other fixtures semi annually
- Anticipate replacement of force mains, valves, sumps and other fixtures every five years

Leachate Monitoring Operation and Maintenance

- Perform leachate monitoring in accordance with the PMP and other permits
- Inspect leachate-monitoring wells with each sampling event
- Perform closure of leachate monitoring wells in accordance with the PMP

5.0 Landfill Gas System Operation and Maintenance

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain the LFG management system
- Hire a piping subcontractor as needed to replace or repair LFG vents

LFG Vent Maintenance

- Inspect LFG vents in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Anticipate replacing or repairing 10% of the LFG vents every five years

LFG Monitoring Operation and Maintenance

- Perform LFG monitoring quarterly for the first five years, semi-annually thereafter
- LFG Probes will be monitored for Lower Explosive Limit (LEL) of methane.
- Inspect LFG probes in accordance with the manufacturer's recommendation, but not less than quarterly during the first two years and semi-annually thereafter
- Replace LFG probes as needed

LFG Contingencies

- LEL readings in excess of 10% in perimeter gas probes or structures will trigger a landfill contingency, (see Contingency Plan)
- Should a LFG contingency exist, additional gas vents will be installed or other actions taken, as necessary to meet the requirements of Rule R299.4433 and the Contingency Plan.

6.0 Property Security and Marker Maintenance

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain Property security and signage

Marker Repair and Replacement:

- Inspect markers annually
- Anticipate replacing signs every five years

Access Roadway Maintenance:

- Inspect access roads annually
- Anticipate repairing 10% of paved roadway surfaces annually
- Repair any pavement surface within 6 months of identifying damage.

7.0 Sanitary Sewer Discharge and Pre-Treatment System

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain the sanitary sewer discharge and pre-treatment systems
- Hire a mechanical, electrical or pumping subcontractor as needed to repair the sanitary sewer discharge and pre-treatment systems

Power Supply Operation and Maintenance:

- Inspect the electrical power supply in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Perform maintenance on electrical power supply as needed
- Anticipate replacement of electrical power connections every five years

Electronic Controls Operation and Maintenance:

- Inspect the electronic controls in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Perform maintenance on electrical controls as needed
- Anticipate replacement of electrical controls every five years

Pump Operation and Maintenance

- Inspect the leachate extraction pumps in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Anticipate pump replacement for each sump every five years

Mixing, Storage and Flocculent Tanks:

- Inspect all tanks in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Clean out storage tanks semi-annually
- Cleanout mixing tanks semi-annually
- Remove flocculants from flocculent tanks as needed
- Anticipate replacement for each tank every five years

Telemetry System

- Should a remote control telemetry system be utilized to operate the treatment and discharge system, the telemetry system will be inspected in accordance with the manufacturer's recommendation, but not less than the permit requirements

Operations and Inspections

- The treatment and discharge systems will be operated in full compliance with applicable permits
- Monitoring of discharge will be in full compliance with applicable permits and regulations
- Reporting of the results of monitoring the treatment and discharge systems will be in full compliance with applicable permits and regulations
- Copies of all reports will be sent to MDEQ ERD as well as the permitting agency
- Discharge permits will be attached and be considered as part of the O&M Plan.

8.0 Surface Water (NPDES) Discharge and Pre-Treatment System

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain the surface water discharge and pre-treatment systems
- Hire a mechanical, electrical or pumping subcontractor as needed to repair the surface water discharge and pre-treatment systems

Power Supply Operation and Maintenance:

- Inspect the electrical power supply in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Perform maintenance on electrical power supply as needed
- Anticipate replacement of electrical power connections every five years

Electronic Controls Operation and Maintenance:

- Inspect the electronic controls in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Perform maintenance on electrical controls as needed
- Anticipate replacement of electrical controls every five years

Pump Operation and Maintenance

- Inspect the leachate extraction pumps in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Anticipate pump replacement for each sump every five years

Mixing, Storage and Flocculent Tanks:

- Inspect all tanks in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Clean out storage tanks semi-annually
- Cleanout mixing tanks semi-annually
- Remove flocculants from flocculent tanks as needed

- Anticipate replacement for each tank every five years

Telemetry System

- Should a remote control telemetry system be utilized to operate the treatment and discharge system, the telemetry system will be inspected in accordance with the manufacturer's recommendation, but not less than the permit requirements

Operations and Inspections

- The treatment and discharge systems will be operated in full compliance with applicable permits
- Monitoring of discharge will be in full compliance with applicable permits and regulations
- Reporting of the results of monitoring the treatment and discharge systems will be in full compliance with applicable permits and regulations
- Copies of all reports will be sent to MDEQ ERD as well as the permitting agency
- Discharge permits will be attached and be considered as part of the O&M Plan.

9.0 Groundwater Extraction Wells System

Staffing Required:

- Provide adequate maintenance staff to perform scheduled duties to maintain the groundwater well systems
- Hire a mechanical, electrical or pumping subcontractor as needed to repair the groundwater well systems

Power Supply Operation and Maintenance:

- Inspect the electrical power supply in accordance with the manufacturer's recommendation, but not less than the permit requirements
- Perform maintenance on electrical power supply as needed
- Anticipate replacement of electrical power connections every five years

Electronic Controls Operation and Maintenance:

- Inspect the electronic controls in accordance with the manufacturer's recommendation but not less than the permit requirements
- Perform maintenance on electrical controls as needed
- Anticipate replacement of electrical controls every five years

Pump Operation and Maintenance

- Inspect the groundwater extraction pumps in accordance with the manufacturer's recommendation, but not less than the permit requirements

- Anticipate pump replacement for each sump every five years

Telemetry System

- Should a remote control telemetry system be utilized to operate the groundwater extraction system, the telemetry system will be inspected in accordance with the manufacturer's recommendation, but not less than the permit requirements

Operations and Inspections

- The groundwater extraction system will be operated in full compliance with applicable permits
- Monitoring of groundwater will be in full compliance with applicable permits and regulations
- Reporting of the results of monitoring the groundwater will be in full compliance with applicable permits and regulations
- Copies of all reports will be sent to MDEQ ERD as well as the permitting agency
- Groundwater well installation permits will be attached and be considered as part of the O&M Plan.

10.0 Monitoring Requirements

Staffing Required:

- Provide adequate monitoring and sampling staff to perform scheduled duties to monitor to discharge and treatment systems, or
- Hire a monitoring and sampling subcontractor as needed to perform scheduled duties to monitor to discharge and treatment systems

Use Restrictions:

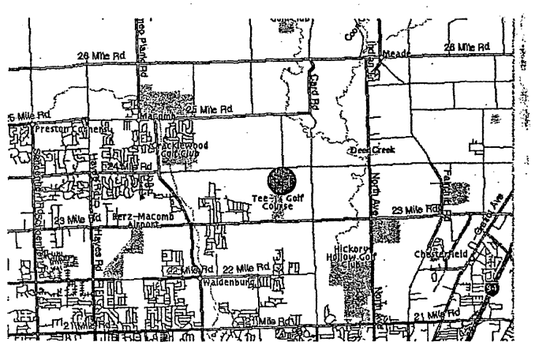
- Monitoring staff or subcontractor will ensure that monitoring efforts do not conflict with end use restrictions
- Monitoring staff or subcontractor will ensure that monitoring efforts are performed in compliance with applicable permits or regulations
- SMDA will request well logs of all new wells within the restricted areas on a semi-annual basis
- SMDA will retain copies of restrictive use covenants
- SMDA will verify property ownership on a semi-annual basis and that new owners are aware of the restrictions
- Reviews of the use restrictions, as defined in the Restrictive Covenant, will be performed whenever there is a change in the activities and uses of the property. After each review, the findings and any actions taken will be reported to MDEQ.
- Reviews of use restrictions will also be performed every five years.

Appendix I
Drawing Set

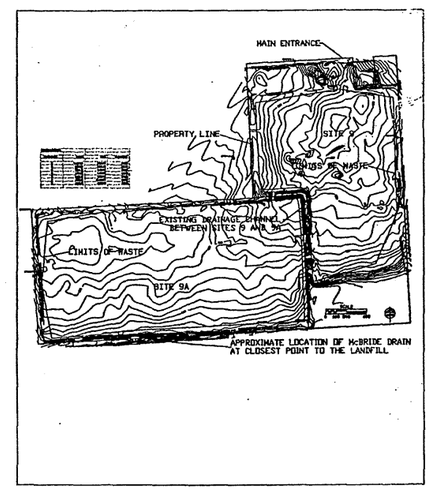
REMEDIAL ACTION PLAN
SOUTH MACOMB DISPOSAL AUTHORITY
SITES 9 AND 9A

SHEET INDEX

1. TITLE SHEET
2. EXISTING CONDITIONS
3. BOTTOM OF WASTE GRADES
4. TOP OF FINAL COVER GRADES
5. LEACHATE DEWATERING SYSTEM
6A. DETAIL DRAWINGS
6B. DETAIL DRAWINGS
6C. DETAIL DRAWINGS
7. PERIMETER COLLECTOR PIPELINE PROFILE
8A. MONITORING WELL LOCATIONS
8B. AQUIFER #1 MONITORING WELLS
8C. AQUIFER #2 MONITORING WELLS
8D. AQUIFER #3 MONITORING WELLS
9A. PRETREATMENT FACILITY AND SANITARY SEWER DISCHARGE
9B. PRETREATMENT FACILITY AND SANITARY SEWER DISCHARGE



LOCATION MAP



SITE MAP

OWNER:
SOUTH MACOMB DISPOSAL AUTHORITY
2001 PLEASANT AVENUE, BOX 286
ST. CLAIR SHORES, MI 48080
(810)777-1284
CONTACT: MS. MARY RIVARD

3/11/02

OPERATOR:
PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OH 45249
(513)489-6789
CONTACT: MR. MARK MATHER

General Notes

TITLE SHEET

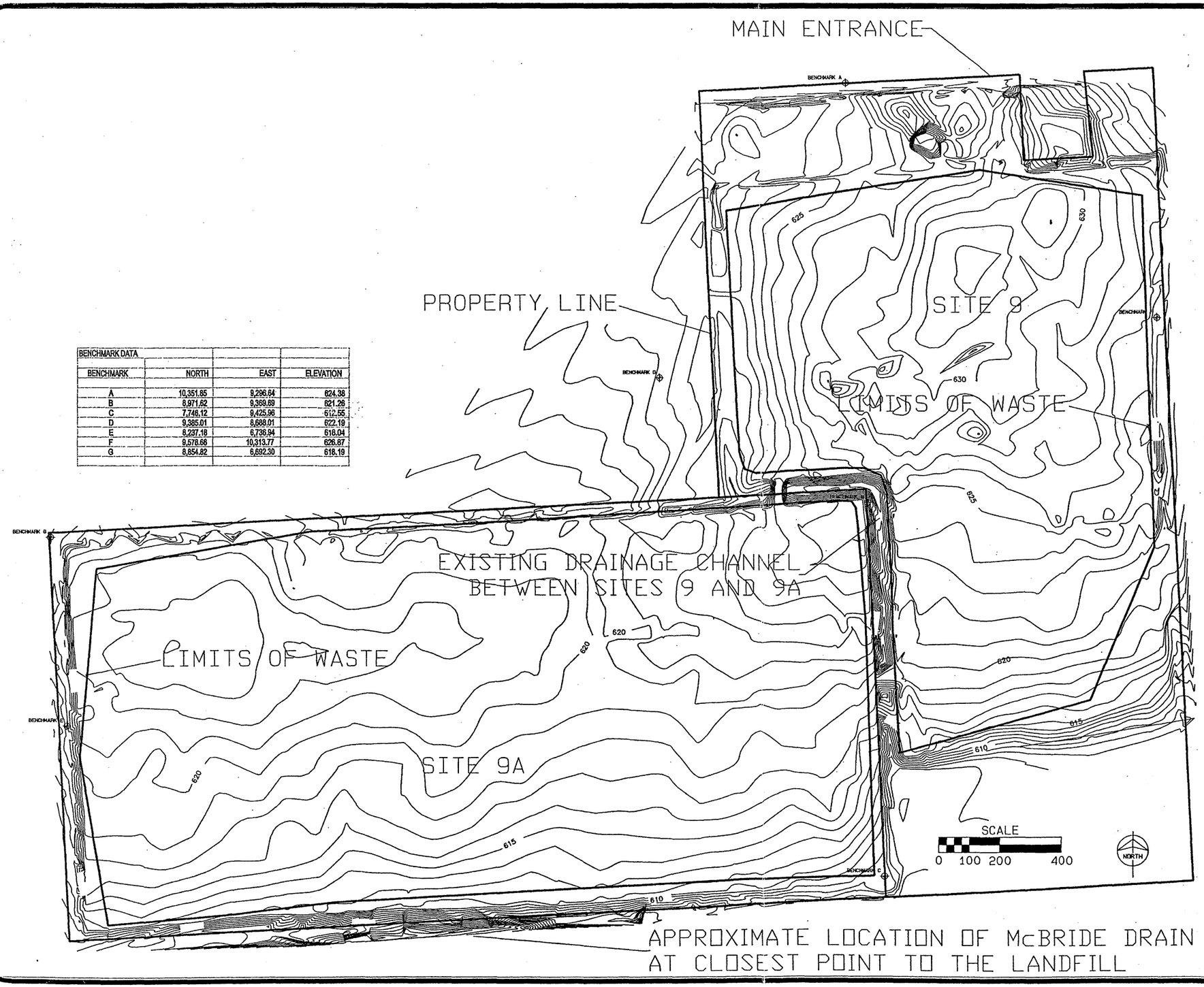
No.	Revision/Issue	Date
3	REVISION NO. 3	2/02
2	REVISION NO. 2	1/02
1	REVISION NO. 1	4/01

Firm Name and Address
PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA
Date: NOVEMBER 2000
Scale: AS SHOWN
Sheet: 1

BENCHMARK DATA			
BENCHMARK	NORTH	EAST	ELEVATION
A	10,351.85	9,296.84	624.38
B	8,971.62	9,369.89	621.26
C	7,746.12	9,425.96	612.55
D	9,385.01	8,668.01	622.19
E	8,237.18	6,736.94	618.04
F	9,578.68	10,313.77	626.87
G	8,854.82	6,692.30	618.19



General Notes

NOTE: BENCHMARKS, PROPERTY LINES, EXISTING GRADES AND ELEVATIONS TAKEN FROM TOPOGRAPHIC SURVEY PERFORMED BY RAYMOND J. DONELLY & ASSOC. OF TROY, MICHIGAN DATED JUNE 22, 1999.

