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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

MAR 27 2015

CERTIFIED MAIL 7010 1060 0002 1703 8211
RETURN RECEIPT REQUESTED

Dr. James M. Chansler, P.E.
Director, DeKalb County Department
of Watershed Management
1580 Roadhaven Drive
Stone Mountain, Georgia 30083

Re: Approval of the Revised System-Wide Hydraulic Model Program
U.S. District Court Civil Action 1:10cv4039-WSD

Dear Dr. Chansler:

The U.S. Environmental Protection Agency Region 4 and the Georgia Environmental Protection Division have reviewed and hereby approve the revised System-Wide Hydraulic Model Program for DeKalb County submitted February 18, 2015, pursuant to Section VI.B.vii of the Consent Decree referenced above. DeKalb County shall implement the revised System-Wide Hydraulic Model Program in accordance with the schedule included in the submittal. In addition, DeKalb County shall certify the status of the implementation of the revised System-Wide Hydraulic Model Program, including its completion, in the Semi-Annual Report or Annual Report pursuant to Section IX of the subject Consent Decree.

Please contact Ms. Sara Janovitz at (404) 562-9870 or via email at janovitz.sara@epa.gov, if you have any questions.

Sincerely,

for Alexander Johnson

Maurice L. Horsey, IV, Chief
Municipal & Industrial Enforcement Section
NPDES Permitting and Enforcement Branch

cc: Mr. Hsin-Sheng Yeh
Georgia Environmental Protection Division

Ms. Marzieh Shahbazaz
Georgia Environmental Protection Division

Mr. Charles Lambert
DeKalb County

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System-Wide Hydraulic Model

Department of Watershed Management (DWM) Capacity, Management, Operations, and Maintenance (CMOM) Program

FEBRUARY 2015

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Acronyms

AWWTF	Advanced Wastewater Treatment Facility
CMOM	Capacity, Management, Operations, and Maintenance
CS	Collection Systems (InfoWorks™)
DWM	Department of Watershed Management
GIS	Geographical Information System
ID	Identification
IT	Information Technology
MG	Million gallons
MGD	Million gallons per day
NPDES	National Pollutant Discharge Elimination System
PARSARP	Priority Area Sewer Assessment and Rehabilitation Program
PSIG	Pounds per square inch gauge
QA/QC	Quality Assurance/Quality Control
RDI/I	Rainfall Derived Infiltration and Inflow
SSO	Sanitary Sewer Overflow
USEPA	United States Environmental Protection Agency
WCTS	Wastewater Collection and Transmission system
WRC	Water Reclamation Center

1. System-Wide Hydraulic Model Overview

1.1 Introduction

DeKalb County's (the County) wastewater collection and transmission system (WCTS) is divided into three (3) drainage basins consisting of thirty-five (35) sewersheds. The WCTS collects wastewater from thirty two (32) sewersheds with no sewer services in the remaining three (3) sewersheds. The majority of the wastewater generated in the northern part of the County, is collected and conveyed to the City of Atlanta R.M. Clayton Water Reclamation Center (WRC) for treatment. Wastewater in the southern part of the County is collected and treated at DWM's Snapfinger Creek Advanced Wastewater Treatment Facility (AWWTF) and the Pole Bridge Creek AWWTF. To date, mapping of the 32 sewersheds has been substantially completed under Capacity, Management, Operations, and Maintenance (CMOM) Sewer mapping Program. Refer to the DeKalb County CMOM *Sewer Mapping Program* for a more detailed description.

The County's Department of Watershed Management (DWM) is in the process of developing a computer-based dynamic hydraulic model (the Model) for the County's WCTS. The Model will integrate data from the sewer mapping program and the flow monitoring programs. The three (3) completed models of the Shoal Creek, Pole Bridge, and Cobb Fowler sewersheds have been updated to reflect the system updates from year 2012 to year 2014. These models will be combined into basin-wide models as described in Section 1.5.5.3.

