CHAPTER 2: SYSTEM CHARACTERIZATION

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SUPPORTING INFORMATION

CHAPTER 2: SYSTEM CHARACTERIZATION

2.1 SYSTEM CHARACTERIZATION OBJECTIVES

Objectives of system characterization within the context of the Final Sanitary Sewer Discharge Plan (SSDP) include:

- Calibrating and validating the hydraulic models.
- Identifying and verifying system deficiencies and problem areas, including sanitary sewer overflows (SSOs), by analysis of assembled data using validated hydraulic models.

The objectives are met by collecting system data and developing hydraulic models that are consistent with the data that represent Louisville and Jefferson County Metropolitan Sewer District (MSD)'s separate sanitary sewer system (SSS). This chapter serves as a framework for solution development to eliminate known or suspected capacity-related SSOs, within the established level of protection.

2.2 EXISTING SSDP DATA

This section of the Final SSDP provides compilation and evaluation of data from three key areas:

- Existing Water Quality Treatment Center (WQTC) service areas and existing WQTC capacity evaluations.
- Existing collection systems, primarily gravity sewers and pump stations.
- Flow Monitoring and associated rain gauge network.

These compilations are focused on building representative hydraulic models and in determining collection system deficiencies.

2.2.1 WQTC Service Areas

This section provides a background summary of each of the six WQTC regional service areas as well as a number of small WQTCs that make up MSD's sewer service area. Table 2.2.1 includes information on service area size, design capacities, dates of construction, and lengths and diameters of sewers.

While MSD has built the regional treatment facilities and the required interceptors to treat and convey flow in each service area, much of the collection system was built by other communities or by private developers. When MSD acquired these systems beginning in the 1960s, it also acquired the system deficiencies and operations and maintenance (O&M) concerns, many of which are the root cause of current SSOs.

TABLE 2.2.1

WATER QUALITY TREATMENT CENTER (WQTC) CHARACTERISTICS

WQTC	Sub-Service Area	KPDES Permit Number	Year Built	Year Acquired by MSD	Design Capacity	Discharge To	Sanitary Sewer Pipe in Collection System (mi)	Pipe Size Range	Most Common Pipe Materials	Sanitary Pump / Lift Stations	Scheduled WQTC Diversion Date	Expected Receiving WQTC
Cedar Creek	--	KY0098540	1995	1995	7.5 MGD	Cedar Creek	125	8"-36"	VCP, PVC	28	N/A	N/A
Hite Creek	--	KY0022420	1970	1970	6.0 MGD	Hite Creek	120	8"-27"	PVC	35	N/A	N/A
Floyds Fork	--	KY0102784	2001	2001	3.25 MGD	Floyds Fork	98	8"-54"	VCP, PVC	20	N/A	N/A
Jeffersontown	--	KY0025194	1956	1990	4.0 MGD	Chenoweth Run	112	8"-36"	VCP, PVC	27	2015	To be Determined
Morris Forman	--	KY0022411	1958	1958	120 MGD	Ohio River	1,000	8"-72"	VCP, RCP, PVC	118	N/A	N/A
--	Middle Fork	N/A	N/A	N/A	N/A	--	348	8"-53"	VCP, RCP, PVC	19	N/A	N/A
--	Beechwood Village	N/A	N/A	N/A	N/A	--	6.8	8"-10"	VCP	--	N/A	N/A
--	Ohio River Force Main / Muddy Fork	N/A	N/A	N/A	N/A	--	185	8"-48"	VCP, PVC	30	N/A	N/A
--	Hikes Point / Highgate Springs PS	N/A	N/	N/A	N/A	--	100	8"-36"	VCP	3	N/A	N/A
--	Buechel Branch	N/A	N/A	N/A	N/A	--	57	8"-36"	VCP	--	N/A	N/A
--	Northern Ditch	N/A	N/A	N/A	N/A	--	130	8"-72"	VCP	6	N/A	N/A
Derek R. Guthrie	--	KY0078956	1986	1986	30 MGD	Ohio River	852	8"-120"	VCP, PVC	68	N/A	N/A
--	Pond Creek	N/A	N/A	N/A	N/A	--	495	8"-120"	VCP, PVC	40	N/A	N/A
--	McNeely Lake	N/A	N/A	N/A	N/A	--	31	8"-24"	VCP, PVC	6	N/A	N/A
--	Mill Creek	N/A	N/A	N/A	N/A	--	309	8"-78"	VCP, PVC	20	N/A	N/A
--	Valley Village	N/A	N/A	N/A	N/A	--	17	8"-27"	VCP, PVC	2	N/A	N/A
Hunting Creek North	--	KY0029106	1964	1999	0.358 MGD	Harrods Creek	14	8"-15"	VCP, PVC	10	2015	HC WQTC

TABLE 2.2.1

WATER QUALITY TREATMENT CENTER (WQTC) CHARACTERISTICS

WQTC	Sub-Service Area	KPDES Permit Number	Year Built	Year Acquired by MSD	Design Capacity	Discharge To	Sanitary Sewer Pipe in Collection System (mi)	Pipe Size Range	Most Common Pipe Materials	Sanitary Pump / Lift Stations	Scheduled WQTC Diversion Date	Expected Receiving WQTC
Hunting Creek South	--	KY0029114	1968	1999	0.251 MGD	Harrods Creek	11	8"-10"	VCP, PVC	8	2015	HC WQTC
Ken Carla	--	KY0022497	1968	1997	0.010 MGD	Harrods Creek	0.5	8"	VCP	1	2015	HC WQTC
Shadow Wood	--	KY0031810	1979	2008	0.085 MGD	Harrods Creek	2.0	8"-10"	PVC	3	2015	HC WQTC
Timberlake	--	KY0043087	1973	1999	0.200 MGD	Harrods Creek	6.0	8"-10"	PVC	11	2015	HC WQTC
Berrytown	--	KY0036501	1975	1995	0.075 MGD	Floyds Fork	5.9	8"-12"	VCP, PVC	5	2011	FF WQTC
Chenoweth Hills	--	KY0029459	1972	1990	0.200 MGD	Chenoweth Run	6.4	8"-12"	VCP, PVC	2	2015	To be Determined
Silver Heights	--	KY0028801	1963	1990	0.500 MGD	Mud Creek	6.8	8"-15"	VCP	1	Beyond 2014	DRG WQTC
Bancroft	--	KY0039021	1966	1998	0.080 MGD	Goose Creek	3.0	8"-15"	VCP	--	Beyond 2014	MF WQTC
Glenview Bluff	--	KY0044261	1976	1976	0.010 MGD	--	0.3	8"	VCP, PVC	--	Beyond 2014	MF WQTC
Lake Forest	--	KY0042226	1988	2005	0.470 MGD	Chenoweth Run	22	8"-18"	VCP, PVC	6	2011	FF WQTC
Lake of the Woods	--	KY0044342	1976	1989	0.044 MGD	Chenoweth Run	1.0	8"	VCP, PVC	1	Beyond 2014	To be Determined
McNeely Lake	--	KY0029416	1964	1986	0.205 MGD	Pennsylvania Run	4.0	8"-12"	VCP	4	Beyond 2014	DRG WQTC
Starview	--	KY0031712	1971	1988	0.100 MGD	Chenoweth Run	2.4	8"-10"	VCP, PVC	1	2011	FF WQTC
Yorktown	--	KY0036323	1968	1991	0.150 MGD	Northern Ditch	2.9	8"-15"	VCP, PVC	1	2010	DRG WQTC

Legend: KPDES – Kentucky Pollutant Discharge Elimination System, MGD - million gallons per day, VCP – vitrified clay pipe, RCP - reinforced concrete pipe, PVC - polyvinyl chloride

WQTC: HC – Hite Creek, FF - Floyds Fork, DRG - Derek R. Guthrie, MF - Morris Forman

2.2.1.1 Cedar Creek

The Cedar Creek WQTC was constructed in 1995 by MSD to provide service to one of the fastest growing areas of Jefferson County. The new facility facilitated the elimination of nine small treatment plants and numerous septic systems. The plant was expanded in 2003 to its present design capacity of 7.5 million gallons per day (mgd). The Cedar Creek WQTC is located near Bardstown and Cedar Creek Roads in Southern Jefferson County. The landuse consists primarily of single-family residential with a small amount of multi-family, commercial, industrial, and vacant or undeveloped land. Refer to Exhibit 2.2.1 in Appendix 2.2.1, Pipe Material, 100-year Floodplain, and Non-conforming Slopes Maps, for a map of the Cedar Creek service area.