EXISTING CONDITIONS

No.	Revision/Issue	Date
2	REVISION NO. 2	2/02
1	REVISION NO. 1	4/01

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

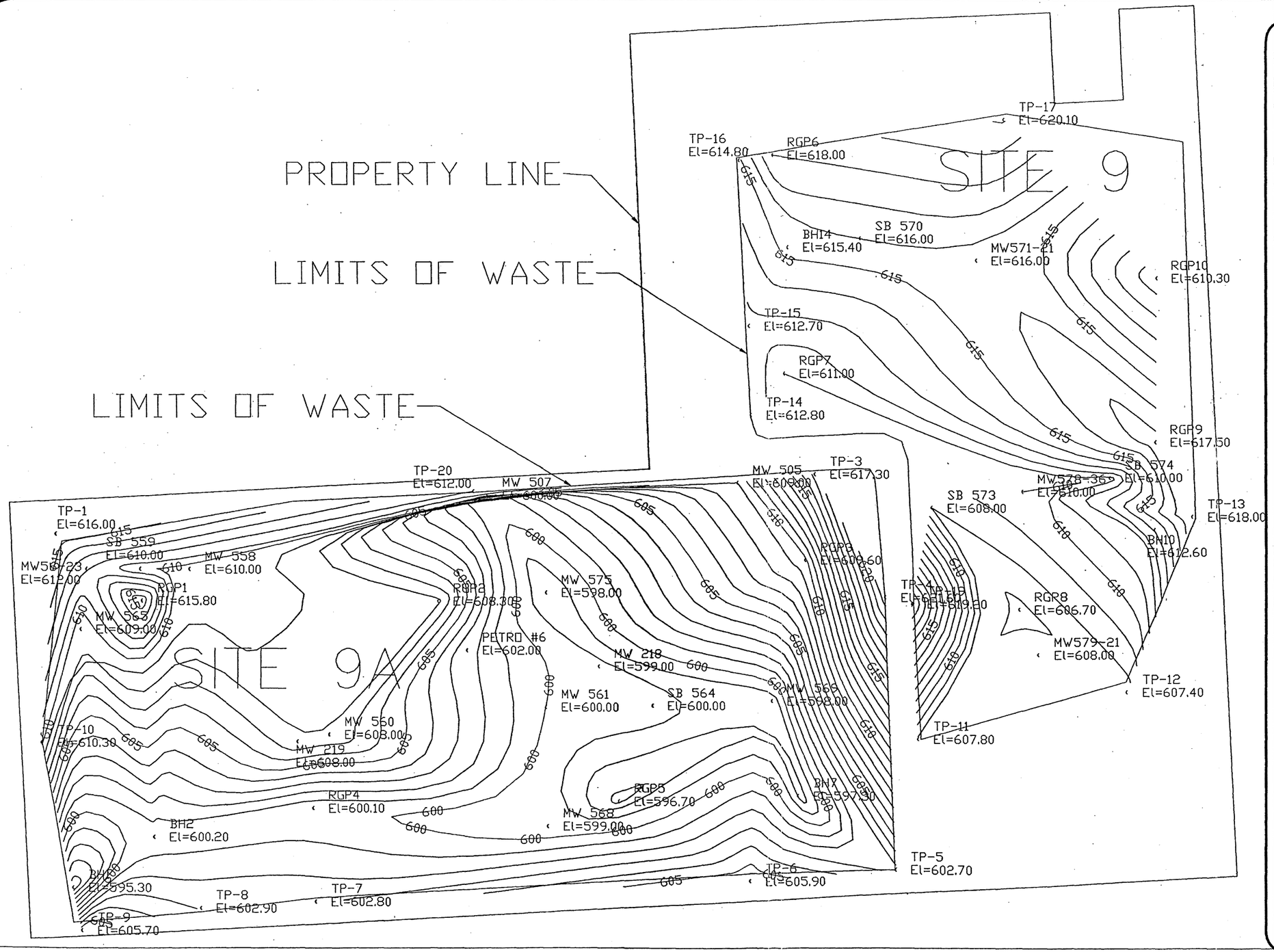
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA

Date: NOVEMBER 2000

Scale: AS SHOWN

Sheet: 2



General Notes

NOTE: BORING LOCATIONS TAKEN FROM DRAGUN CORP. FIGURE 3 CROSS-SECTION LOCATION MAP DATED FEB 1995

BOTTOM OF WASTE GRADES

No.	Revision/Issue	Date
2	REVISION NO. 2	2/02
1	REVISION NO. 1	4/01

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

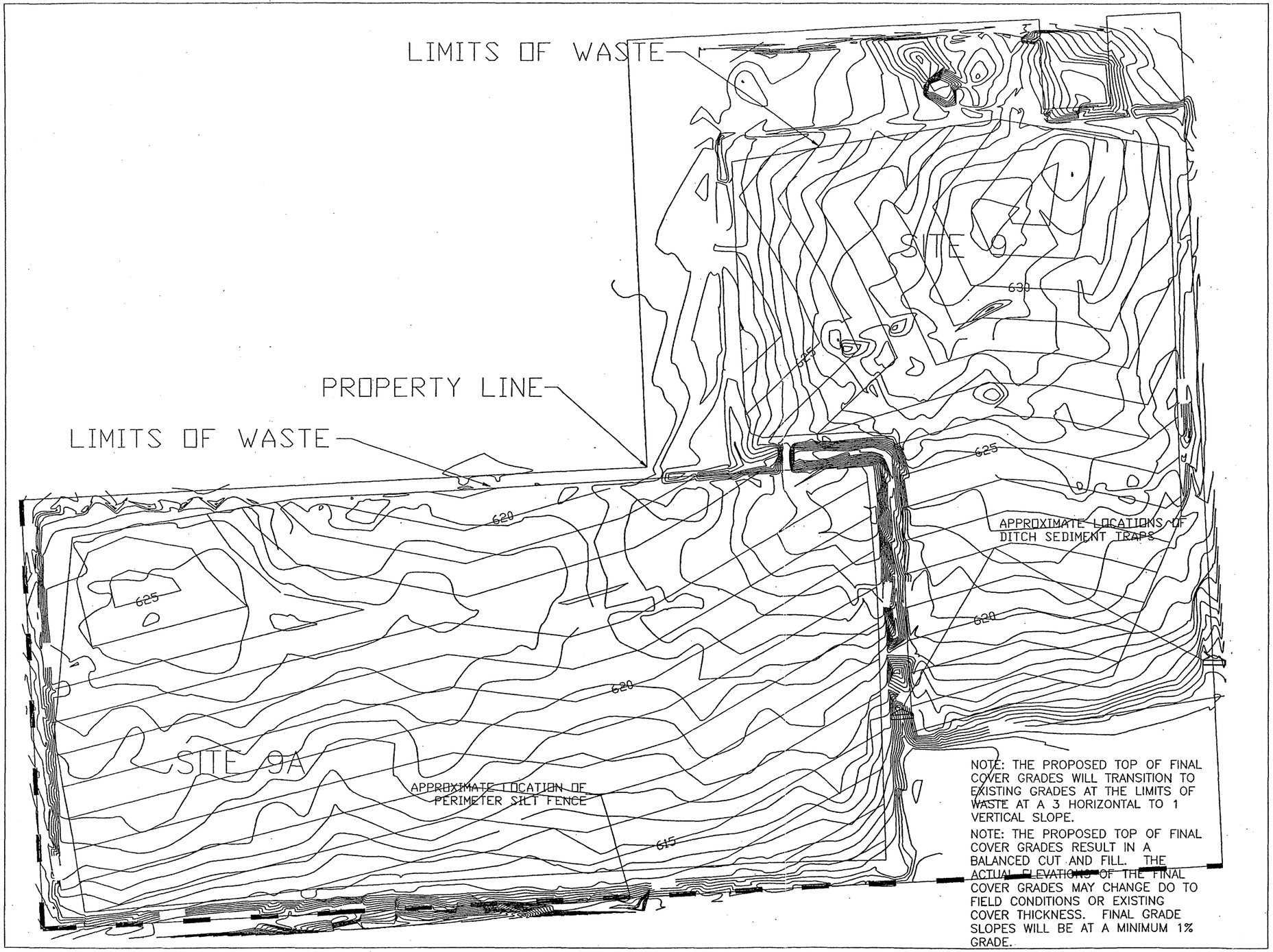
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA

Date: NOVEMBER 2000

Scale: AS SHOWN

Sheet: 3



NOTE: THE PROPOSED TOP OF FINAL COVER GRADES WILL TRANSITION TO EXISTING GRADES AT THE LIMITS OF WASTE AT A 3 HORIZONTAL TO 1 VERTICAL SLOPE.

NOTE: THE PROPOSED TOP OF FINAL COVER GRADES RESULT IN A BALANCED CUT AND FILL. THE ACTUAL ELEVATIONS OF THE FINAL COVER GRADES MAY CHANGE DO TO FIELD CONDITIONS OR EXISTING COVER THICKNESS. FINAL GRADE SLOPES WILL BE AT A MINIMUM 1% GRADE.

General Notes

TOP OF FINAL COVER GRADES

No.	Revision/Issue	Date
2	REVISION NO. 2	1/02
1	REVISION NO. 1	4/01

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

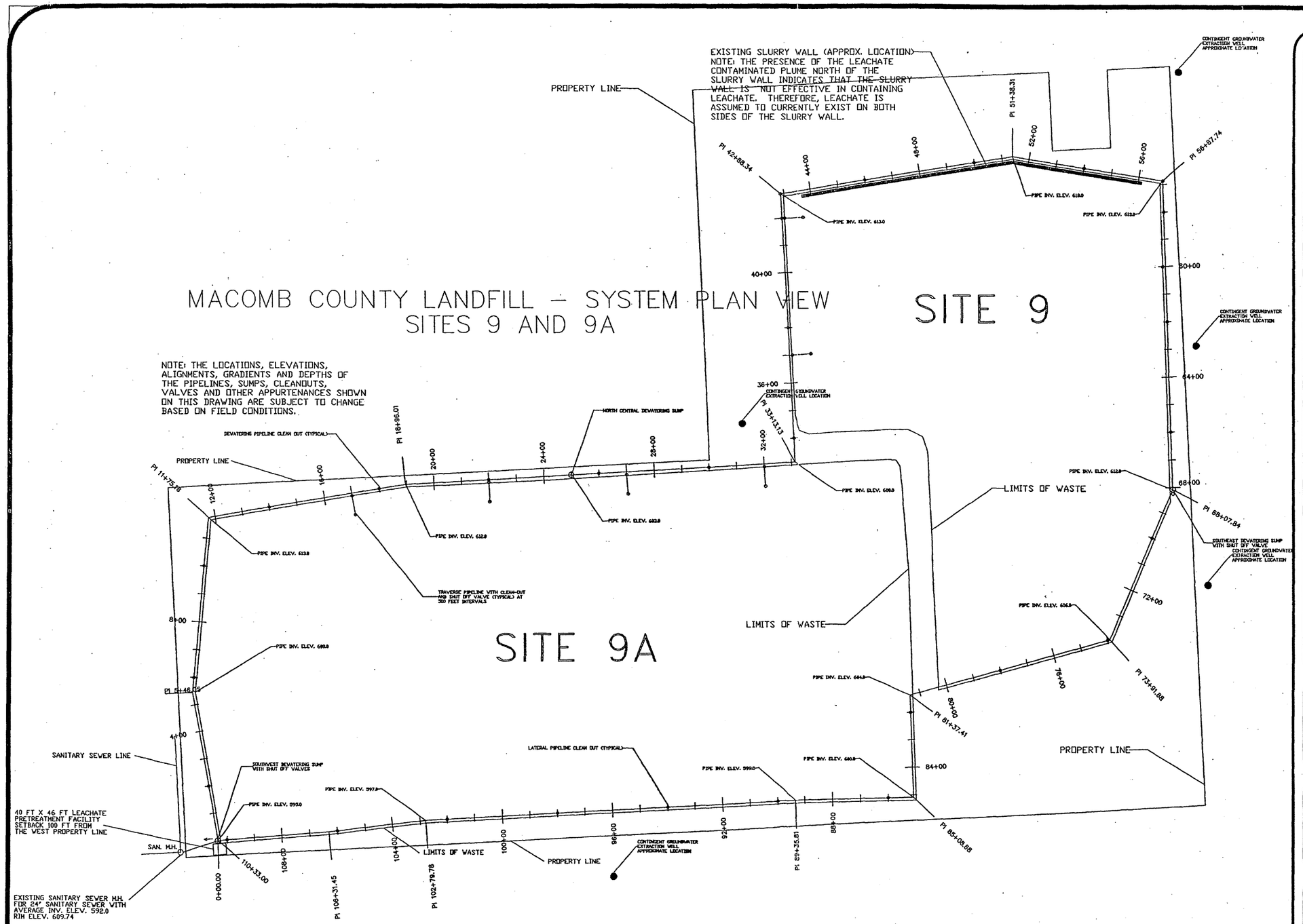
Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C000-012 SMDA
Date: NOVEMBER 2000
Scale: AS SHOWN
Sheet: 4

MACOMB COUNTY LANDFILL – SYSTEM PLAN VIEW
SITES 9 AND 9A

NOTE: THE LOCATIONS, ELEVATIONS, ALIGNMENTS, GRADIENTS AND DEPTHS OF THE PIPELINES, SUMPS, CLEANOUTS, VALVES AND OTHER APPURTENANCES SHOWN ON THIS DRAWING ARE SUBJECT TO CHANGE BASED ON FIELD CONDITIONS.