1.2 Purpose and Goals

The Model will be used to determine the system capacity under dry weather and wet weather conditions and to enable the County to identify, characterize, and address hydraulic deficiencies. The purpose and goals of the System-Wide Hydraulic Model Program are to:

- Comply with capacity assurance requirements.
- Develop and maintain a functional tool that is used in the determination of whether adequate capacity exists for continued collection of wastewater for existing and future flows during dry and wet weather conditions.
- Assist the County in meeting level of service performance objectives expected by customers.
- Develop a tool that will help the County determine required capital and operational improvements.
- Provide a tool for assisting the County in the responding to and managing development and economic growth.

By modeling the system, an understanding of the hydraulic behavior of the WCTS will assist DWM in making informed decisions concerning strategic planning and capital improvements required to meet the performance goals of the County and environmental regulations.

1.3 Regulatory Drivers

The County DWM System-Wide Hydraulic Model is a program that incorporates criteria that are set forth in the Consent Decree – DeKalb County, Civil Action File No. 1:10-cv-4039-WSD. In addition, various guidance documents and materials were consulted in the formulation of the Program, such as the following:

- U.S. Environmental Protection Agency (USEPA) *Guide for Evaluating Capacity, Management, Operations, and Maintenance (CMOM) Programs at Sanitary Sewer Collection Systems*, 2005; and USEPA *Region 4 Guide to Collection and Transmission System Management, Operation, and Maintenance Programs*, 2003.
- Georgia Association of Water Professionals and Georgia Water Environment Federation, *Guidance for the Georgia Environmental Protection Division (GAEPD) Zero Tolerance Strategy entitled Capacity, Management, Operations, and Maintenance Consent Agreement Guidance*, 2006.
- Metropolitan North Georgia Water Planning District *Wastewater Management Plan*, 2009.
- Code of DeKalb County, as Revised 1988; Ordinance Number 35, Article IV, Number 25 – Sewers and Sewage Disposal, Division 2, Sewer Construction and Assessments and Division 3, Building Sewers and Connections.
- DWM *Potable Water Main, Gravity Sanitary Sewer, and Sanitary Sewer and Force Main Design Standards* (2009 Edition Version 1.0).
- DWM National Pollutant Discharge Elimination Systems (NPDES) permits for Pole Bridge AWWTF (NPDES - GA0026816) and Snapfinger AWWTF (NPDES - GA0024147).

1.4 Resources

The Sanitary Sewer System Hydraulic Model is supported by the current staff in the DWM. The resources listed below represent the staff and software currently used by the County and could change to meet the County's needs or other requirements.

Current DWM Staff and Resources

- Assistant Director of Department of Watershed Management
- Program Manager Team
- Engineer Principal / Hydraulic Modeler
- 4 full licenses of InfoMaster™
- 3 full licenses InfoWorks™ Collection System (CS)
- ESRI® ArcGIS® Licenses

Additional Resources

- Engineers trained with InfoMaster™ and InfoWorksCS™
- Continuous training for key staff in modeling software

Information Technology (IT) staff to support the modeling software maintenance and database management

1.5 Activities

1.5.1 Overview

The Model establishes a viable and effective computerized sanitary sewer capacity certification and planning process. Among other things, this will enable the County to predict the impacts of peak flows on the WCTS and treatment facility infrastructure. As such, the program document includes the following components:

- Description of the software that the County is using to develop the model.
- Description of database management.
- Type and source of data for model setup and calibration, including survey and mapping data, Geographical Information System (GIS) data, record drawings, sewer system maps, flow and rainfall monitoring data, and sewer inspection records.
- Approach and criteria that the County is using to uniformly develop and calibrate basin models.
- System Capacity Assessment -

The following components comprise the DWM System-Wide Hydraulic Model:

- Hydraulic Modeling Software
- Database Management
- Data Source for Model Setup and Calibration
- Approach and Guidelines of Model Development and Calibration
- System Capacity Assessment
- Capacity Assurance Program
- Model Maintenance

description of how the model will be used to assess the system capacity availability and constraints, system improvement and upgrade needs.

- Capacity Assurance Program - to set forth definitions and parameters for determining the adequacy of collection, transmission, and treatment capacity for additional flow from existing connections and future connections, and establish regulations of permitting additional flow to WCTS.
- Model Maintenance to keep system model routinely updated and calibrated based on the sewer system improvements and future flow conditions.