2.2.1.2 Floyds Fork

Construction of the Floyds Fork WQTC was completed in 2001 with a design capacity of 3.25 mgd to provide service to a fast growing area of Jefferson County. It also eliminated several small treatment plants and off-loaded some areas that were previously directed to the Jeffersontown WQTC. The Floyds Fork WQTC is located at the end of Blue Heron Road off Shelbyville Road in Eastern Jefferson County. The landuse consists primarily of single-family residential housing with a small amount of apartments, commercial development, and vacant or undeveloped land. Refer to Exhibit 2.2.2 in Appendix 2.2.1 for a map of the Floyds Fork service area.

2.2.1.3 Hite Creek

The Hite Creek WQTC was constructed by MSD in 1970 to provide service to the newly constructed Ford Motor Company Kentucky Truck Plant and the surrounding suburbs in eastern Jefferson County. Two expansions have occurred at the treatment plant, along with various upgrades, to increase the present design capacity to six mgd. The Ford Motor Company Kentucky Truck Plant contributes approximately 1 mgd to the treatment facility. The landuse consists primarily of single-family residential areas with a small amount of multi-family areas, commercial lots, vacant or undeveloped land, and the Ford Motor Company Kentucky Truck Plant. Refer to Exhibit 2.2.3 in Appendix 2.2.1 for a map of the Hite Creek service area.

2.2.1.4 Jeffersontown

The Jeffersontown WQTC was constructed in 1956 and was expanded several times to its current design capacity of four mgd. MSD acquired the Jeffersontown WQTC in 1990. In 1998, the system was placed under an Agreed Order by the Kentucky Department of Environmental Protection (KDEP) (Case No. 97201). The Agreed Order required various rehabilitation projects and treatment plant upgrades because the average annual hydraulic load was at 90 percent of its permitted capacity and the system experienced wet weather SSOs at the siphon just upstream of the WQTCs headworks. Improvements made by MSD to the plant from 1997 to 2000 added phosphorous removal, ultraviolet (UV) disinfection, and a new return activated sludge pump station. The Jeffersontown Service Area is located at Taylorsville Road and Watterson Trail in central Jefferson County. The landuse consists primarily of single-family residential and industrial with a small amount of commercial and vacant or undeveloped land. Refer to Exhibit 2.2.4 in Appendix 2.2.1 for a map of the Jeffersontown service area.

2.2.1.5 Morris Forman

The Morris Forman WQTC is the largest treatment plant in the MSD service area with a design capacity of 120 mgd. It was originally built in 1958 as a primary treatment plant that removed only heavy, solid wastes. The plant was rededicated in 1975 as a secondary treatment facility that treated organic matter and bacteria. The plant serves most of Louisville Metro and is the bio-solids processing facility for the entire service area.

The Morris Forman service area is the largest sewershed in the MSD collection system. The majority of the landuse in the service area is residential, with some smaller areas of commercial, industrial, and parks. Refer to Exhibits 2.2.5 through 2.2.7 in Appendix 2.2.1 for maps of the Morris Forman service area.

Within the Morris Forman service area are several key features associated with SSOs and known system deficiencies. These features are discussed below.

Middle Fork

The Middle Fork service area is located within the Morris Forman Service area and primarily serves the areas within the Middle Fork of Beargrass Creek watershed. The landuse consists primarily of single-family residential area.

Beechwood Village

Beechwood Village is located along the Sinking Fork Interceptor in St. Matthews, which is a part of the Middle Fork service area. The landuse consists of single-family residential area. The Beechwood Village separate SSS has experienced excessive inflow and infiltration (I/I) since the construction of the neighborhood's sanitary sewers in the early 1960s. Available data suggests that the separate SSS was constructed to substandard conditions, adding to the infiltration problems typically associated with clay pipe. The neighborhood is also located in an area with unusually high groundwater and poor drainage. MSD acquired the system in the mid-1960s and has since been working with the neighborhood to alleviate chronic basement backups. The five locations where temporary pumping occurs during wet weather are the locations called out in the Consent Decree as a part of the Beechwood Village neighborhood and are addressed in the Interim SSDP.

Ohio River Force Main / Muddy Fork

The Ohio River Force Main (ORFM) / Muddy Fork service area is located along the Ohio River in northeast Jefferson County. The area consists primarily of single-family residential housing and vacant or undeveloped land along with a small number of apartments and commercial development. The service area is generally bounded on the northwest by the Ohio River, northeast by Gene Snyder Freeway (I-265) South, and south by Westport Road.

Hikes Point / Highgate Springs Pump Station

The Hikes Point / Highgate Springs Pump Station area is located at the intersection of Hikes Lane and Goldsmith Lane. The majority of the landuse in the service are is residential, with some smaller areas of commercial and parks. MSD constructed Highgate Springs Pump

Station in 1963, which was designed to relieve the Beargrass Interceptor and prevent surcharging in the Highgate Springs sewer system. During dry weather, a weir prevents flow from the 36-inch diameter Highgate Springs Interceptor from entering the station's wet well. The flow is passed through the pump station by gravity and through a 30-inch tide gate into the Beargrass Interceptor. During wet weather, the tide gate closes, and flow from the Highgate Springs Interceptor spills into the wet well of the Highgate Springs Pump Station. For small storm events, one pump discharges directly into the Beargrass Interceptor. For increasingly larger events, the remaining three pumps will turn on sequentially until three pumps are discharging to the creek and preventing basement backups to approximately 300 homes. The Highgate Springs Pump Station and five additional locations where temporary pumping occurs during wet weather are the locations called out in the Consent Decree as a part of the Hikes Point area and are addressed in the Interim SSDP.

Buechel Branch

The Buechel Branch service area is located in central Jefferson County and is part of the South Fork of Beargrass Creek watershed. The landuse consists primarily of residential area with some commercial and industrial area. In the late 1970s, the Southeastern Interceptor was constructed because of a system constriction on the Beargrass Interceptor. The Southeastern Interceptor extends from the Southeastern Diversion structure to the Northern Ditch Interceptor.

Northern Ditch

The Northern Ditch area is located near the intersection of I-65 and Preston Highway. The majority of the landuse in the service area is residential and industrial.

2.2.1.6 Derek R. Guthrie WQTC

Construction of the Derek R. Guthrie WQTC (formerly known as the West County Wastewater Treatment Plant) began in 1984 and the WQTC came on-line in 1986 with a design capacity of 15 mgd. The Derek R. Guthrie WQTC eliminated over 45 small WQTCs and numerous pump stations and septic systems in the Pond/Mill Creek area where water quality was significantly impaired by small WQTC permit violations and failing septic systems. As the service area and population has grown, treatment capacity has been added to increase the present design capacity to 30 mgd. The Derek R. Guthrie modeled area serves primarily single-family residential customers, commercial, and vacant or undeveloped land. Refer to Exhibits 2.2.13 through 2.2.15 in Appendix 2.2.1 for maps of the Derek R. Guthrie service area.