General Notes

LEACHATE DEWATERING SYSTEM

No.	Revision/Issue	Date
2	REVISION NO.2	1/02
1	REVISION NO.1	4/01

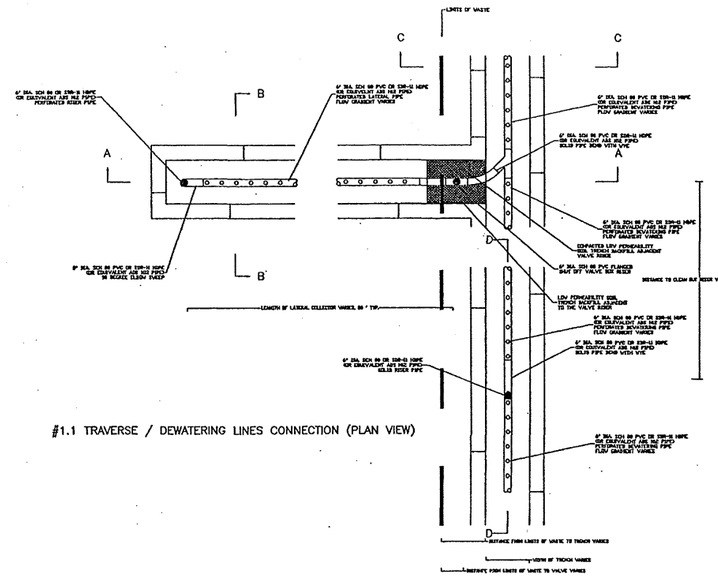
Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

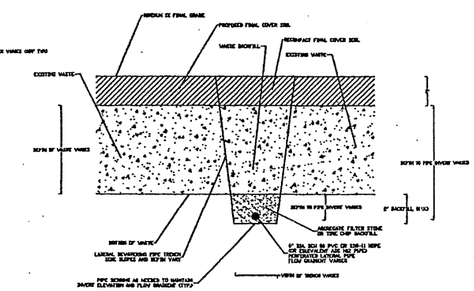
Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

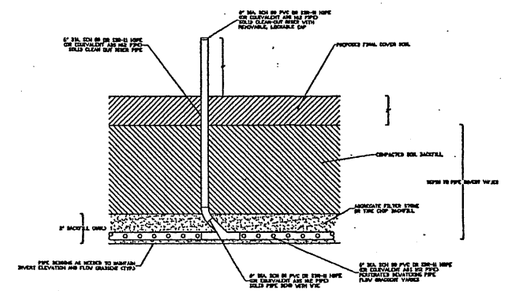
Project: C00-012 SMDA
Date: NOVEMBER 2000
Scale: AS SHOWN
Sheet: 5



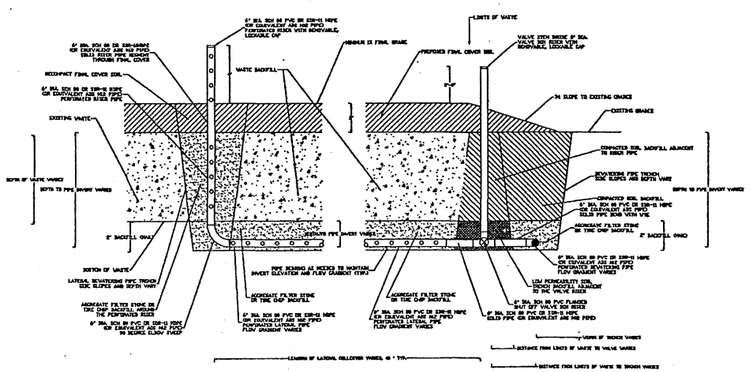
#1.1 TRAVERSE / DEWATERING LINES CONNECTION (PLAN VIEW)



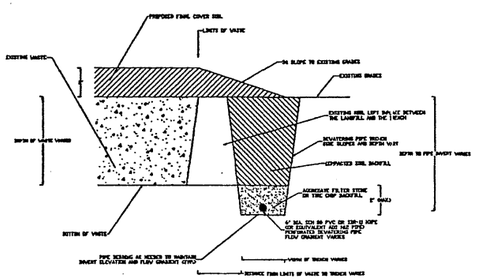
#1.3 TRAVERSE LINE TRENCH (XSECTION VIEW, B – B)



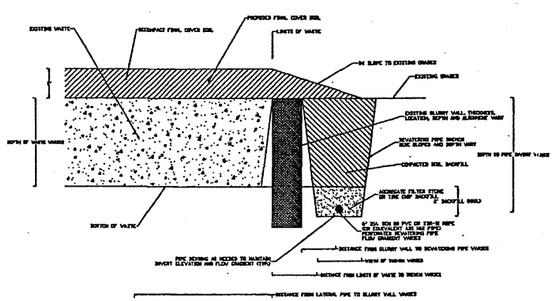
#1.5 DEWATERING LINE TRENCH (PROFILE VIEW, D – D)



#1.2 TRAVERSE / DEWATERING LINES CONNECTION (PROFILE VIEW, A – A)



#1.4 DEWATERING LINE TRENCH (XSECTION VIEW, C – C)



#1.6 DEWATERING LINE TRENCH
ADJACENT TO SLURRY WALL (XSECTION VIEW)

MACOMB COUNTY LANDFILL SITES 9 AND 9A – DETAIL SHEET #1
(NO SCALE)

General Notes

DETAIL DRAWINGS

No.	Revision/Issue	Date
#1	REVISED LEACHATE SYSTEM	JAN 02

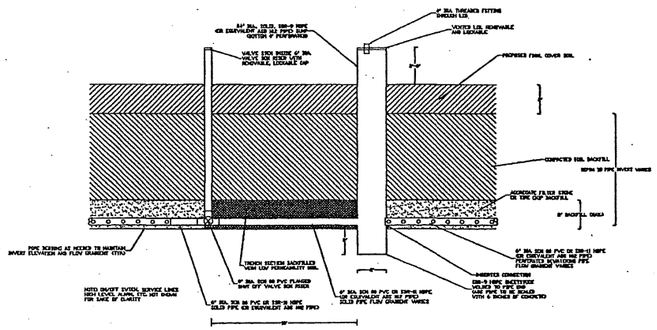
Firm Name and Address

PETRO ENVIRONMENTAL
TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

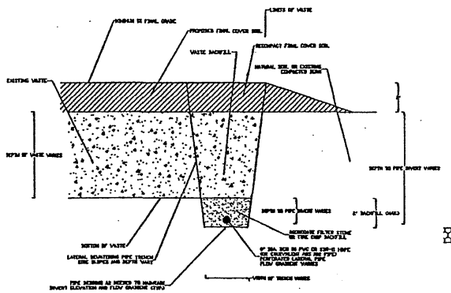
Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

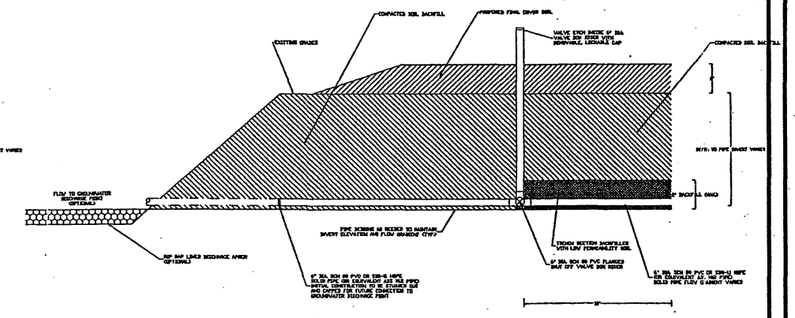
Project: C00-012 SMDA
Date: JANUARY 2002
Scale: AS SHOWN
Sheet: 6A



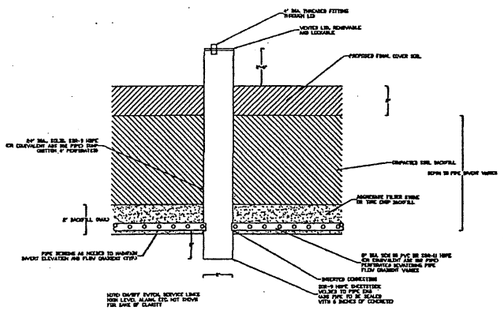
#2.1 DEWATERING LINE SUMP WITH SHUT OFF VALVE (PROFILE VIEW, D – D)



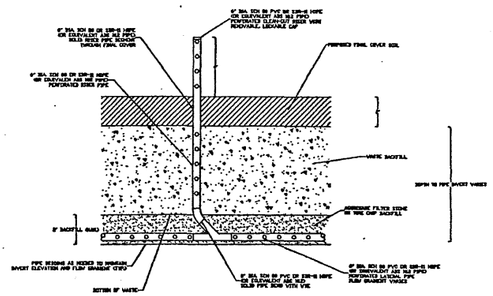
#2.3 LATERAL LINE TRENCH ALONG SOUTHERN BOUNDARY(XSECTION VIEW)



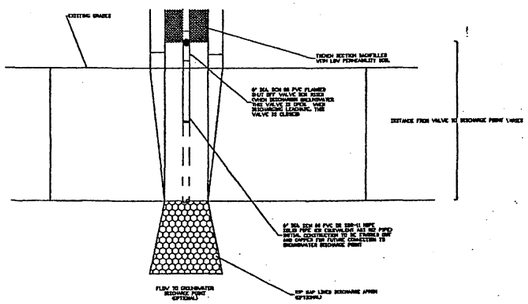
#2.5 GROUNDWATER DISCHARGE LINE (PROFILE VIEW)



#2.2 DEWATERING LINE SUMP (PROFILE VIEW, D – D)



#2.4 LATERAL LINE TRENCH (PROFILE VIEW, D – D)



#2.6 GROUNDWATER DISCHARGE LINE (PLAN VIEW)

MACOMB COUNTY LANDFILL SITES 9 AND 9A – DETAIL SHEET #2
(NO SCALE)

General Notes

DETAIL DRAWINGS

No.	Revision/Issue	Date
#1	REVISED LEACHATE SYSTEM	JAN 02

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

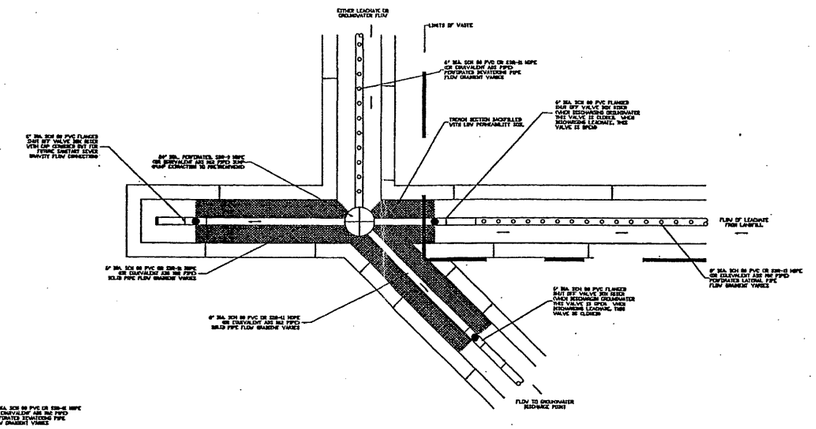
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA

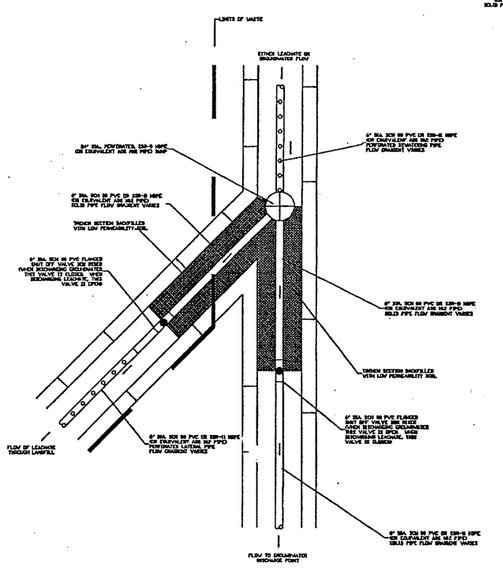
Date: JANUARY 2002

Scale: AS SHOWN

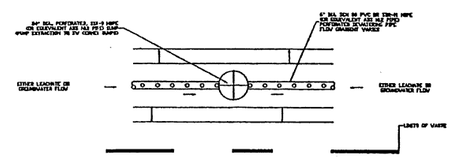
Sheet: 6B



#3.2 DEWATERING SUMPS, SOUTHWEST CORNER (PLAN VIEW)