1.5.2 Description of Hydraulic Modeling Software

A hydraulic model is a mathematical model of a fluid introduced into a water/wastewater sewer/storm sewer system at various rates and pressures. It is used to analyze system hydraulic behavior under variable conditions. In general, commercial sewer modeling software is developed with a graphical user interface that allows ease of data input and extraction. In addition, data output can be accomplished by means of both tabular and graphical output.

InfoWorks™ CS is a computer model with a graphic interface to GIS that is used for the modeling of the WCTS. InfoWorks™ CS is a Relational Database platform that utilizes an asset/database management system for the sanitary sewer system. This relational database is combined with geographical analysis to provide a single environment that integrates asset planning with hydraulic modeling in InfoWorks™ CS. The software also incorporates full solution modeling of backwater effects and reverse flow, open channels, trunk sewers, complex pipe connections, and complex ancillary structures.

InfoWorks™ is an infrastructure management system for water distribution, wastewater collection, and storm water networks. InfoWorks™ is built upon ArcMap GIS, the County's current GIS software, therefore, the County will have most of the benefits of InfoNet without having two separate spatial data sets (one set in InfoNet and one in ArcMap) and InfoMaster offers sophisticated planning tools to help define and manage CIP projects and rehabilitation projects.

1.5.3 Database Management

DWM has designated a server for the hydraulic model database. InfoWorks™ CS is the database platform for the sewer system model. ESRI® ArcGIS® and InfoMaster™ are used for mapping data management and inventory. Telog Enterprise and Flowlink are used for flow and rainfall database management.

Each database is maintained internally with the assistance of the DWM Information Technology (IT) team.

1.5.4 Data Source for Model Setup and Calibration

DWM is developing the components required to establish a viable and effective system-wide hydraulic model. The main components are: infrastructure data, hydrologic flow data and operational data.

1.5.4.1 Infrastructure Data

The source for the infrastructure data for the model network included the Sanitary Sewer System Mapping Program, the GIS database, InfoMaster™ system inventory, record drawings, sewer system maps, and inspection records.

The on-going drainage sewershed mapping and inventory activities provide the sewer system data needed to support the modeling efforts. Currently each of the 32 sewered sewersheds have been substantially mapped and inventoried. The program involves field location, verification, and surveys of the sanitary sewer manholes, lift stations, and associated infrastructure to create an accurate and comprehensive sanitary sewer system map. Most systems have asset that remain difficult to locate or confirm because, for example, manholes have been buried or modified without the utility's knowledge. The *Sewer Mapping Program* document contains more specific information about the sewer mapping program and sewer system.

The County GIS system is a computer-based system used for geographic data creation, maintenance, storage, analysis, and mapping. The system is being implemented by the Engineering and Technical Services Division.

Modelers will check the data accuracy and format before commencing modeling input from GIS and InfoMaster™. For compatibility between GIS and modeling software, modelers will ensure the nodes and links are imported from GIS to modeling software properly.

1.5.4.2 Hydrologic Flow Data

The source for the hydrologic flow data includes:

- DeKalb County CMOM *System-Wide Flow and Rainfall Monitoring Program*. The flow and rainfall data will be used to determine the wastewater flow and pattern and groundwater infiltration, as well as model calibrations.
- DeKalb County Water Consumption Records for determining the accurate wastewater rates from residential, commercial, and industrial users.
- Flow data from wastewater treatment facilities and lift stations.
- Most recent census data from Census Bureau to estimate the wastewater flow rate.
- Most recent land use map to determine the characteristics of wastewater flow (residential/commercial/industrial).

Under the County's comprehensive flow monitoring program, DWM currently has fifteen (15) billing meters and two hundred (200) flow monitors including one hundred and six (106) existing flow monitors and ninety five (94) newly installed flow monitors in 2014. Temporary flow monitors will be installed based on ongoing hydraulic modeling needs. There are also currently thirty-four (34) rain gauges installed including seventeen (17) existing rain gauges and seventeen (17) newly installed rain gauges in 2014. DWM also maintains billing and flow monitoring data since 2008. This data will be used in the hydraulic model data input and calibration. Refer to the DeKalb County CMOM *System-Wide Flow and Rainfall Monitoring Program*.

1.5.4.3 Operational Data

Operational data from wastewater treatment facilities and lift stations, such as pump switch on and off levels in the wet well, pump design and operating flow rates, will be used for the model setup.