There are four key features within the Derek R. Guthrie Service Area associated with SSOs and known system deficiencies. These features are outlined below.

Pond Creek

The Pond Creek area of Derek R. Guthrie is located at the intersection of Preston Highway and the I-265. The majority of the landuse in the service area is residential and undeveloped/vacant land.

McNeely Lake

The McNeely Lake sewershed is located at I-265 and Smyrna Parkway in southern Jefferson County. The majority of the landuse in the service area is residential and undeveloped/vacant land. The McNeely Lake area was acquired in stages during the late 1980s and 1990s. The area was comprised of six small WQTCs: The Pines; Pleasant Valley; Apple Valley; Maple Grove; Old Maple Grove; and McNeely Lake. In 1999, five of the small WQTCs were eliminated and directed to the Derek R. Guthrie WQTC. McNeely Lake WQTC is still in service.

Mill Creek

The Mill Creek sewershed is located near the intersection of Dixie Highway and Greenwood Road. The majority of the landuse is residential and undeveloped/vacant land.

Valley Village

The Valley Village sewershed is located at Dixie Highway and Watson Lane in southwestern Jefferson County. The majority of the landuse is residential and undeveloped/vacant land. The Valley Village system was acquired in 1986 and the original small WQTCs were eliminated in 1989 with the construction of a gravity interceptor to the Derek R. Guthrie WQTC.

2.2.1.7 Prospect

The Prospect area in northeastern Jefferson County contains five small WQTCs listed below and their characteristics are outlined in Table 2.2.1. These WQTCs primarily serve single-family residential customers with a small amount of multi-family residential and commercial area. Refer to Exhibit 2.2.8 in Appendix 2.2.1 for a map of the Prospect service area.

- Hunting Creek South WQTC
- Ken Carla WQTC
- North Hunting Creek WQTC
- Shadow Wood WQTC
- Timberlake WQTC

2.2.1.8 Small WQTCs

After the 1937 flood, less floodprone suburban areas became more desirable and began to be developed at an increasing rate. Suburban expansion occurred and new homes were built to use septic tanks to dispose of their sewage. However, in many suburban areas of Jefferson County, septic tanks were not a good solution due to topography, low permeability soil types, and shallow bedrock. In wet weather, groundwater would typically rise above the level of the septic tank systems, and raw sewage would stand in the yards and drainage ditches. As a solution, the Louisville Metro Board of Health agreed to allow individual septic tanks where the land could accommodate them, and to require small "package" WQTCs where septic tanks would not work well. These package WQTCs were typically operated by the developers. By mid-1972, there were about 350 small WQTCs in Jefferson County.

MSD began to acquire these systems as the regional sewer system developed. Small WQTC acquisitions became controversial, for a time, until pressure from state and federal regulators made it clear that their owners would have to make large investments to meet new water pollution regulations. Several court decisions also affirmed that MSD had the power to take over small WQTC systems when MSD sewer lines reached the area.

The ten small WQTC service areas currently operated by MSD located outside of the Prospect area are listed below and their characteristics are outlined in Table 2.2.1. These small WQTCs primarily serve single-family residential customers in multiple areas of Jefferson County. Refer to Exhibits 2.2.9 through 2.2.12 in Appendix 2.2.1 for maps of the Small WQTC service areas.

- Berrytown WQTC
- Chenoweth Hills WQTC
- Silver Heights WQTC
- Bancroft WQTC
- Glenview Bluff WQTC
- Lake Forest WQTC
- Lake of the Woods WQTC
- McNeely Lake WQTC
- Starview WQTC
- Yorktown WQTC

2.2.1.9 Existing Treatment Plant Capacity Evaluation

MSD has acquired and eliminated over 300 privately owned WQTCs and six regional plants were expanded, upgraded, or constructed. The Updated SSOP outlines WQTC operation parameters such as the year of construction, year acquired by MSD, design capacity, average influent flow, collection system size, and number of customers.

Under the CMOM Programs, MSD developed the Louisville and Jefferson County System Capacity Assurance Plan (SCAP). One of the activities of the SCAP is to confirm the flow capacities of all the WQTCs and pumping stations and compare them to current base and peak flows. The following summarizes the regional and small WQTC capacity evaluations.

Regional WQTCs

Treatment capacities at the regional WQTCs were evaluated in 2007. Evaluation included review of the most recent engineering design and construction plans, individual site visits, and performance certifications where available. WQTC performance under 2007 loading conditions was also reviewed to validate the results of the engineering studies.

Table 2.2.2 summarizes the annual average flow capacity and the peak flow capacity of each regional WQTC.

TABLE 2.2.2

SUMMARY OF REGIONAL WQTC CAPACITY EVALUATION & RESULTING LIMITATIONS

WQTC	Rated Permitted Capacity (mgd)	Peak Hour Design Flow (mgd)	2007 Average Day Flow (mgd)	2007 Peak Day Flow (mgd)	Limiting Unit Process (Peak Flow)
Morris Forman	120	350	100	204	Clarifier
Derek R. Guthrie	30	96	24	70	Clarifier
Cedar Creek	7.5	26.0	3.7	17.4	Clarifier
Hite Creek	6.0	16.0	4.0	14.0	Aeration
Jeffersontown	4.0	9.5	3.7	17.9	Clarifier
Floyds Fork	3.25	10.4	1.80	6.77	Clarifier

Small WQTCs

Treatment capacities at the small WQTCs were evaluated in 2007. Evaluation included review of the most recent engineering design and construction plans, individual site visits, and performance certifications where available. WQTC performance under 2007 loading conditions was also reviewed to validate the results of the engineering studies.

Table 2.2.3 summarizes the annual average flow capacity and the peak flow capacity of each small WQTC.

TABLE 2.2.3

SUMMARY OF SMALL WQTC CAPACITY EVALUATION & RESULTING LIMITATIONS

WQTC	Rated Permitted Capacity (gpd)	Peak Hour Design Flow (gpd)	2007 Average Day Flow (gpd)	2007 Peak Day Flow (gpd)	Limiting Unit Process (Peak Flow)	Planned Elimination Date
Bancroft	80,000	183,000	37,000	65,000	Disinfection	Beyond 2014
Berrytown	75,000	275,000	95,000	640,000	Disinfection	2011
Chenoweth Hills	200,000	576,000	147,000	738,000	Clarifier	2015
Glenview Bluff	10,000	26,000	4,000	6,000	Aeration	Beyond 2014
Hunting Creek South	251,000	630,000	180,000	768,000	Clarifier	2015
Ken Carla	10,000	50,000	3,000	29,000	Aeration	2015
Lake Forest	470,000	1,034,000	384,000	1,725,000	Aeration	2011
Lake of the Woods	44,000	161,000	31,000	285,000	Aeration	Beyond 2014
McNeely Lake	205,000	282,000	104,000	661,000	Disinfection	Beyond 2014
North Hunting Creek	358,000	792,000	325,000	786,000	Disinfection	2015
Shadow Wood	85,000	162,000	52,000	550,000	Disinfection	2015
Silver Heights	500,000	889,000	301,000	1,570,000	Disinfection	Beyond 2014
Starview	100,000	288,000	108,000	500,000	Clarifier	2011
Timberlake	200,000	646,000	76,000	606,000	Clarifier	2015
Yorktown	150,000	432,000	194,000	876,000	Clarifier	2010

2.2.2 Collection System Evaluation

MSD has developed detailed design models for each WQTC service area based on Louisville and Jefferson County Information Consortium (LOJIC) data, as-built drawings, and field investigation records. The models generally include sewers ranging from large interceptors to small local 8-inch lines, pump stations, and control features such as diversion weirs or interceptor flow controls.