#3.1 DEWATERING SUMPS, SOUTHEAST CORNER (PLAN VIEW)



#3.3 DEWATERING SUMP, NORTH CENTRAL (PLAN VIEW)

MACOMB COUNTY LANDFILL SITES 9 AND 9A – DETAIL SHEET #3
(NO SCALE)

General Notes

DETAIL DRAWINGS

No.	Revision/Issue	Date
#1	REVISED LEACHATE SYSTEM	JAN 02

Firm Name and Address

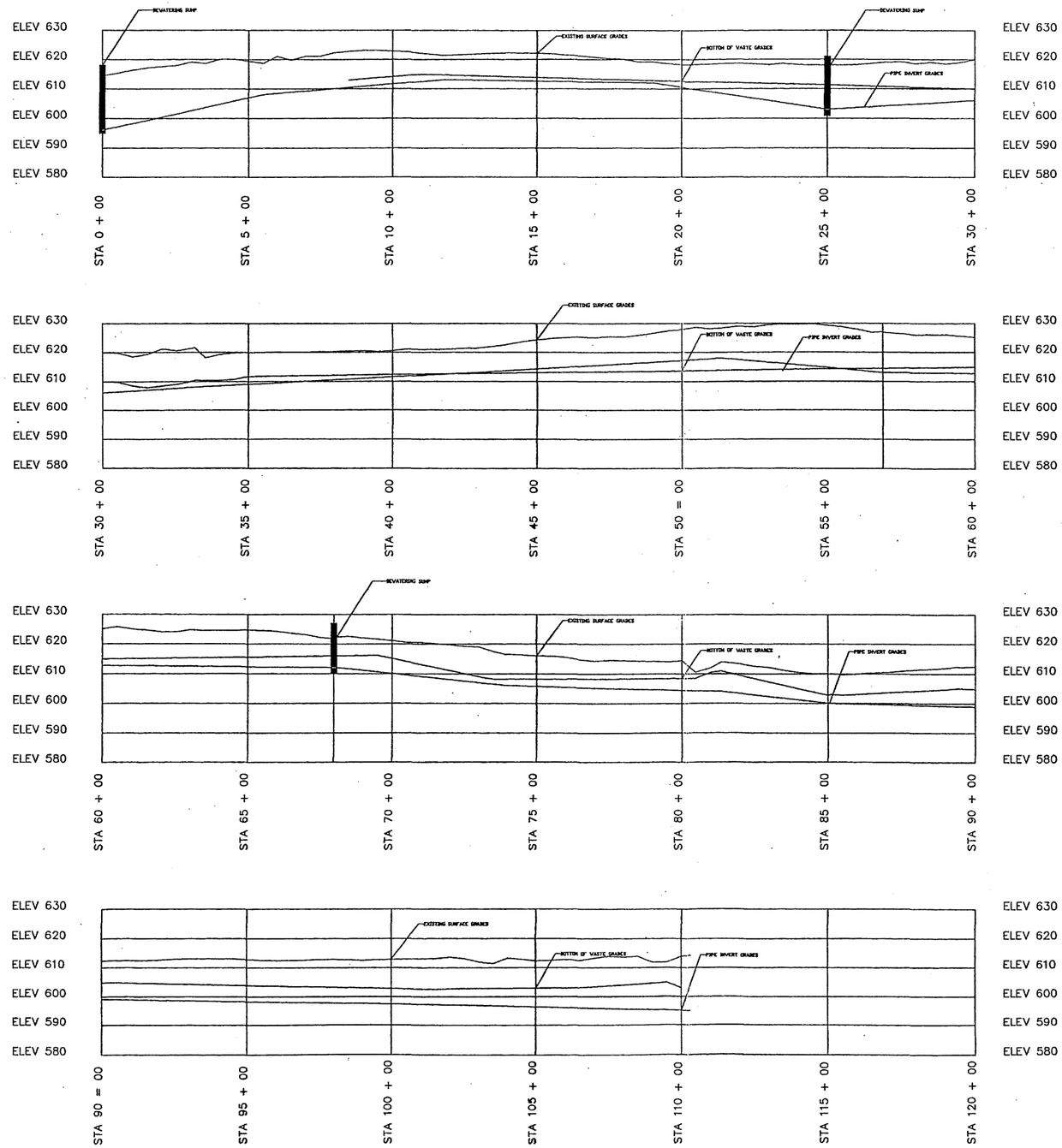
PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA
Date: JANUARY 2002
Scale: AS SHOWN
Sheet: 6C

DEWATERING PIPELINE PROFILE



General Notes

PERIMETER COLLECTOR PIPELINE PROFILE

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

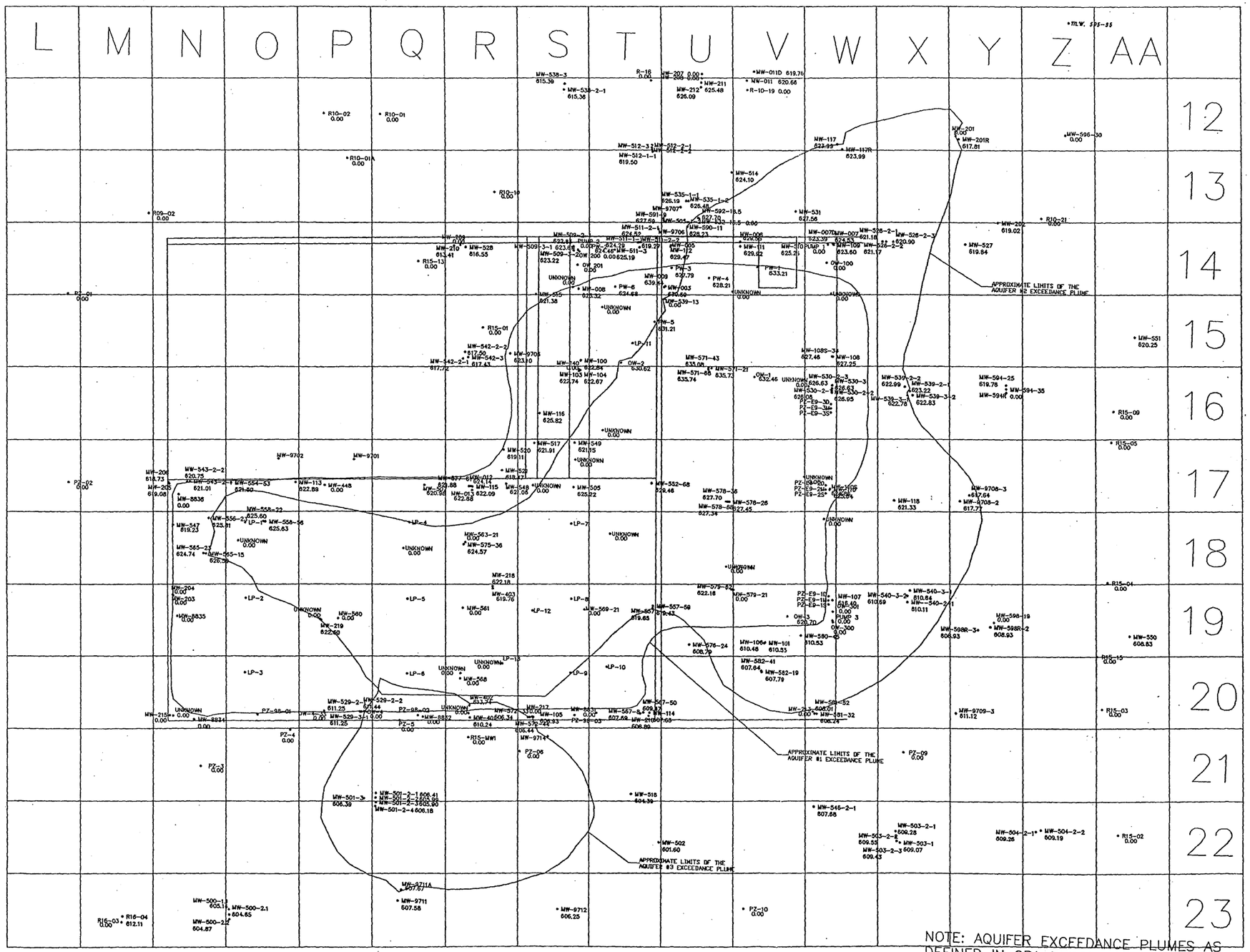
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012 SMDA

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 7



NOTE: AQUIFER EXCEEDANCE PLUMES AS DEFINED IN CRA REPORT OF JUNE 2000

General Notes

MONITORING WELL LOCATIONS

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

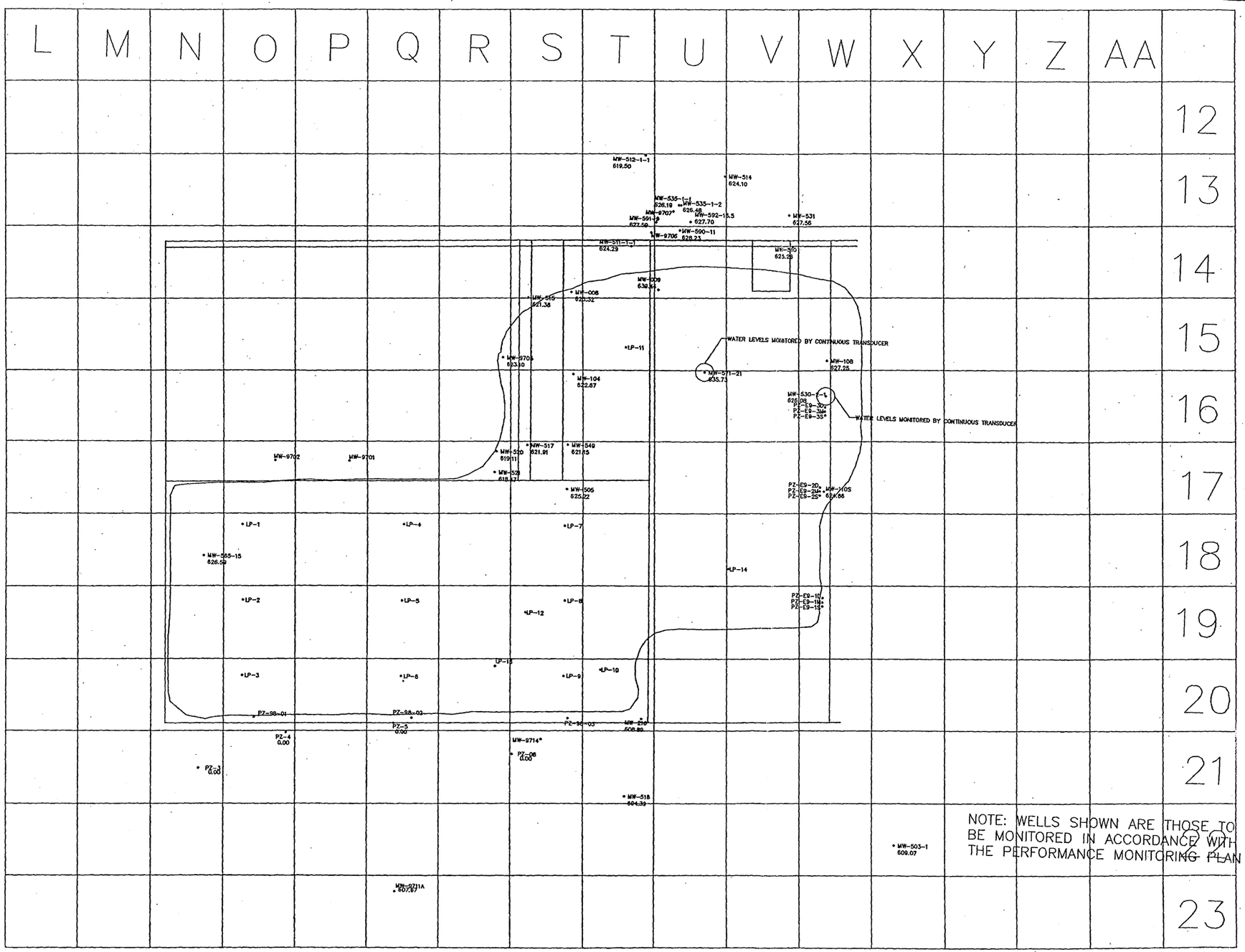
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012 SMDA