1.5.5 Approach and Guidelines of Model Development and Calibration

The approach and guidelines of model development and calibration include:

- Approach and guidelines of model development.
- Guidelines of model Quality Assurance/Quality Control (QA/QC)
- Guidelines of model calibration and verification

1.5.5.1 Approach and Guidelines of Model Development

The County is implementing a phased model development strategy based on the three hydrological sewer basins; Snapfinger, Pole Bridge, and Intergovernmental and capacity assessment by using the peak flow factor selected from actual monitored storm events in early 2015. This strategy is in tandem with the DeKalb County CMOM *Sewer Mapping Program*. A key result of implementing this strategy is that it will better meet the intent of the Priority Area Sewer Assessment and Rehabilitation Program (PASARP) by allowing the basin wide model sewer network to be built and assessed more quickly in order to identify the sewer segments with capacity concerns to allow expeditious integration with observed significant sewer structural deficiencies. This approach is appropriate since historical data such as that provided in the PASARP document indicates the County does not have a serious system-wide capacity issue. The quicker integration of capacity and structural information means the County can advance the system improvements using the principals embodied in System Capacity Assessment and Capacity Assurance as discuss in the sections below.

The County has started model development based on sewer mapping's progress and the availability of verified data. Standardized protocols are important to build a basin-wide model from the individual sewersheds. They will include a plan to implement a common platform to create the hydraulic model and to facilitate updates to the model as system changes occur. The model input, data format, server and database platforms, network construction protocols, file transfer and verification procedures, as well as workstation computer configurations will be standardized to ensure the accuracy, efficiency, and uniformity of integration for a system-wide hydraulic model.

The standard approach and guidelines will include but not limited to the followings:

- Software version
- Model file naming convention
- Model data source flag naming convention
- Model node, link, and pump identification (ID) naming convention
- Dry weather period selection
- Dry weather flow and diurnal pattern development
- Groundwater infiltration development
- Dry weather calibration standards
- Node assignment for sub-catchments

- Sub-catchment naming convention
- Runoff routing and volume method selection
- Wet weather events selection
- Wet weather event calibration standards
- Model verification
- Model output and report
- Model sensitivity analysis for input parameters and variables
- Model integration
- Model maintenance and update

The methodology selection, assumptions, design and operational criteria, and limitations of the model will be documented.

1.5.5.2 Guidelines of Model QA/QC

The following QA/QC will be performed to ensure the model accuracy and quality:

- Check model for data discrepancies with GIS
- Check convention discrepancies within model [e.g., ID prefix, scenario naming convention]
- Check pattern multipliers
- Check shutoff head on pump curve
- Check maximum flow on pump curve
- Check if pipe auto-length option is on or off
- Check network connectivity and identify potential issues:
- Orphan nodes and pipes
- Parallel pipes
- Pipe crossing without connecting
- Nodes in close proximity
- Check for redundant and complex controls (programmable logic controller, controls, and initial status)
- Check pump curve matches the latest pump test
- Check prefixes that are used to label components
- Check named view and bookmarks are added for key components
- Check level data are always relative to system datum
- Check pump status switch on / off level, switch on level must be greater than the switch-off level
- Check flap valve, orifice/sluice gate, weir or other user-defined control settings

- Check Hazen Williams coefficients are used consistently with the selected calculation model
- Check Manning coefficients are used for gravity mains
- Check headloss type and coefficients properly set for pipes

1.5.5.3 Guidelines of Model Calibration and Verification

Model calibration is the process of adjusting model parameters so that the model output matches the measured sewer flow for the same time period. Model calibration is achieved by providing the model with known hydrologic and hydraulic parameters at several input locations and comparing the simulated flows at one or more discharge locations with those measured in the field at the same location. For each calibration point, the percentage variance, predicted and observed dry- and wet-weather hydrographs, and calibration parameters are presented.

Calibration points include available monitored points, including the fifteen billing meters and flow monitors. The DWM local rain gauges, U.S. Geological Survey rain gauges, and other available official rain gauges will be used to account for rainfall spatial variation impact on the model calibration.