Additionally, GIS tools were used to characterize the system, such as system connectivity, pipe material, pipe in the 100-year floodplain, and pipe with non-conforming slope (pipe slopes that do not meet minimum MSD design criteria). The calibrated and validated hydraulic models were used to establish existing system conditions such as surcharged pipes, SSO volumes, and hydraulic restrictions (outlined later in this section), as well as identify modeled overflow points (MOPs).

2.2.2.1 Existing Gravity-Sewer Condition Evaluation

GIS mapping and database queries were utilized to characterize the existing gravity sewer system. These evaluations were comprehensive and intended to provide initial assessments. In most cases, the evaluations were a review of the appropriate GIS mapping, especially those in the vicinity of known SSOs or MOPs, once identified.

The evaluations included the following by sewershed and shows references to relevant data and figures in this section:

- Sewer pipe material (Figure 2.2.1)
- Sewers in the 100-year floodplain (Figure 2.2.2)
- Sewers with non-conforming slopes (Figure 2.2.2)

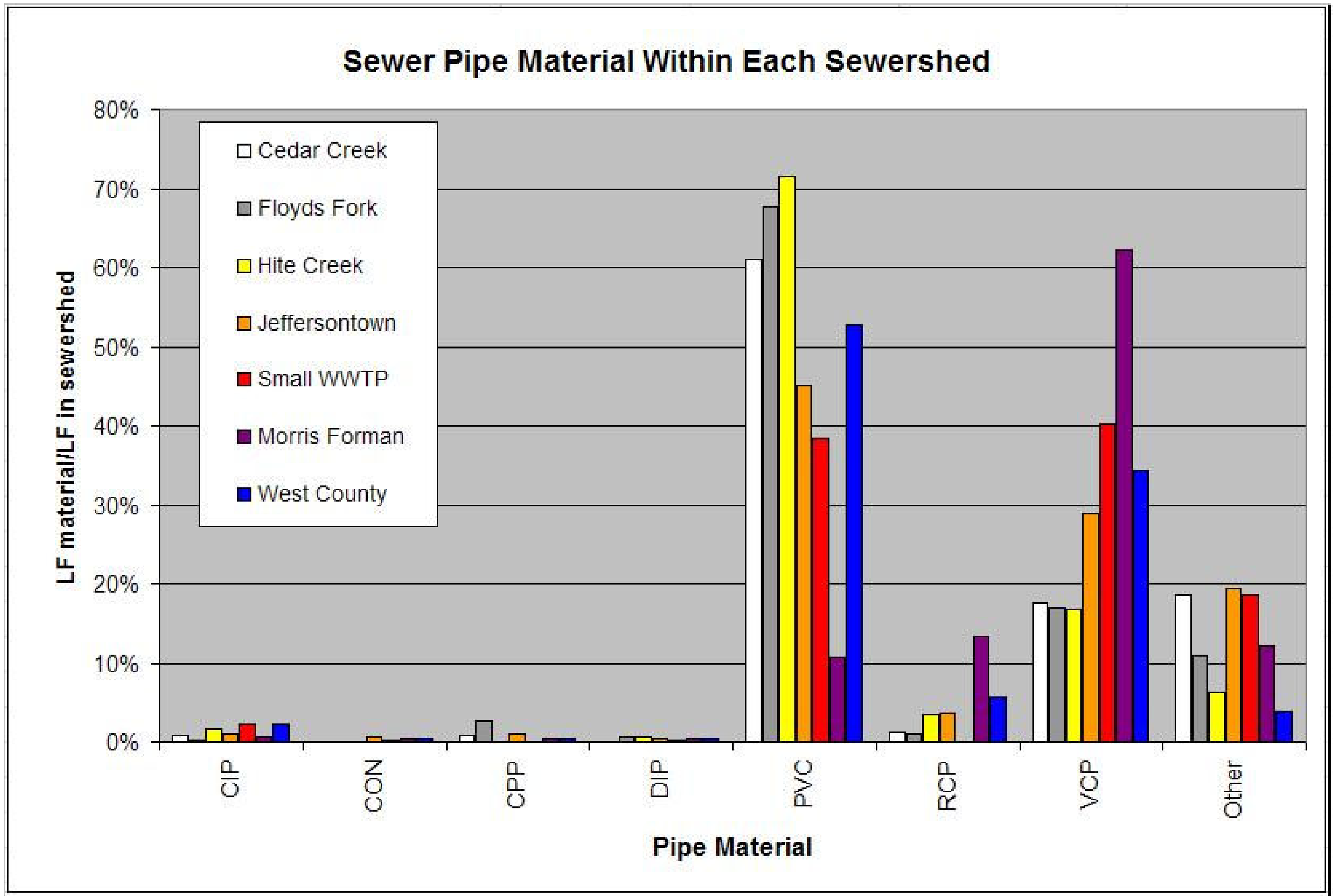
Mapping related to these evaluations are listed and available in Appendix 2.2.1:

- Sewer pipe material (Exhibits 2.2.1 through 2.2.15)
- Sewers in the 100-year floodplain (Exhibits 2.2.16 through 2.2.30)
- Sewers with non-conforming slopes (Exhibits 2.2.31 through 2.2.45)

Validated models were used to develop summaries of existing conditions for the hydraulic capacity in the gravity sewer system. These evaluations are summarized in this section and include the following:

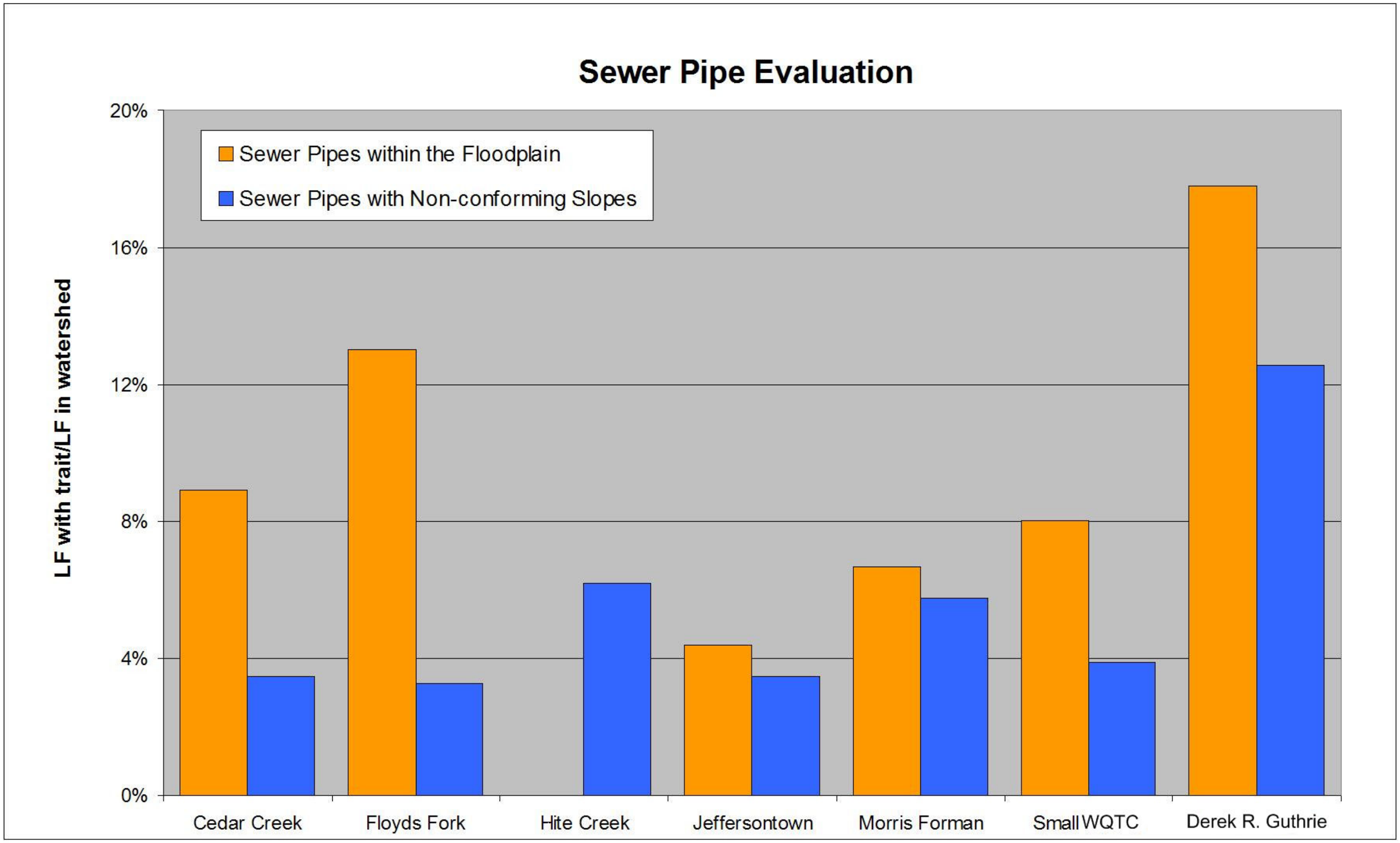
- Locations and volume of SSOs for various levels of protection
- Surcharged sewers
- Number of hydraulic bottlenecks
- The existing conditions evaluation identified specific capacity deficiencies in the system that would need to be addressed by SSO abatement solutions.