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 8A



NOTE: WELLS SHOWN ARE THOSE TO BE MONITORED IN ACCORDANCE WITH THE PERFORMANCE MONITORING PLAN

General Notes

AQUIFER #1 MONITORING WELLS

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

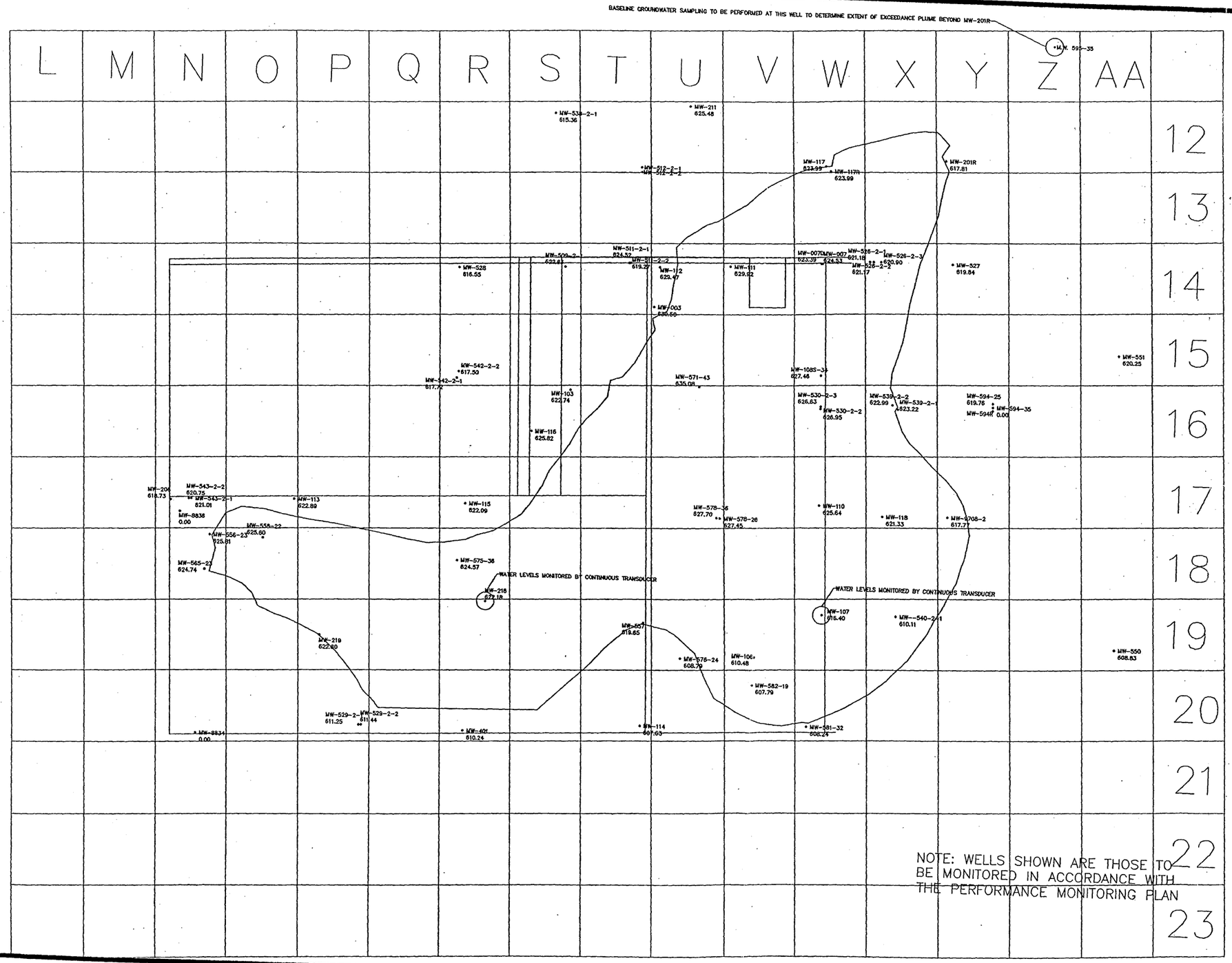
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012 SMDA

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 8B



NOTE: WELLS SHOWN ARE THOSE TO BE MONITORED IN ACCORDANCE WITH THE PERFORMANCE MONITORING PLAN

General Notes

AQUIFER #2 MONITORING WELLS

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

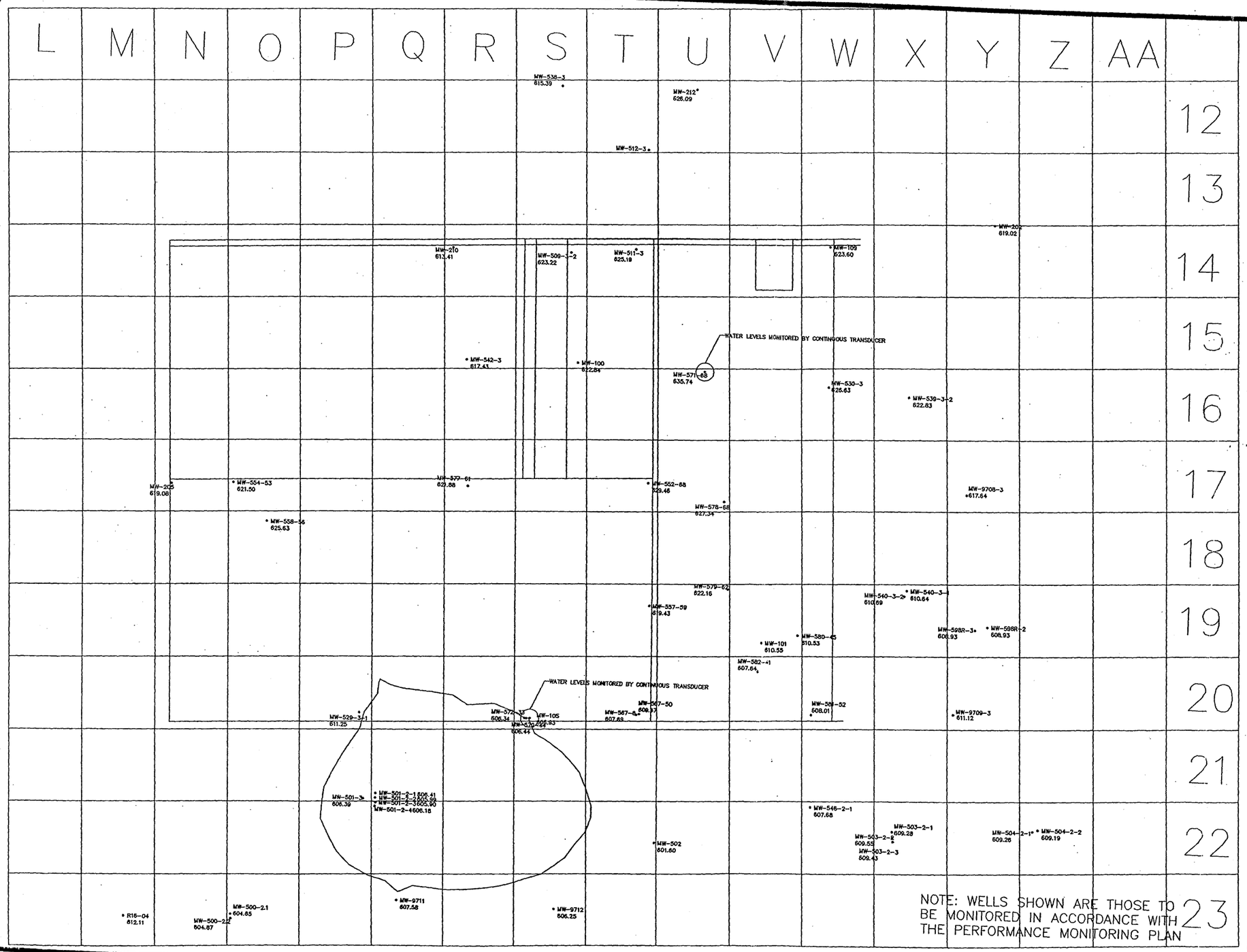
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: C00-012 SMDA

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 8C



NOTE: WELLS SHOWN ARE THOSE TO BE MONITORED IN ACCORDANCE WITH THE PERFORMANCE MONITORING PLAN

General Notes

AQUIFER #3 MONITORING WELLS

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

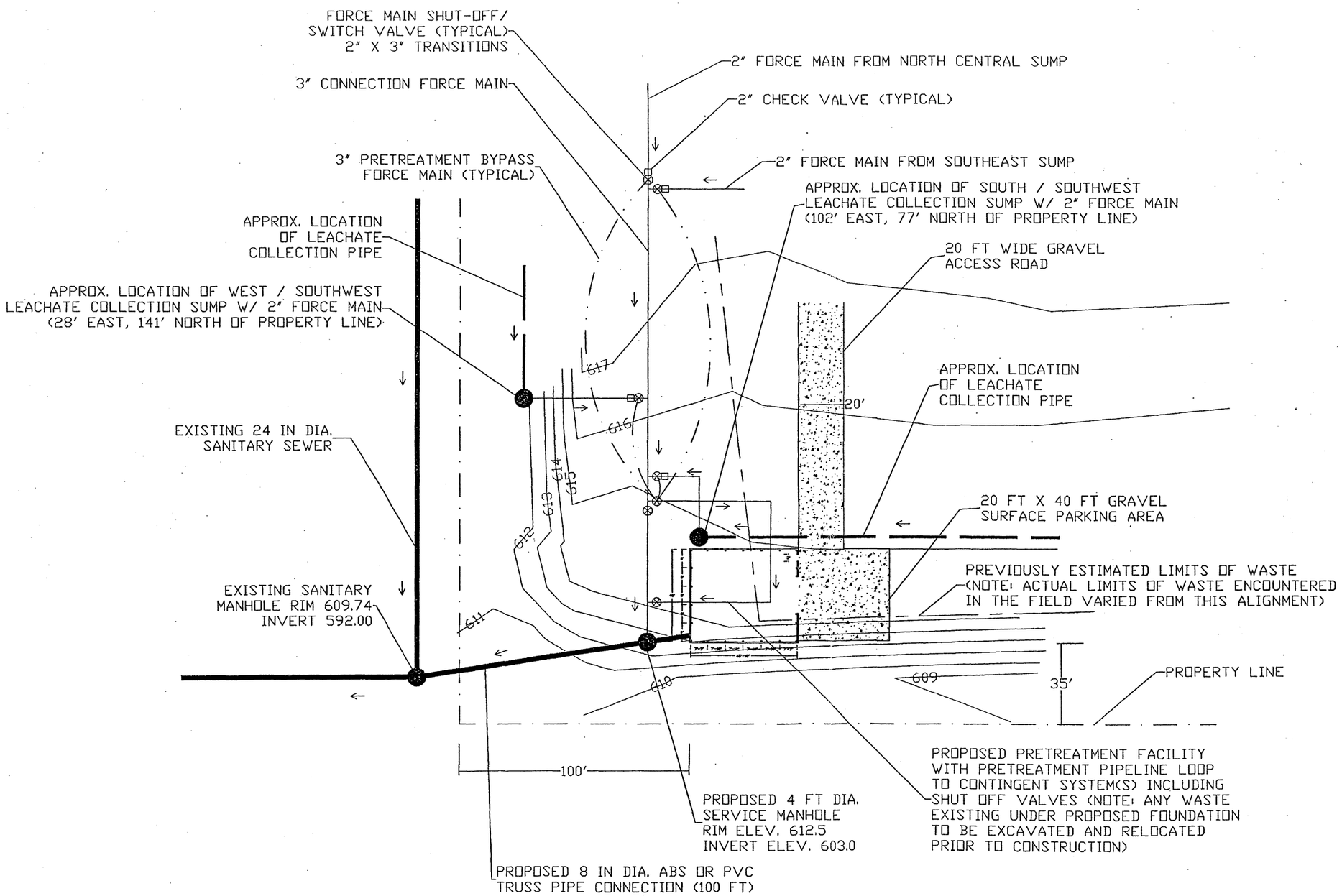
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012 SMDA

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 8D



General Notes

PRETREATMENT FACILITY AND SANITARY SEWER DISCHARGE

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL
TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

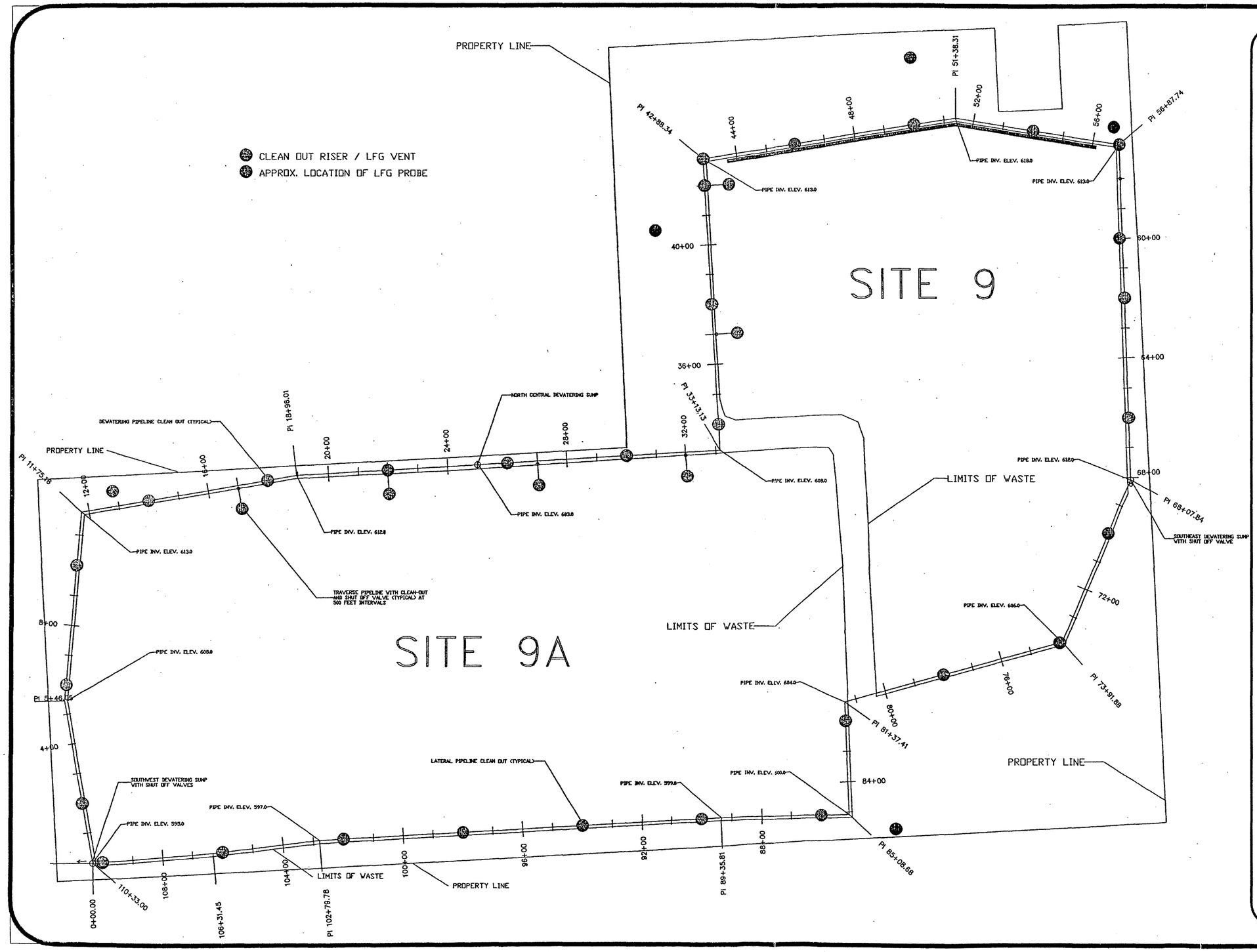
MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: MI-00-0001