The model is calibrated for both dry-weather and wet-weather flow conditions based on the flow rate and volume, depth, and shape of the hydrograph defined under the model development guidelines. Selected rainstorm events will be used for the wet-weather calibration.

There are different runoff rate model solutions in InfoWorks™ CS to simulate Rainfall Derived Infiltration and Inflow (RDI/I) rate and volume, the runoff rate model best fit for DeKalb County WCTS is selected. The ground infiltration model can be used for long-term simulation to account for the inter-event impacts and different soil conditions; however, the degree of significance of impact from groundwater infiltration at different sewersheds and sub-catchments will be analyzed using long term flow monitoring data to determine if the groundwater infiltration model is needed.

The sensitivity analysis will also be performed to determine the response of model to the changes of input parameters and variables following the protocols established under this program.

The calibrated hydraulic model is also verified with actual system data including flow monitoring data, DWM operations and maintenance records and data including basement backup complaints, records of sanitary sewer overflows (SSOs), maintenance records, and interviews with DWM staff to match the model results.

The model calibration report will include:

- Documentation of survey and mapping data, GIS data, record drawings, and sewer system maps used for model construction
- Development of wastewater flow and groundwater infiltration incorporated into the model

- Dry weather period section for dry weather calibration and storm events selection for the wet weather calibrations
- Selection of methods and parameters
- Assumptions
- Model limitations
- Summary of flow rate and volume, depth from model versus monitoring data
- Hydrographs of dry and wet weather calibration results
- Summary of the results

The separate sewersheds will be integrated into basin -wide hydraulic models for the Snapfinger and Pole Bridge basins. The Intergovernmental Basin diverts sewershed flows for the most part into the City of Atlanta, Fulton County, and Gwinnett County; therefore, in the Intergovernmental Basin the hydraulic models will remain at the sewershed basis. The final models will be checked for such things as connectivity, duplication of nodes, and flow inputs. The models will be calibrated using system-wide flow data from flow monitoring sites, billing meter sites, lift stations, and treatment plants, to represent the impact from wastewater treatment facilities and main interceptors. The models will also be checked for the performance of sensitivity analysis and verified through "reality check" with operation and maintenance records.

1.5.6 System Capacity Assessment

The hydraulic model is a tool used to determine the adequacy of the WCTS and treatment capacity and to ensure sustainable wastewater services are provided by DeKalb County. The sewer models will assure sufficient capacity for present needs and anticipated future growth. Development and maintenance of a model is essential to performing a capacity assessment of the problem areas where capacity related issues are identified (such as overflows or hydraulic overload at treatment facilities).

As described in Section 1.5.5.1, an early assessment will be made by the County using the hydraulic model and the peak flow from selected storm events. Subsequently, once the model is calibrated and verified using the selected monitored storm events, the model will be available as needed to simulate baseline (current) and alternative (future) conditions, as well as long-term simulations using historical flow data or data collected after system rehabilitation has progressed to further predict the capacities of major sewer section, force mains, likelihood and location of SSOs, and available capacity in sanitary sewers for future flow, and provide additional recommendations for sewer rehabilitation and requirements of relief sewer lines.

1.5.6.1 Baseline and Alternative Runs, Long-Term Simulations for Capacity Assessment Using Calibrated Wet Weather Flow Projections

There are various model simulation scenarios that are typically run such as current flows (baseline), future 5, 10, 15, and 20 years flows, ultimate development flows, and failure analysis of critical infrastructure or historical long-term or event storms. The County will

use these or other wet weather conditions to find a design condition that presents the most feasible combination of capacity enhancement alternatives.

1.5.6.2 Model Input and Simulations

Under baseline, alternative, and failure analysis of critical infrastructure /historical long-term simulation, the model will be setup to incorporate the specific scenario conditions including:

- Selected rainfall events / historical long-term rainfall data for failure analysis
- Wastewater flow input under the current conditions and future condition (5-, 10-, 15-, and 20-year projections) based on the population changes and development plan
- Wastewater pattern change for future conditions due to future development changes
- Any infrastructure changes and updates under the alternative conditions
- Runoff parameters impacted by future development
- Current and proposed future wastewater treatment facility and lift station operational conditions

The model will be simulated for each scenario conditions based on the time period of dry weather condition, selected rainfall events or historical long-term periods.