FIGURE 2.2.1 SEWER PIPE MATERIAL BY SEWERSHED



Note: CIP (cast iron pipe), CON (poured in place concrete pipe), CPP (cured in place pipe), DIP (ductile iron pipe), PVC (polyvinylchloride pipe), RCP (reinforced concrete pipe), VCP (vitrified clay pipe), Other (brick, ABP, ACP, ADS, CMP, HPDE, PEP, ST, STL, unlisted)

FIGURE 2.2.2 SEWERS LOCATED IN 100-YEAR FLOODPLAIN AND WITH NON-CONFORMING SLOPES BY SEWERSHED



2.2.2.2 Pump Station Capacity Evaluations

Developing pump station performance curves that represent the station's capacity under varying system conditions is a critical element for modeling a collection system. MSD maintains a set of as-built drawing and specifications that list pump capacity. While nameplate capacity and as-built drawings can list design capacity, actual in-situ testing provides the best estimate of capacity. Prior to modeling, MSD performed drawdown tests at pump stations, including all large pump stations and those associated with SSO or surcharged areas. The drawdown test consisted of measuring a pump's ability to drawdown, or drop, in the pump station wet-well volume and the corresponding time. After accounting for inflow during the test, the average pump discharge was determined. If there were several pumps, each was tested individually.

The drawdown tests results were compared to design data to note pump stations that were not performing at designed capacity. The design data was used at several small pump stations where drawdown tests were not performed.

2.2.3 Flow Monitoring

MSD has been collecting environmental data sets for almost 20 years. Rain data have been collected continuously on a network of rain gauges across Jefferson County since the early 1990s. In 2003, a network of radar rainfall data was added to fill in the gaps in physical distance between the rain gauges. Rain data can be simultaneously evaluated with many of the other data sets to help determine the timing and impact of wet weather.

Sewer flow meters have been in place in various locations in the MSD collection system since the early 1990s. These meters have been used to assess existing conditions, locate I/I, determine SSO volumes, and assist sewer modeling efforts. The majority of the historical meters were temporary meters used for evaluation studies, but MSD has installed several permanent meters that are used for real time control (RTC) of storage within larger pipes to reduce SSOs. For purposes of this Volume of the IOAP, flow monitoring is essential for capturing flow data used for model calibration, testing the success of SSO abatement projects, and analyzing system performance after projects have been constructed.

2.2.3.1 Flow Monitoring for SSDP Modeling

MSD had approximately 145 flow meters temporarily installed by a contractor from January 2007 through mid-June 2007 to support hydraulic modeling and sewer system improvements planning. Approximately 45 additional flow meters were purchased by MSD to provide better coverage of the system. With the addition of these monitors, MSD will have approximately 69 permanent flow meters for use within the system.

One storm during the 2007 monitoring period was used specifically to calibrate and verify the models. This storm occurred on April 14, 2007, and rainfall gauges recorded depths of 1.2-inch to 1.54-inch over 21 hours during the storm event. A smaller storm was also recorded on April 11, 2007, and in some modeling areas this storm was used to assist in model calibration.

2.2.3.2 Rain Gauge Network and Radar Rainfall

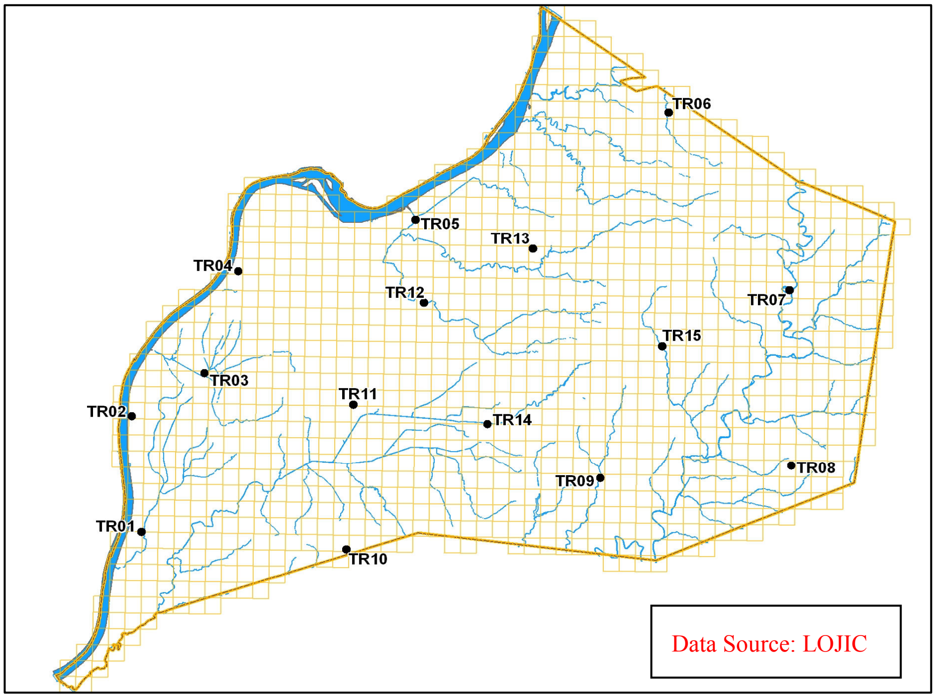
Rainfall data has been collected continuously on a network of rain gauges across Jefferson County since the early 1990s. During 2003, a network of radar rainfall data was added and rainfall data is currently gathered continuously at 15 rain gauge sites throughout the MSD sewer system.

FIGURE 2.2.3 RAIN GAUGE

The gauges are tipping-bucket type rain gauges (see Figure 2.2.3), where rainfall enters the gauge and is funneled down to a small "bucket." The bucket will tip and empty when 0.01 inches of rain is collected. The amount of rain (tips) is accumulated and every five minutes the data is stored in MSD's database for an accurate history of the rainstorm.