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 9A



General Notes

LANDFILL GAS VENT AND PROBE PLAN

No.	Revision/Issue	Date

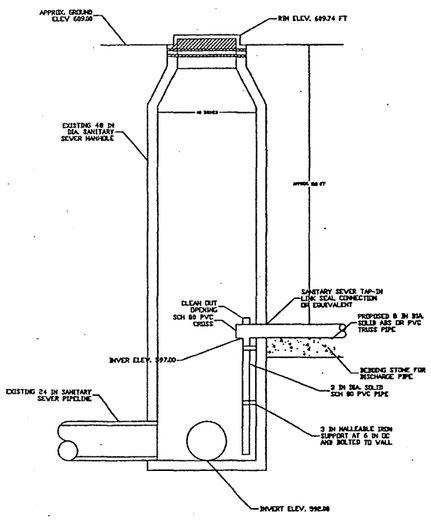
Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

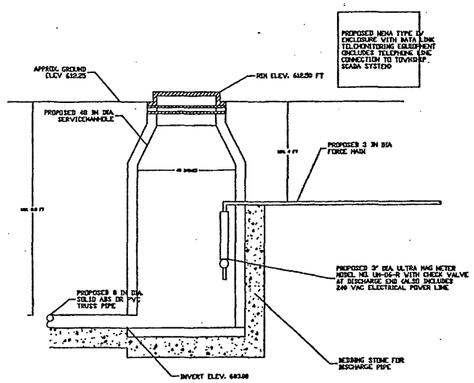
Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

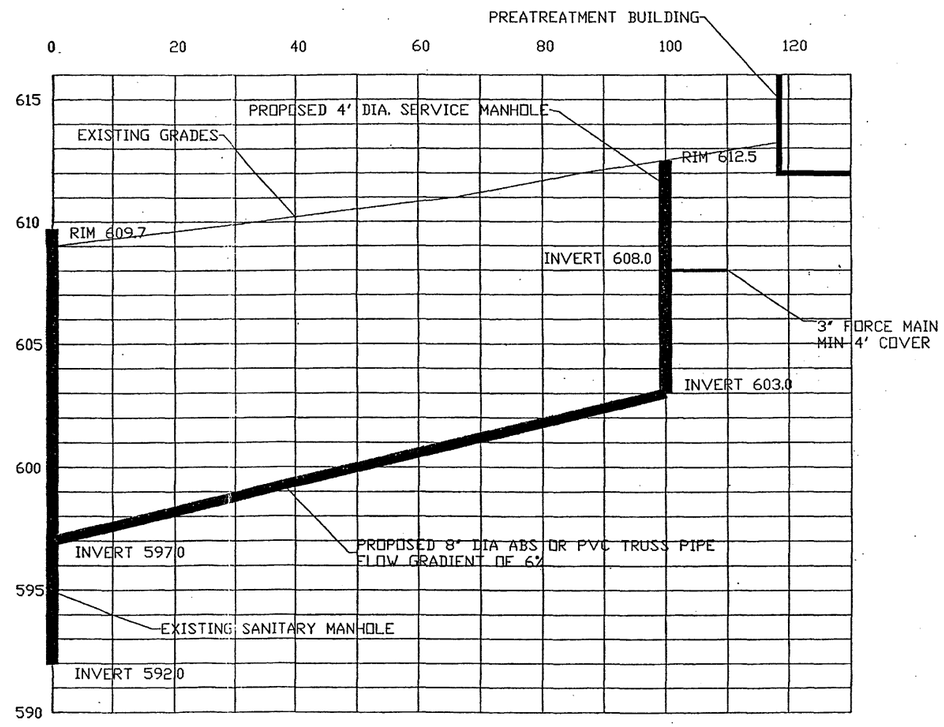
Project: C00-012 SMDA	Sheet 1 OF 1
Date: FEBRUARY 2002	
Scale: AS SHOWN	



EXISTING SANITARY MANHOLE



PROPOSED SERVICE MANHOLE



PROPOSED SEWER TAP-IN PROFILE

General Notes

PRETREATMENT FACILITY AND SANITARY SEWER DISCHARGE

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: MI-00-0001

Date: FEBRUARY 2002

Scale: AS SHOWN

Sheet: 9B

Appendix J
Leachate and Groundwater Management Plan

Leachate and Groundwater Management Plan

for

SOUTH MACOMB DISPOSAL AUTHORITY
LANDFILLS 9 AND 9A

By
Petro Environmental Technologies, Inc.

February 2002

SMDA Landfill Sites 9 and 9A
Leachate and Groundwater Management Plan
Table of Contents

1 Introduction 3
2 Leachate Quantity 3
3 Areal Extent of Contaminant Plume 4
4 Clean Up Criteria 5
5 Management Plan 5
6 Discharge Methods 5

Attachments

I. Leachate Quantity Estimates
II. Sewer Tap-In Resolution

1 Introduction

This Leachate and Groundwater Management Plan (LGMP) for the Macomb County Landfill Properties 9 and 9A is designed to effectively dispose of contaminated water removed from the site by the collection systems described in the site's Remedial Action Plan (RAP). The PMP is considered as part of the RAP and together will ensure that the properties are remediated in accordance with the applicable regulations and court decisions. This LGMP is specific to the extraction, disposal and (if necessary) pretreatment action measures. Engineering and construction of the collection systems are discussed in the RAP.

The Macomb county landfill was a Type II Municipal Solid Waste Landfill under current Michigan DEQ rules that were operated as solid waste disposal areas under the provisions of the Garbage and Refuse Disposal Act 1965 PA 87, as amended. It is owned and was operated by the South Macomb Disposal Authority (SMDA). The Macomb County Landfill consists of two Properties, 9 and 9A. The landfill covers approximately 159 acres. Property 9 covers approximately 75 acres with approximately 65 acres utilized for solid waste disposal. The remaining 10 acres is utilized as buffers on the north and east sides. Property 9A covers approximately 84 acres with approximately 80 acres utilized for solid waste disposal. The remaining 4 acres is utilized as buffer on the west and south sides.

Property 9 was licensed to receive municipal solid waste from April 29, 1968 to September 1, 1975, a period of approximately 88 months. During this time it received approximately 680,000 cubic yards of municipal solid waste, an average of 7,727 cubic yards per month.

Property 9A was licensed to receive municipal solid waste from February 22, 1971 to September 1, 1979, a period of approximately 102 months. During this time it received approximately 1,200,000 cubic yards of municipal solid waste, an average of 11,765 cubic yards per month.

At no time was the Macomb County Landfill licensed to receive hazardous waste or hazardous substances for purposes of disposal. There is no record of any disposal operation involving hazardous materials.

2 Leachate Quantity

Estimates of existing leachate quantities have been performed based on available site information. The computations from data and assumptions are included in the tables in Attachment I. This information is summarized below:

- **Table I**. Provides estimates of current in-place waste volume based on receipt rates provided by CRA, assuming standard landfill compaction rates of 50% and a typical further consolidation and settlement of an additional 20% since landfill

closure. Also provided are estimates of soil volumes in the landfill based on boundaries (bottom of waste, top of waste existing surface) generated on CADD models derived from boring logs. The soil is either mixed in with the waste or the homogenous existing soil cover. From boring logs and field observations, it is estimated that roughly 1/3 of the soil is silty sands and 2/3 is clayey soil.

- **Table II.** Provides an estimate of the saturated soil/waste mass based on piezometeric head contour elevations as measured by the Dragun Corporation. This represents a conservative estimate; Petro Environmental recently measured lower leachate levels, but this may be a current season condition. We used the more conservative Dragun water elevations to determine saturation quantities

- **Table III**. Provides estimates of current leachate volumes based on standard values for potential free liquid (porosity less the field capacity) for waste, silty sand and clayey soils. An average value of the amount of leachate per cubic foot of saturated waste and soil media (below the existing cover) is derived and then used to estimate the total quantity of leachate in the landfills.

- **Table IV**. Provides an estimate of the saturated mass requiring dewatering to meet the capture goals of the Consent Order. Table IV also derives a gallon estimate of the leachate removal quantity. Finally, Table IV derives the average gallons per day needed to meet the Consent Order dewatering requirement. The amount of leachate removed is derived from the amount of area/volume <u>above</u> a parabolic draw down curve (Area =1/3 x base x height).

- Also attached are two schematics illustrating the above concepts for leachate removal in Site 9 and Site 9A.

It is estimated that the landfills contain approximately 32,000,000 gallons of leachate. Removal of 1/3 of this amount, or 10,800,000 gallons, will establish a drawdown curve in the landfill. A removal rate of approximately 7,300 gallons per day for four years will achieve this goal.

Because these landfills are irregularly shaped and waste is heterogeneous, precise estimates of water flows and quantities are not possible. Therefore, Petro Environmental has made a series of very conservative yet realistic assumptions. The leachate discharge rate will vary over time, with initial rates possibly as high as the 0.2 cfs (more than 100,000 gallons per day).

3 Areal Extent of Contaminant Plume

The extent of three contaminant plumes has been estimated by CRA's "Supplemental Plume Delineation Report". Each plume is located within one of the three aquifers located at the site. Plan drawing #8, "Monitoring Wells and Contaminant Plumes", shows the limits of each contaminant plume.

4 Clean Up Criteria

Chemical containment (or chemical capture) is defined as the stabilization and/or reduction of the plume that extends beyond the boundaries of the Property, which exceeds the higher of Part 201 residential health-based drinking water criteria as contained in the January 29, 1999 update of Part 201 Generic Cleanup Criteria Tables of the August 31, 1998 MDEQ Environmental Response Division Memorandum #18 as amended by the October 2, 1998 Update or background as determined pursuant to the Consent Decree. Chemical capture will be considered to exist if the chemical concentrations of the groundwater in the sentinel wells remain below the higher of Part 201 residential health-based drinking water criteria or background and if the chemical concentrations in all of the monitoring wells do not change in a way that indicates that the plume is expanding.

5 Management Plan

The primary goal of the LGMP is to pump and remove all contaminated water that exceeds the health based clean up criteria. The performance of this plan will be an iterative process:

- Install and operate pumps in the collection sumps.
- Measure the effectives of the sump pumps within the guidelines of the Performance Monitoring Plan (PMP).
- Install additional groundwater extraction systems if health based plume is not receding.

6 Discharge Methods

All contaminated water will be discharged off-site or to the sanitary sewer adjacent to the site. The sewer tap permit with Macomb Township is not finalized. However, the tap-in permit and available sewer flow capacity will dictate the performance standards for discharge flows. An agreement exists that allows for a 194,000 gallons per day maximum discharge. A copy of the resolution allowing for a tap-in to the sanitary sewer is provided in Attachment II.

Any changes in the quality of the groundwater which affect the discharge to the sanitary sewer may be remedied by either off-site disposal or on-site pretreatment of the discharge.

Appendix K
Restrictive Covenant for Landfill Properties

LAW OFFICES
DYKEMA GOSSETT
PROFESSIONAL LIMITED LIABILITY COMPANY
400 Renaissance Center
Detroit, Michigan 48243-1668
TELEPHONE (313) 568-6800
FACSIMILE (313) 568-6658
www.dykema.com

ANN ARBOR, MICHIGAN
BLOOMFIELD HILLS, MICHIGAN
CHICAGO, ILLINOIS

GRAND RAPIDS, MICHIGAN
LANSING, MICHIGAN
WASHINGTON, DC

WILLIAM R. SCHIKORA

DIRECT DIAL: (313) 568-6685
E-MAIL: WSCHIKORA@DYKEMA.COM

April 2, 2002

RECEIVED
APR - 3 2002
6410
ERD-SUPERFUND

David Kline
MDEQ-ERD-Superfund
Constitution Hall
3rd Floor, South
525 W. Allegan Street
Lansing, Michigan 48933

Re: Site 9 and 9A Deed Restrictions

Dear Mr. Kline:

As we discussed, I am writing to seek your concurrence that the enclosed deed restrictions for the Site 9 and 9A properties associated with the SMDA landfill site are acceptable to the MDEQ and will be included in the Final Remedial Action Plan. These deed restrictions are meant to replace the generic ones included in Petro's most recent RAP submittal.

Mr. Dloski and I would appreciate your written concurrence that the enclosed deed restrictions are acceptable to MDEQ. If you should have any questions, please do not hesitate to contact me.