1.5.6.3 System Assessment Based on Model Simulation Output

Under each model simulation, the following model outputs will be obtained for system assessment, including:

- The cumulative flow [in million gallons (MG)] and maximum flow [in million gallons per day (MGD)] will be used to predict the volume and peak flow for force mains and the major gravity sewer lines during the dry weather and wet weather conditions.
- The surcharge state will be used to identify the locations of surcharging and backups, as well as likelihood of capacity related SSOs where
  - Surcharge state < 1, pipe is not surcharged;
  - Surcharge state = 1, surcharged at upstream and/or downstream end of the pipe, indicating surcharge is caused by downstream hydraulic constrain and backup;
  - Surcharge state = 2, surcharged at upstream and/or downstream end of the pipe, indicating the surcharge and hydraulic constrain at this pipe section due to flow exceeds its capacity;
- The Flood Volume Lost (MG) will be used to predict the locations and volume of capacity related SSOs.
- The maximum flow depth (feet) and maximum flow (MGD) will be used to predict the hydraulic pressure [pounds per square inch gauge (psig)] and flow capacity at any point in force mains throughout the WCTS.

- The model will incorporate the flow capacity of each lift station throughout the County's WCTS, based on the design conditions and drawdown tests, to predict the peak flows during the wet weather and dry weather conditions.
- The model will incorporate proposed developments to predict the flow regime of those portions of the WCTS that will be receiving flows.

Based on the model output, the WCTS system will be assessed for the following:

- Sewer system improvements such as rehabilitation and relief sewer to reduce RDI/I and remove the hydraulic constraints which are the causes of back-ups /surcharges and SSOs
- Improvements for lift stations and force mains
- Improvements needed for treatment facilities
- Determination of the limits for additional flows from existing connections and proposed future developments
- Improvements on system maintenance and operations

1.5.7 Capacity Assurance Program

The model also serves as a planning tool that assists the County in deciding how a treatment facility's remaining flow capacity could be used and whether an equipment or infrastructure upgrade is necessary to assure future treatment capacity. This approach also prioritizes sewer pipe and lift station upgrades to increase sanitary sewer system capacity during wet weather conditions. The hydraulic model addresses both structural upgrades and infiltration/inflow reduction.

In addition, increasing flows from existing sewer service connections and proposed new development will need to be reviewed and authorized to ensure the system will not be overloaded to cause the system to surcharge and backup, and have SSOs. The Capacity Assurance Program includes:

- A priority list for the sewer sections requiring rehabilitation and improvement for RDI/I reductions and removal of hydraulic constraints.
- A list of lift stations /treatment facility upgraded needs.
- Specific definitions and parameters to determine the adequacy of collection, transmission and treatment capacities.
- Standard procedures for using the model to determine the adequate capacity throughout the collection, transmission and treatment system prior to permit increases of wastewater flows from existing sewer service connections and from proposed new development.
- A certification of adequate collection, transmission, and treatment capacity performed by a Professional Engineer registered in the State of Georgia, and accepted by the County (where the records of certification and data will be maintained by the County).

- Regulation of issuing permits for new sewer service connections or increase in flow from existing sewer service connections. The permit shall only be issued based on the certification of sufficient capacity of collect, transmit and the treat the flows without causing any hydraulic surcharge and SSOs.

1.5.8 Model Maintenance

The WCTS is continually upgrading and changing. The future accuracy of the hydraulic model will depend on regular updating, maintenance and even re-calibration to reflect physical changes in the network and the changed flow characteristics of service connections.

Once the construction of new connections or any other physical changes to the system are completed, tested, accepted, and the County receives as-built drawings, the sewer system maps are first updated on an ongoing basis in GIS. The model will then be updated regularly to incorporate all those GIS changes.

The County has designated resources to maintain and update the model to incorporate all updates and changes to the system, and recalibrate the model using contemporaneous flow monitoring data.