MSD currently receives radar rainfall data over a grid of approximately 1400 cells throughout the county and its immediate boundary (see Figure 2.2.4). These cells have rainfall depths reported every five minutes during wet weather and provide a thorough representation of the rainfall distribution differences across the county. Rainfall data is simultaneously evaluated with many of the other data sets to help determine the timing and impact of wet weather. Radar Rainfall and data from these gauges is used for model calibration, in determining "threshold" rainfall volumes for validation and for augmenting level of protection rainfall distributions.

FIGURE 2.2.4 TELEMETERED RAIN GAUGE NETWORK AND RAINFALL PIXEL GRID



Additional information on the rain gauge system can be found on MSD's website at http://www.msdlouky.org/aboutmsd/rainfall.cfm.

2.3 CONVEYANCE SYSTEM MODELING

This section provides general background information related to model development. Detailed discussions of individual modeling efforts are discussed in Section 2.5.

2.3.1 Modeling History

MSD's separate SSS system within Jefferson County is divided into three main areas: Beargrass Creek, Floyds Fork/North County, and Mill Creek/Pond Creek. The Beargrass Creek sewershed includes the Morris Forman WQTC; the Floyds Fork/North County sewershed includes the Cedar Creek, Floyds Fork, Hite Creek, and Jeffersontown WQTCs; and the Mill Creek/Pond Creek sewershed includes the Derek R. Guthrie WQTC.

The following discussion includes historic modeling efforts for the following areas:

- The Middle Fork and Beargrass Creek collection systems which flow to the Morris Forman WQTC, including Beechwood Village, ORFM/Muddy Fork, Hikes Point/Highgate Springs Pump Station, Buechel Branch, and Northern Ditch.
- The Cedar Creek collection system, which flows to the Cedar Creek WQTC.
- The Pond Creek, McNeely Lake, Mill Creek, and Valley Village collection systems, which flow to the Derek R. Guthrie WQTC.
- The Jeffersontown collection system, which flows to the Jeffersontown WQTC.
- A portion of the Prospect collection system, which includes Hunting Creek North, Hunting Creek South, and Timberlake WQTCs.

2.3.1.1 Middle Fork of Beargrass Creek Collection System

Middle Fork (including Beechwood Village)

In 2003, the Middle Fork XP-Stormwater and Wastewater Management Model (XP-SWMM) Hydraulic Model was built and calibrated to 1998-1999 flow monitoring data. This calibration was used to analyze the system for deficient sewers and SSOs for various rainfall depths. Since the original flow monitoring data was older, new flow monitoring was performed in 2003-2004 and the model was re-calibrated. The model covered an area of approximately 14,283 acres.

Both the 1998-1999 and 2003-2004 calibrated models showed similar results: the majority of the wet weather problems were occurring in the Beechwood Village/Sinking Fork and Lower Middle Fork sub-sewersheds. These two areas contain the majority of SSO locations, SSO volume, and capacity-deficient sewers in Middle Fork. The model was used to perform capacity assessments and analyze potential improvements in Beechwood Village and other areas of Middle Fork.

Ohio River Force Main / Muddy Fork

The ORFM XP-SWMM Hydraulic Model was built and calibrated in 2000-2001 using 1998-1999 flow monitoring data. The ORFM is a dual force main consisting of 92,000 linear feet (LF) of pipe. There are eight connected pump stations and approximately 7,600 acres covered in the model. The model was used to evaluate numerous operational scenarios to determine how the system would function with different combinations of pumps in operation and at maximum flow conditions.

Hikes Point / Highgate Springs

The Hikes Point XP-SWMM Hydraulic Model was developed as part of the 1997 Sanitary Sewer Evaluation Study (SSES). This model was used to test various scenarios for in-line storage in the area affected by wet weather emergency pumped SSOs and results were used to establish design parameters for the Hikes Point Phase 1B rehabilitation project. In 2002, the model was updated and recalibrated to 2002 flow monitoring data for use with the RTC system developed by MSD. Also at this time, the system was extended to include the Southeastern Diversion Structure. In 2003, the model was used to perform analyses for several SSO sites with the goal of determining whether emergency pumps were required and if so, at what depth of flow they should be activated. The model covers an area of approximately 5,500 acres.

In 2003-2004, the model was used as the basis for the Hikes Point System Improvement Phase 1 Project. It was used to develop a solution to eliminate SSOs, both model-predicted and known. The model was also used to determine available hydraulic capacity in the system for various storm events.

In 2004-2005, the XP-SWMM model was used for the Hikes Point Capacity Assessment Project to refine solutions developed in the system improvements project and evaluate options for redirecting flows external to the Hikes Point system throughout the area. Cost estimates were refined and ground truthing was performed to help identify the most viable abatement options.

Southeastern Diversion Structure / Buechel Branch / Northern Ditch

In the early 1990s, an evaluation of relief capacities of the Southeastern Diversion Structure and Southeastern Interceptor was conducted using the XP-SWMM program. The objective was to optimize the flow diversion approach to provide relief to the Hikes Point and Buechel Branch areas upstream of the diversion structure, but this created surcharging and SSOs upstream. Currently the flow diversion gate is normally closed during wet weather.

The Buechel Branch XP-SWMM hydraulic model was built and calibrated in 2002-2003, using 2002 flow monitoring data collected during the RTC project. The Buechel Branch RTC model covers approximately 2,800 acres and is centrally located at the intersection of Breckenridge and Nachand Lanes. The Northern Ditch area was also included in the Buechel Branch RTC model. In 2003, minor updates were made to this model, which included adding a small amount of new residential development.

2.3.1.2 Cedar Creek Collection System

The Cedar Creek XP-SWMM hydraulic model was originally built and calibrated in 2000-2001 using 1998-1999 flow monitoring data. This model consisted of sanitary sewers tributary to the Cedar Creek WQTC. New system infrastructure was added and system rehabilitation projects took place in 2002-2003 so the model was updated to include the changes. The model was recalibrated for wet weather flow and dry weather flow (DWF) using flow monitoring data collected in 2002-2003.

Future conditions scenarios were analyzed in conjunction with the Jeffersontown Interceptor Condition Assessment project. Areas that were proposed to be diverted to the Cedar Creek area in the Jeffersontown Action Plan were added to the model and the effects analyzed. The Cedar Creek model covers approximately 3,600 acres of area.

2.3.1.3 Pond Creek Collection System

The Pond Creek XP-SWMM hydraulic model was built and calibrated in 2002-2003 using 1997-1998 flow monitoring data. The model consists of 10-inch and greater diameter sanitary sewer tributary to the Pond Creek and Mill Creek interceptors but does not include the Valley Village Interceptor. The model covers approximately 29,100 acres.

Derek R. Guthrie Spline Model (including Valley Village)

The Derek R. Guthrie WQTC spline hydraulic model was built by joining the Mill Creek model with a spline model of the Pond Creek system under the Derek R. Guthrie Conveyance System Improvements Project. The Valley Village interceptor was incorporated into the model. This model was originally calibrated in 2002-2003 using 1997-1998 flow monitoring data in the Pond Creek system, and 2001-2002 flow monitoring data in the Mill Creek system. The model was updated and recalibrated after system rehabilitation using 2002-2003 flow monitoring data. The model covers approximately 43,000 acres. The Derek R. Guthrie WQTC spline model was used for analysis of the proposed Pond Creek Interceptor storage basin as well as to identify system corrections to eliminate the direct entry of Mill Creek floodwaters to the system.