Very truly yours,

DYKEMA GOSSETT PLLC

William R. Schikora

William R. Schikora

cc: Larry Dloski
Mark Mather

DET02\142612.1
ID\WRS

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GRAND RAPIDS, MICHIGAN
LANSING, MICHIGAN
WASHINGTON, DC

WILLIAM R. SCHIKORA

DIRECT DIAL: (313) 568-6685
E-MAIL: WSCHIKORA@DYKEMA.COM

May 28, 2002

David Kline
MDEQ-ERD-Superfund
Constitution Hall
3rd Floor, South
P.O. Box 30426
Lansing, Michigan 48909

MAY 29
6841

Re: SMDA Consent Decree

Dear Mr. Kline:

Enclosed, please find two documents related to the SMDA Consent Decree. The first is a survey of the SMDA property (Sites 9 and 9A) which gives the site boundaries and extent of waste. The second is an excerpt from the approved minutes of the Macomb Township Board of Trustees indicating that the Board has approved the language in the proposed deed restrictions.

If you should have any questions, please do not hesitate to contact me.

Very truly yours,

DYKEMA GOSSETT PLLC

William Schikora

William R. Schikora

cc: Bob Reichel
Roger Timm

DET02\147303.1
ID\WRS

6b. Rezoning Request: R-1 to C-2; Located north of Hall Road and approx. 1100' west of Heydenreich Road; Garland Commons, Petitioner. Permanent Parcel No. 08-33-400-021.

Secretary KOEHS reviewed the requested Rezoning Request: R-1 to C-2.

Petitioner: Mr. William McPharlin, president of Interfin, Inc., present.

Public Portion: Ruth Hansen, Macomb Township resident, stated her concerns and questions regarding the requested rezoning request of R-1 to C-2. Supervisor BRENNAN held further discussion with the Township resident. Mr. Dloski, the Township Attorney stated the options available to the resident.

MOTION by OLIVER seconded by MEERSCHAERT to approve the Rezoning Request: R-1 to C-2; Located north of Hall Road and approx. 1100' west of Heydenreich Road; Garland Commons, Petitioner. Permanent Parcel No. 08-33-400-021.

MOTION carried.

7. Restrictive Covenants; Sites 9 and 9A.

Mr. Dloski, the Township Attorney reviewed the Restrictive Covenants; Site 9 and 9a.

Public Portion: None.

MOTION by DUNN seconded by MALBURG to approve the language of the Convenants and Restrictions for Sites 9 and 9a.

FOR THIS MOTION: DUNN, MALBURG, BUCCI, OLIVER, MEERSCHAERT, KOEHS, BRENNAN.

OPPOSED: NONE.
ABSENT: NONE.

MOTION carried.

8. Request to Adopt Bond Authority Resolution.

Petitioner: Mr. Dennis Neiem, of Millar Canfiled, Paddock and Stone; reviewed the request to the Members of the Board.

MOTION by MEERSCHAERT seconded by OLIVER to approve the request to adopt the Bond authority Resolution as follows:

DECLARATION OF RESTRICTIVE COVENANT
FOR THE SITE 9 PROPERTY

MDEQ Reference No.: RC-ERD-01-002

This Restrictive Covenant has been recorded with the Macomb County Register of Deeds for the purpose of protecting public health, safety, and welfare and the environment.

South Macomb Disposal Authority ("SMDA") has submitted to the Michigan Department of Environmental Quality ("MDEQ") a Remedial Action Plan (RAP) that includes site specific land use-based cleanup criteria as allowed for in Section 20120a(2) of Part 201 of the Natural Resources and Environmental Protection Act ("NREPA"), 1994 PA 451, as amended, MCL 324.202101 et seq, for the environmental remediation associated with the property located in the Township of Macomb, County of Macomb ("Property") known as Site 9 and more particularly described as:

Property Tax ID Number of Property: 20-08-15-100-012; 20-08-15-200-002.

See Attachment A for a legal description of the Property.

See Attachment B for a survey of the Property that delineates the Property boundaries.

See Attachment C for a survey of the Property that delineates the extent of waste.

As used herein, the term "Owner" shall mean at any given time the then current title holder of the Property.

NOW THEREFORE, Macomb Township, 19925 23 Mile Road, Macomb, Michigan, pursuant to Section 20120b(4) of NREPA and the Consent Decree dated [**date**] for Case No. 85-3838 CZ entered by and between SMDA and the MDEQ, hereby imposes restrictions on the Property and covenants and agrees that:

1. The Owner shall restrict the uses of the Property to no use (i.e., only activities associated with the maintenance of the remediation system for the closed landfill). The Michigan Department of Environmental Quality ("MDEQ") has determined that the applicable exposure assumptions for the use of the Property are those assumptions utilized in the creation of the Commercial Subcategory IV cleanup criteria as described in MDEQ Operational Memorandum

No. 18, dated June 7, 2000. Accordingly, the Owner shall prevent all use of the Property except as described above. Other uses of the Property are possible only after a site-specific risk assessment for the proposed use is approved by the MDEQ.

2. The Owner shall restrict activities at the Property that may interfere with a remedial action, operation or maintenance, monitoring, or other measures necessary to assure the effectiveness and integrity of the remedial action.

a. The Owner shall not remove or alter the permanent markers required by the Remedial Action Plan.

b. The Owner shall restrict activities at the Property that may result in exposures above levels established in the RAP. The Owner shall prevent excavation activities on any portion of the Property as described in Attachment B except for activities associated with the maintenance of the remediation system conducted in compliance with the Health and Safety Plan contained in the RAP. All excavations shall be back-filled to original or better specifications within 30 days of initiating the excavation, unless a longer period is approved by the MDEQ. The portion of the Property that is within the areal extent of waste as described in Attachment C shall not be excavated without prior approval from MDEQ.

c. Wells shall not be installed on any portion of the Property as described in Attachment B for extracting groundwater for any purpose except environmental study, monitoring, or remediation; irrigation; or dewatering of excavations, provided that the installation and operation of such wells is in compliance with applicable federal, state and local laws and regulations.

d. Placement of structures on that portion of the Property within the areal extent of waste as described in Attachment C shall be prohibited, unless and until MDEQ reviews and approves of the design details of such structures. Structures on that portion of the Property that is not within the areal extent of waste as described in Attachment C shall be constructed in compliance with a methane mitigation plan approved by the MDEQ. Site plans shall be submitted to Macomb Township for review, approval, and issuance of building permits.

e. The Owner shall not alter, damage or otherwise interfere with the operations of the remediation systems including, but not limited to: groundwater collection and treatment systems, leachate collection and treatment systems, gas venting systems, and groundwater monitoring wells.

3. The Owner shall provide notice to the MDEQ of the Owner's intent to convey any interest in the Property 14 days prior to consummating the conveyance. A conveyance of title, an easement, or other interests in the Property shall not be consummated by the Owner without adequate and complete provision for compliance with the terms and conditions of the Restrictive Covenant.

4. The Owner shall grant to the MDEQ and its designated representatives the right to enter the Property at reasonable times for the purpose of determining and monitoring compliance with

the RAP, including the right to take samples, inspect the operation of the remedial action measure and inspect records relating to the remedial action.

5. The Owner shall grant to Petro Environmental Technologies, Inc. ("Petro"), or its successors and designees, the right to enter the Property at reasonable times for the purpose of constructing the remedy and performing operation and maintenance activities associated with the remedial action. Such activities may include, but not be limited to, monitoring, repairs to the cap, mowing the grass, and maintaining the fence, as needed.

6. For so long as Macomb Township allows Petro, SMDA, and/or their agents and/or successors to discharge into the Township's sewer system collected leachate and groundwater from the vicinity of Sites 9 and 9A, at a maximum discharge rate of 0.2 cubic feet per second, unless the discharge occurs during non-peak hours that can be monitored by the Township, no Deep Injection Well will be installed or utilized on the Property as part of the remediation of Sites 9 and 9A. See Order of October 11, 2001 entered in the Macomb County Circuit Court.

If surface or subsurface soils found on the Property are relocated, they must be managed in accordance with the requirements of Section 20120c of NREPA and other applicable state and federal laws.

The state may enforce the restrictions set forth in this Restrictive Covenant by legal action in a court of appropriate jurisdiction. Macomb Township may enforce the October 11, 2001 order referenced above in a court of appropriate jurisdiction.

This Restrictive Covenant shall run with the Property and shall be binding upon all future owners, successors, lessees or assigns and their authorized agents, employees, or persons acting under their direction and control, and shall continue until the MDEQ or its successor approves modifications or rescission of the Restrictive Covenant. A copy of this Restrictive Covenant shall be provided to all future owners, heirs, successors, lessees, agents and transferees by the person transferring the interest.

If any provision of the Restrictive Covenant is held to be invalid by any court of competent jurisdiction, the invalidity of such provision shall not affect the validity of any other provisions hereof. All such other provisions shall continue unimpaired in full force and effect.

The undersigned person executing this Restrictive Covenant is the Owner, or has the express written permission of the Owner, and represents and certifies that he or she is duly authorized and has been empowered to execute and deliver this Restrictive Covenant.

IN WITNESS WHEREOF, the said Owner of the above-described Property has caused this Restrictive Covenant to be executed on this ___ day of _____, 2002.

Owner's Signature: _____

Print or Type Owner's name and address: _____

_____

_____

Signed in the presence of: _____

Witness Signature: _____

(Print or Type name): _____

Witness Signature: _____

(Print or Type name): _____

STATE OF MICHIGAN)
)
COUNTY OF _____)

The foregoing instrument was acknowledged before me this ___ day of _____, 2002 by

_____, Owner.

_____
Notary Public

_____
(print or type name)

_____ County, Michigan

My Commission Expires: _____

DET02\125825.8
ID\WRS

PROPERTY OWNED BY MACOMB TOWNSHIP

Situated in the Township of Macomb, Macomb County, Michigan, described as:

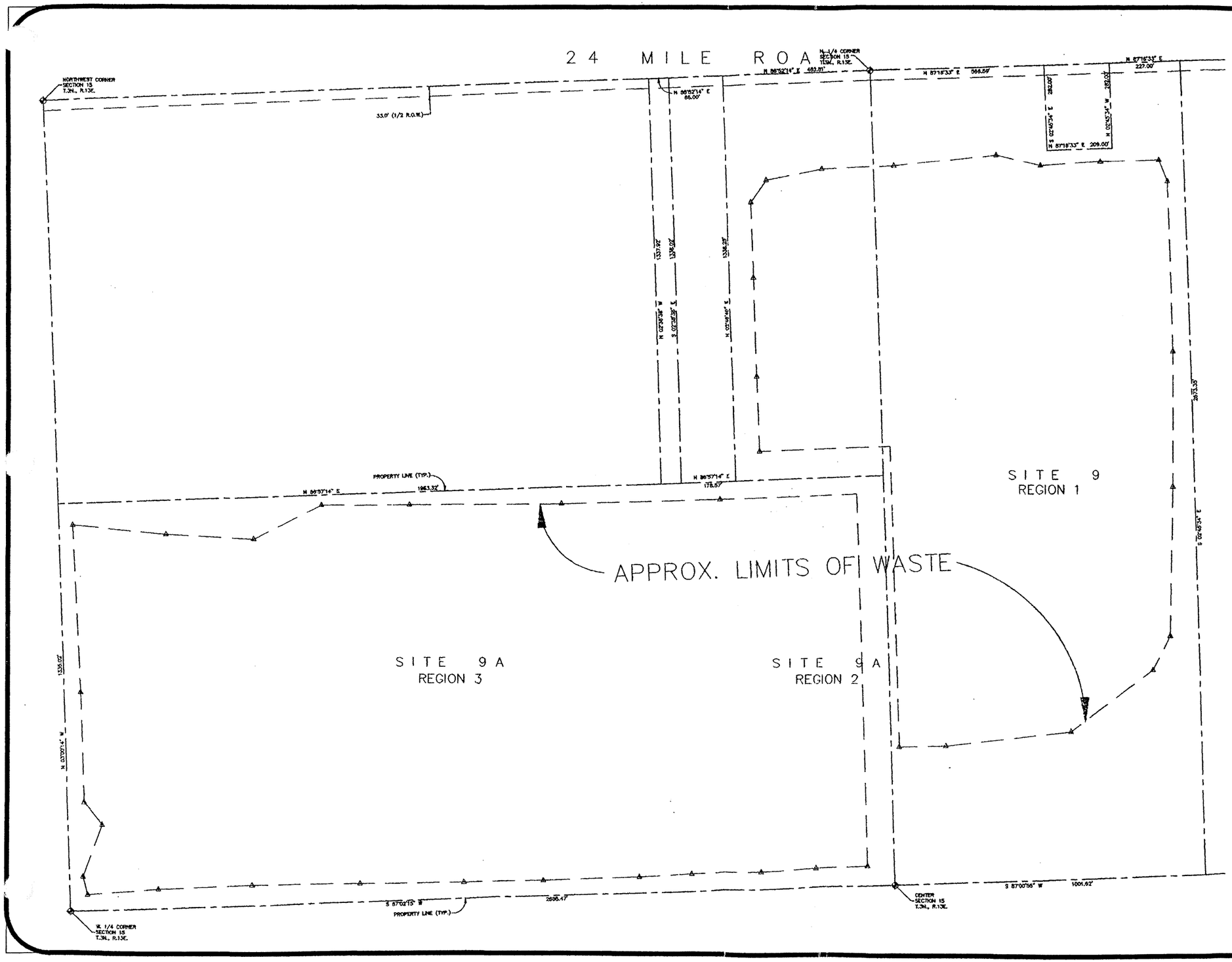
Parcel No. 20-08-15-100-012

T3N, R13E SEC 15 BEG AT THE N ¼ POST SEC 15; TH SO*28'W 1354.65 FT; TH N89*40'W 160.83 FT; TH NO*28'E 1353.72 FT; TH E 160.83 FT TO PT OF BEG. 5A

Parcel No. 20-08-15-200-002

T3N, R13E, SEC 15 W ¾ OF W ½ OF NE ¼ EXC PARCEL 209.6 FT E & W BY 282 FT N & S BEING 227 FT W OF NE COR. CONTAINING 58.25 A.