2. Model Implementation

2.1 Schedule and Enhancement

Hydraulic Model Milestone Schedule

Activity	2012	2013	2014	2015/2016	2016/2017
Mapping Program	Outline requirements to complete the remaining 11 sewersheds	Complete work on 3 sewersheds	Complete work on the remaining 8 sewersheds		
Hydraulic Modeling Program		Modeling activity starts	On-going hydraulic modeling	Completion of calibrated dry weather flow models and peak flow runs for the three basins	Completion of calibrated wet weather flow models. Models available to start Capacity Assessment and Capacity Assurance

3. Program Procedures

DWM Procedures for the System-Wide Hydraulic Model have been developed to document a process by which DWM conducts its implementation.

Basin-Wide Hydraulic Model procedures are provided in this section and include:

- Hydraulic Model Management
- Network Model List of Inputs

3.1 Hydraulic Model Management

Effective model management is essential to the success of modeling for planning, decision support, and operation. Standard procedures of model management including formal systems and rules were initially developed during the design of the individual models for the three completed sewersheds (Shoal Creek, Pole-Bridge, and Cobb Fowler) to assist the basin-wide model development for Intergovernmental, Snapfinger, and Pole-Bridge basins. Those procedures are being continuously updated and will be codified by the end of 2017 based on the revised model development schedule shown in Section 2.1. The updated procedures will reflect the latest updates of DWM CMOM program and enhance the future model maintenance procedures with the updated DWM information management systems. The formal systems and rules are listed below and will be followed for proper management of the model:

1. A model manager will be in charge to ensure the integrity of the hydraulic model and data for DWM. The basin-wide models will be managed by modelers of DWM and external consultants. Agreement and rules for access to data files, outputs, data updates, cost of service and intellectual property will be developed upon the basin-wide models completion.
2. Only one master model will be used. This is a read only file that is available to users to view.
3. Formal systems are set up to ensure that the master model is up to date and that it reflects reality and system updates (e.g., new infrastructure, revised zonal boundaries). Once the construction of new connections or any other physical changes to the system are completed, tested, accepted, and the County receives as-built drawings, the sewer system maps are first updated on an ongoing basis in GIS. The model will then be updated quarterly to incorporate all those GIS changes. Procedures will be included in the DWM model development protocol to enhance future model maintenance.
4. Formal systems are developed to ensure efficient and reliable data transfer to and from other service provider information systems like GIS. The initial development for three completed sewersheds included the format for model data input such as GIS mapping and asset inventory data, flow and rainfall monitoring data, model data source flag naming convention, etc. This system of rules is being continuously updated during the model development based on the revised schedule shown in Section 2.1.
5. Records of the source and quality of each model component are kept. Notes on the context of the model are maintained.
6. Each model has an audit trail on how the model was built to provide some assurance on the quality of the model.
7. Processes are in place to ensure that tedious, repetitive tasks can be automated, or at least minimized. This allows modelers to allocate more time to the analysis of network performance. The initial developed rules for three completed sewersheds included mode file naming convention, model data source flag naming convention, model node, link, and pump ID naming convention, etc. For example, the data sources other than default in InfoWorks™ CS were added (such as AB represents As-Built Drawings, FM represents Flow Monitoring Data, and GI represents GIS data, etc.). Modelers could just select the corresponding data source from "drop-

down" window under data sources. This will ensure that tedious and repetitive tasks will be automated.

8. Operational as well as Engineering and Technical Services Division staff have ownership of the model.

3.2 Network Model List of Inputs

A network model requires a wide range of inputs. Inputs for Network modeling are listed in table below:

	Sewerage
Mains	• Pipe diameter (nominal) • Length • Material/class • Location • Invert levels • Sedimentation Depth if applicable • Pipe diameter (internal) • Number of connections • Age • Friction factors • Grade (pipe & manhole)
Maintenance Holes	Location, invert levels, ground levels
Overflow Structures	Location, invert levels, ground levels, operating levels, diameter, volume outfall location
Valves	• Type • Diameter • Location • Operational control settings if applicable
Pumps	• Location • Type • System head curves including power & efficiency • Performance testing/monitoring data (e.g. flows, suction and discharge pressure, drawdown tests, operating periods) • Operational control settings (e.g.. for pump control valves and variable frequency drives)
Wet/Dry Wells	• Location • Volume, area • Ground level, invert levels • Operation levels
Treatment Plants	• Location • Operating levels • Capacity
Spatial Data	• Land Use Plans • Priority Infrastructure Plan • Contour Plans • Infrastructure data for model input