McNeely Lake

The McNeely Lake hydraulic model is part of the Pond Creek hydraulic model. To improve the calibration, previous flow monitoring data, pump run records, and downstream flow monitoring data were reviewed. The Derek R. Guthrie WQTC spline model was used in 2004-2005 to review hydraulic solutions on the Pennsylvania Run study area collection system due to planned and future developments.

Mill Creek

The Mill Creek model was built and calibrated in 2001-2002 using 2001 flow monitoring data. The model was built to simulate dry weather and wet weather flow in the separate SSS system. This model was part of the Derek R. Guthrie WQTC spline model, which was built by joining the Mill Creek model with the Pond Creek system model.

2.3.1.4 Jeffersontown Collection System

The Jeffersontown XP-SWMM hydraulic model was originally built and calibrated in 1998-1999 using 1997-1998 flow monitoring data. This model consisted of sanitary sewer tributary to the Jeffersontown WQTC. Model runs were performed to evaluate the system response to various storm events and was used to identify SSOs within the model. The project modeled approximately 4,650 acres. In 2001, this model was used to evaluate scenarios for inclusion in the Jeffersontown Facilities Plan submitted to the KDOW in August 2002.

A simple hydraulic isolation analysis was performed in 2002-2003 using 2002 flow monitoring data. This analysis created several artificial free outfalls within the system to evaluate the performance of the sub-basins independent of the primary interceptors. The model was revised to reflect the impact of the Jeffersontown Facilities Plan. The Facilities Plan was then updated to include anticipated flows from undeveloped areas. Finally, the model was used to evaluate various options to improve the system and eliminate unauthorized discharges. A report detailing this information and providing recommendations for capacity improvements for SSO eliminations was completed in September 2005.

2.3.1.5 Prospect Collection System

The Prospect XP-SWMM Hydraulic Model includes the North Hunting Creek, Hunting Creek South, and Timberlake WQTCs covering approximately 1,856 acres. The Shadow Wood WQTC was not modeled because it was privately-owned at the time. The Prospect model was built to simulate dry weather and wet weather flows, and was calibrated in 2002 using 1999-2000 flow monitoring data. The model was used in conjunction with existing data and wet weather inspections to develop a comprehensive solution for the elimination of SSOs at the Gunpowder Pump Station. The project was completed in August 2004.

2.3.2 Objectives of the Modeling Program

Objectives and uses of the modeling program include:

- Performing alternative and solution analysis for SSO volume reduction and elimination
- Projecting capacity for new development
- Performing future analysis, with an increased investment in calibration/validation, of system upgrades due to age and asset deterioration
- Simulating storm events and system response investigation

2.3.3 SSDP Model Development

The hydrologic and hydraulic modeling software selected for all hydraulic modeling was InfoWorks. The InfoWorks program is designed not only to model wet weather effects on collection systems, but to also take advantage of a large GIS database provided by LOJIC. InfoWorks has the ability to import XP-SWMM models, allowing MSD to build on extensive prior modeling, as detailed in Section 2.3.1.

There are a total of 11 modeled areas in the Final SSDP (refer to Figure 2.3.1 at the end of the chapter). MSD provided each modeling team with known system hydraulic information such as known SSO location, volume and duration; pump station runtime information; known surcharge areas; and other relevant data for each modeled area. This information was used by the modeling teams in calibration and validation of the models.

2.3.3.1 Modeling Guidelines

As a first step in the program, MSD developed the Hydraulic Sewer System Modeling Guideline Manual (see Appendix 2.4.3 in Volume 2). These procedures improve the detail, quality, and functionality of the sewer models while providing consistent model development criteria.

The guidelines instructed the modelers how to:

- Perform the capacity assessments
- Develop a range of system improvements
- Develop the benefit/cost ratios for the various solutions in a consistent manner
- Confirm reported results are sufficient for development of the Final SSDP

MSD developed the Modeling Guidelines to address the following:

- Update modeling standards, including refining the I/I modeling procedures and assessing flow monitoring
- Review XP-SWMM models to determine deficiencies
    - Identify expansion needs
    - Assess data verification needs
    - Collect record drawings, and
    - Conduct pump-station drawdown tests.
- Switch to the InfoWorks software and develop a platform (server) for retrieving, storing and sharing model data
- Import shape files of the model area into InfoWorks
- Develop flow monitoring basins
- Define hydrologic and hydraulic parameters
- Review modeling input and output

The following summaries provide samples of important guidelines presented in the manual related to initial model development.

Modeling Standards and Migration of Model Data

MSD developed a full set of modeling standards prior to performing any separate SSS modeling. This included calibration standards, use of flow monitoring data, use of previous models, input and export standards, Quality Assurance / Quality Control (QA/QC) procedures, and modeling techniques for I/I and pump facilities. In parallel with that effort, MSD reviewed past models and determined deficiencies in data, such as inverts and pump data. They also coordinated with MSD crews who conducted drawdown tests at key pump station facilities.

InfoWorks CS is a modeling platform designed around GIS databases and is capable of importing data from other models. Thus, InfoWorks models were not designed from “scratch.”

Flow Monitor Basins

MSD determined that flow monitoring basins should have no more than 100,000 LF of pipe within its boundaries, not including areas contributing flows measured by upstream monitors. As much as practical, each basin had uniform landuse and soils data.

Hydrologic Parameters

Hydrologic parameters refer to the components of the model that are manipulated to simulate rainfall dependent inflow and infiltration (RDI/I). RDI/I is simulated as rain falling on catchments. These catchments are not real, but rather mathematical abstractions used to determine the rate and volume of RDI/I over time.

MSD system models do not account for the effects of snowmelt due to the small volume of water resulting from snowmelt for this region of the country. Likewise, evaporation is ignored due to the relatively short model runs.

DWF is a combination of groundwater infiltration, residential, industrial, and commercial user flows. DWF is defined as the flow that occurs in absence of any runoff due to precipitation. Three main features of DWF are flow volume and rate, diurnal pattern, and spatial distribution. Each is determined from flow monitoring data. DWF is allocated to individual manholes based on spatial data, such as census and landuse.

Hydraulic Parameters

Hydraulic parameters represent the infrastructure of the model. This would include features such as pipes, manholes, pump stations, and force mains. The modeler provides dimensional and geographical information for each feature. The modeler also provides the node and link arrangement to mimic actual infrastructure connections.

MSD provided each modeler with past models and pertinent LOJIC GIS data. With this information, each modeler developed the complete sewershed model and the models were checked with InfoWorks review tools. The following represent critical components of a model’s accuracy and the method used in the modeling procedure to address them.

Pump Stations

Since pump station capacity is critical to developing an accurate model, significant effort was paid to pump station representation (see Section 2.2.2.2). Each procedure was detailed by pump size within the Modeling Guideline Manual. Large pumps are always modeled as dynamic pumps, with capacity a function of wet well and outlet conditions.

Boundary Conditions

In most cases, a downstream boundary condition is a known hydraulic grade line elevation at the point of interface between the modeled system and a system outside of the modeled boundary (e.g. river). During periods of high flow, backwater effects in the conveyance system caused by a high hydraulic grade line at a pump station wet well were captured and modeled.

For the Final SSDP, the following boundary conditions were used:

- For downstream branches, the boundary condition could include WQTC capacity, Interim SSDP project allotment, or existing flow to the combined sewer area.
- For upper branches not tying into a WQTC, Interim SSDP project, or combined sewer system, solutions were determined without regard to downstream impacts (i.e. no penalty for conveyance).

Model Input and Output

Model input selection and the level of detail to which the model is constructed are important to confirm the model is properly constructed. Equally important is a complete review of model output prior to acceptance of model results. After the modeling teams made a thorough review, the model was reviewed by a separate modeling firm to verify accuracy. Additional detail on the quality assurance and quality control (QA/QC) procedure is described in the next section.