DET02\141447.1
ID\WRS



General Notes

PROPERTY LINE AND LIMITS OF WASTE SURVEY

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012

Date: MAY 2002

Scale: AS SHOWN

Sheet 1 OF 1

DECLARATION OF RESTRICTIVE COVENANT
FOR THE SITE 9A PROPERTY

MDEQ Reference No.: RC-ERD-01-002

This Restrictive Covenant has been recorded with the Macomb County Register of Deeds for the purpose of protecting public health, safety, and welfare and the environment.

South Macomb Disposal Authority ("SMDA") has submitted to the Michigan Department of Environmental Quality ("MDEQ") a Remedial Action Plan (RAP) that includes site specific land use-based cleanup criteria as allowed for in Section 20120a(2) of Part 201 of the Natural Resources and Environmental Protection Act ("NREPA"), 1994 PA 451, as amended, MCL 324.202101 et seq, for the environmental remediation associated with the property located in the Township of Macomb, County of Macomb ("Property") known as Site 9A and more particularly described as:

> Property Tax ID Number of Property: 20-08-15-100-013; 20-08-15-100-010; 20-08-15-100-011.
>
> See Attachment A for a legal description of the Property.
>
> See Attachment B for a survey of the Property that delineates the Property boundaries.
>
> See Attachment C for a survey that delineates the extent of waste.

As used herein, the term "Owner" shall mean at any given time the then current title holder of the Property.

NOW THEREFORE, SMDA, 20001 Pleasant, St. Clair Shores, Michigan, pursuant to Section 20120b(4) of NREPA and the Consent Decree dated [**date**] for Case No. 85-3838 CZ entered by and between SMDA and the MDEQ, hereby imposes restrictions on the Property and covenants and agrees that:

1. The Owner shall restrict the uses of the Property to no use (i.e., only activities associated with the maintenance of the remediation system for the closed landfill), golf course, or driving range. The Michigan Department of Environmental Quality ("MDEQ") has determined that the applicable exposure assumptions for the use of the Property are those assumptions utilized in the creation of the Commercial Subcategory IV cleanup criteria as described in MDEQ Operational Memorandum No. 18, dated June 7, 2000. Accordingly, the Owner shall prevent all use of the

Property except as described above. Other uses of the Property are possible only after a site-specific risk assessment for the proposed use is approved by the MDEQ.

2. The Owner shall restrict activities at the Property that may interfere with a remedial action, operation or maintenance, monitoring, or other measures necessary to assure the effectiveness and integrity of the remedial action.

a. The Owner shall maintain and not remove or alter the permanent markers required by the Remedial Action Plan.

b. The Owner shall restrict activities at the Property that may result in exposures above levels established in the RAP. The Owner shall prevent excavation activities on any portion of the Property as described in Attachment B except for activities associated with the maintenance of the remediation system conducted in compliance with the Health and Safety Plan contained in the RAP. All excavations shall be back-filled to original or better specifications within 30 days of initiating the excavation, unless a longer time is approved by the MDEQ. The portion of the Property that is within the areal extent of waste as described in Attachment C shall not be excavated without prior approval from MDEQ.

c. Wells shall not be installed on any portion of the Property as described in Attachment B for extracting groundwater for any purpose except environmental study, monitoring, or remediation; irrigation; or dewatering of excavations, provided that the installation and operation of such wells is in compliance with applicable federal, state and local laws and regulations.

d. Placement of structures on that portion of the Property within the areal extent of waste as described in Attachment C shall be prohibited, unless and until MDEQ reviews and approves of the design details of such structures. Structures on that portion of the Property that is not within the areal extent of waste as described in Attachment C shall be constructed in compliance with a methane mitigation plan approved by the MDEQ. Site plans shall be submitted to Macomb Township for review, approval, and issuance of building permits.

e. The owner shall not alter, damage or otherwise interfere with the operations of the remediation systems including, but not limited to: groundwater collection and treatment systems, leachate collection and treatment systems, gas venting systems, and groundwater monitoring wells.

3. The Owner shall provide notice to the MDEQ of the Owner's intent to convey any interest in the Property 14 days prior to consummating the conveyance. A conveyance of title, an easement, or other interests in the Property shall not be consummated by the Owner without adequate and complete provision for compliance with the terms and conditions of the Restrictive Covenant.

4. The Owner shall grant to the MDEQ and its designated representatives the right to enter the Property at reasonable times for the purpose of determining and monitoring compliance with the RAP, including the right to take samples, inspect the operation of the remedial action measure and inspect records relating to the remedial action.

5. The Owner shall grant to Petro Environmental Technologies, Inc. ("Petro"), or its successors and designees, the right to enter the Property at reasonable times for the purpose of constructing the remedy and performing operation and maintenance activities associated with the remedial action. Such activities may include, but not be limited to, monitoring, repairs to the cap, mowing the grass, and maintaining the fence, as needed.

6. For so long as Macomb Township allows Petro, SMDA, and/or their agents and/or successors to discharge into the Township's sewer system collected leachate and groundwater from the vicinity of Sites 9 and 9A, at a maximum discharge rate of 0.2 cubic feet per second, unless the discharge occurs during non-peak hours that can be monitored by the Township, no Deep Injection Well will be installed or utilized on the Property as part of the remediation of Sites 9 and 9A. See Order of October 11, 2001 entered in the Macomb County Circuit Court.

If surface or subsurface soils found on the Property are relocated, they must be managed in accordance with the requirements of Section 20120c of NREPA and other applicable state and federal laws.

The state may enforce the restrictions set forth in this Restrictive Covenant by legal action in a court of appropriate jurisdiction. Macomb Township may enforce the October 11, 2001 court order referenced above in a court of appropriate jurisdiction.

This Restrictive Covenant shall run with the Property and shall be binding upon all future owners, successors, lessees or assigns and their authorized agents, employees, or persons acting under their direction and control, and shall continue until the MDEQ or its successor approves modifications or rescission of the Restrictive Covenant. A copy of this Restrictive Covenant shall be provided to all future owners, heirs, successors, lessees, agents and transferees by the person transferring the interest.

If any provision of the Restrictive Covenant is held to be invalid by any court of competent jurisdiction, the invalidity of such provision shall not affect the validity of any other provisions hereof. All such other provisions shall continue unimpaired in full force and effect.

The undersigned person executing this Restrictive Covenant is the Owner, or has the express written permission of the Owner, and represents and certifies that he or she is duly authorized and has been empowered to execute and deliver this Restrictive Covenant.

IN WITNESS WHEREOF, the said Owner of the above-described Property has caused this Restrictive Covenant to be executed on this ___ day of _____, 2002.

Owner's Signature: _____

Print or Type Owner's name and address: _____

_____

_____

Signed in the presence of:

Witness Signature: _____

(Print or Type name): _____

Witness Signature: _____

(Print or Type name): _____

STATE OF MICHIGAN)
)
COUNTY OF _____)

The foregoing instrument was acknowledged before me this ___ day of _____, 2002 by

_____, Owner.

_____
Notary Public

_____
(print or type name)

_____ County, Michigan

My Commission Expires: _____

DET02\125825.7
ID\WRS

PROPERTY OWNED BY SMDA

Situated in the Township of Macomb, Macomb County, Michigan, described as:

Parcel No. 20-08-15-100-010

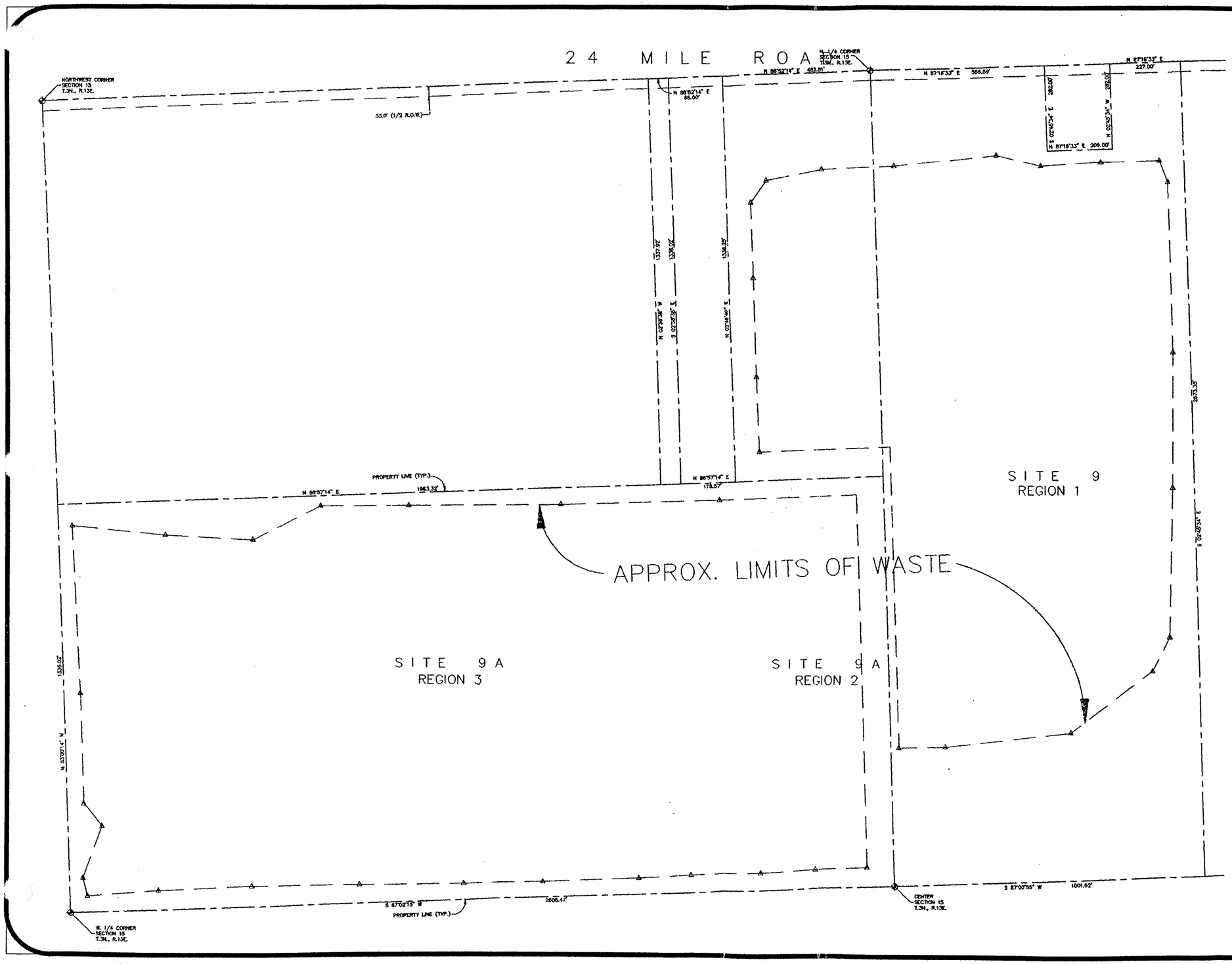
T3N, R13E SEC 15 COMM AT N ¼ POST SEC 15; TH W 321.77 FT TO PT OF BEG; TH SO*28'W 1352.89 FT; TH N89*40'W 161.04 FT; TH NO*28'E 1351.96 FT; TH E 161.04 FT TO PT OF BEG. 5A

Parcel No. 20-08-15-100-011

T3N, R13E SEC 15 COMM AT THE N ¼ POST SEC 15; TH W 160.83 FT TO PT OF BEG; TH SO*28'W 1353.72 FT; TH N89*40'W 160.94 FT; TH NO*28'E 1352.89 FT; TH E 160.94 FT TO PT OF BEG. 5A

Parcel No. 20-08-15-100-013

Town 3 north, range 13 east, section 15, south ½ of northwest ¼ of section 15 and west 33 feet of following: commencing at the north ¼ post of section 15; thence west 482.82 feet to the point of beginning; thence south 0 degrees 28 minutes west 1351.96 feet; thence north 89 degrees 40 minutes west 211.59 feet; thence north 0 degrees 15 minutes east 1350.82 feet; thence east 208.39 feet to the point of beginning; and east 33 feet of the following: Commencing at the north ¼ post of section 15; thence west 691.20 feet to the point of beginning; thence south 0 degrees 15 minutes west 1350.82 feet; thence north 89 degrees 40 minutes west 205.48 feet; thence north 0 degrees 23 minutes east 1349.56 feet; thence east 208.64 feet to the point of beginning, being Eschenburg Road, so called, 66 feet wide.



General Notes

PROPERTY LINE AND LIMITS OF WASTE SURVEY

No.	Revision/Issue	Date

Firm Name and Address

PETRO ENVIRONMENTAL TECHNOLOGIES, INC.
7851 PALACE DRIVE
CINCINNATI, OHIO 45249
(513)489-6789

Project Name and Address

MACOMB COUNTY LANDFILL
SITES 9 AND 9A
REMEDIAL ACTION PLAN
MACOMB, MICHIGAN

Project: COO-012

Date: MAY 2002

Scale: AS SHOWN

Sheet 1 OF 1

Appendix L
Landfill Gas Vent and Probe Plan

See rolled plan set for drawings.