2.3.4 Rainfall Distribution and Level of Protection

Rainfall is characterized by temporal distribution and total volume. Both of these characteristics impact design capacity, pumping rates and optimized solutions. Level of protection is the selection of a rainfall-volume frequency or level for design. This is commonly denoted by an average interval, such as a two-year storm that has a 50 percent probability of occurring in any given year.

From a practical perspective, no sewer system can be designed to consistently convey all system flow during extreme weather events. Therefore, a “design condition” must be defined that reflects the level of protection consistent with community values. The costs for capturing wet-weather events must be balanced with the benefits to community associated with capturing that event. Section 3.2.1 in the following chapter outlines the procedure used for determining consistent costs. Section 3.2.2 outlines the procedure used for determining benefits consistent with community values, as outlined in the Stakeholder process. Section 3.2.3 outlines the procedure used for determining the best benefit-cost ratio, thus defining the preferred level of protection.

In the Final SSDP, the values evaluation framework was used to determine levels of protection that reflect an appropriate level of control of unauthorized discharges for the Louisville Metro community.

2.3.4.1 Base Rainfall Distribution

For the separate SSS modeling, MSD considered two storm distributions: 1) the Natural Resources Conservation Service (NRCS) “long duration” distribution and; 2) the National Oceanographic and Atmospheric Administration (NOAA) “short-duration precipitation,” often referred to as the “cloudburst” distribution. The Natural Resources Conservation Service method is a general large-area storm often used for design of large stormwater and flood control structures such as dams and detention facilities. The NOAA cloudburst distribution uses depth-area-reduction-factors derived from frequency analyses of local hourly precipitation data recorded at the Louisville International Airport. This distribution is typical of shorter duration storms that often cause SSOs in individual basins. It is also similar to the storms captured during the system flow monitoring used for model calibration.

Based on an analysis of over fifty years of historical weather patterns for Jefferson County, MSD determined that a three-hour, high-intensity cloudburst storm reflected the most appropriate storm pattern to use in SSO control evaluation. The NRCS long duration distribution is more appropriate for total system-wide modeling for larger service areas, such as inflow to regional wastewater treatment plants, since the attenuation of the peaks for the larger service area is less dramatic. However, the cloudburst storm is more appropriate for localized collection system modeling and provides for better calibration and validation of the hydraulic models to known SSO locations.

See Appendix 2.3.1, Selection of the Cloudburst Storm, for additional details on the selection of the cloudburst storm.

2.3.4.2 Second Storm Distribution

In some cases, the preferred solution for an SSO will be storage of excess wet-weather flow. Storage, however, will only be effective as an SSO abatement strategy if it can empty in short order. Otherwise, a small second storm immediately after the design storm could cause a full storage facility to overflow.

To account for this, a second smaller rainfall distribution was added after the first such that the rainfall peaks were 12 hours apart. The total rainfall depth for the second storm was consistently set at 0.46”, corresponding to a 10-day recurrence interval storm.

2.3.4.3 Model Simulations

During system characterization, a suite of design conditions was analyzed starting at the 1.27-inch cloudburst up to the 2.60-inch cloudburst. This allowed the opportunity to validate models and determine the extent of various deficiencies, such as surcharging, at each level. During solution optimization, the baseline storm was at the 1.82-inch cloudburst storm level. Once a solution had been identified at this level, the solution was then analyzed at a 2.25-inch cloudburst level and 2.60-inch cloudburst level to compare benefit-cost ratios for a modeled watershed branch. Solution optimization is discussed in detail in Volume 3, Chapter 4.

2.3.5 Model Calibration, Validation, and Baseline Conditions

The following sub-sections summarize critical modeling components related to model and solution development.

2.3.5.1 Model Calibration

Model calibration is the process of comparing model-predicted results to measured flow monitoring and rainfall data from a single, significant rainfall event and to match pump station drawdown test results. The process is iterative and proceeds until the modeled results match the measured data within a pre-defined percentage level of accuracy, called action levels. Model calibration and validation reports are located in Appendix 2.3.2.

Action Levels

The action level of accuracy is 20 percent for the difference in base flow rate (minimum); the action level is 10 percent for the difference in flow volume and the difference in peak flow rate (maximum). The hydrograph shape, mean flow velocity, and water depth predicted by the model and measured by the flow monitoring is also qualitatively compared. Guidelines on adjusting models are detailed in MSD's Hydraulic Sewer System Modeling Guideline Manual, Volume 2, Appendix 2.4.3.

Model Re-calibration

Model re-calibration was required after validation and verification of modeled overflow points (MOPs). MOPs are discussed in detail later in this section. Model calibration and re-calibration was completed in accordance with MSD modeling standards and protocols. The standards can be found in the Hydraulic Sewer System Modeling Guideline Manual, Volume 2, Appendix 2.4.3.

2.3.5.2 Model Validation

Once the model is calibrated, the model is then "validated." Model validation is simply cross-checking the model performance against other recorded storm events or historical system performance data sources, such as known SSO locations, using threshold rainfall depths known to cause overflows, reported overflow volumes, and surcharged pipes. Due to lack of additional, system-wide storm events during the 2007 flow monitoring period, model validation was focused on validating the models to readily available historical overflow data. For details on future model calibration, validation, and flow monitoring procedures reference MSD's Post-Construction Compliance Monitoring Plan detailed in Volume 1, Chapter 6.

Known SSOs

MSD provided threshold 24-hour rainfall and average reported SSO volume for each known SSO in MSD's service area. The calibrated model simulated the 2.2-inch, 2.7-inch, and 3.2-inch level (this corresponds roughly to the six-month, one-year, and two-year Natural Resources Conservation Service design rainfall events) and the modeled SSO locations and volumes were noted. In some cases, modeled SSOs occurred within a few manholes of known SSOs, these locations were considered to represent the known SSOs.

The results were compared to the initial SSO list with two goals in mind. The primary goal was to show overflows at each known SSO location for similar rainfall depth. A secondary goal was to have relative agreement in SSO volume; for example, the SSOs in the sewershed within the top third of the reported volumes were not in the lowest third of the modeled SSO volumes. If parameters needed to be adjusted, the model was modified in a manner similar to calibration modifications. The validated MOPs were not considered for this criterion since there were no reported SSO volumes associated with the locations. Initial validation took place prior to MOP investigations in the spring of 2008.

Surcharged Pipe

MSD provided maps of areas with historical basement flooding based on complaint records and installed back-flow preventers. In most cases these areas coincided with known SSO locations and known hydraulic restrictions. In the few instances where surcharging was not noted in the model, parameters were adjusted upwards to induce surcharging for a 1.27-inch storm in a manner similar to calibration modifications.

Unvalidated SSOs

In some cases, SSOs could not be induced in the model where known SSOs occurred. If the pipe slope in the area was shallow, sedimentation could be applied to the model to induce the SSO (process was performed according to modeling standards). In these cases, MSD investigated the downstream sewer system to locate blockages or other operational problems. If the problem was cleared, the SSO status was changed to “Remediated.” These cases are detailed in Appendix 2.3.2, Model Calibration/Validation Reports, and the sewershed summaries in Section 2.5.

Recalibration

After validation was completed, the model was reviewed to confirm it met calibration standards. If it did not, the model was recalibrated and revalidated until all action items and validation goals were met. In practice, validation and any re-calibration took place simultaneously.

Appropriate Rainfall Distribution

While model calibration and validation was being conducted, MSD contracted to have a rainfall analysis performed and synthetic rainfall events produced for the Louisville Metropolitan area, based on 59 years of rainfall records at the Louisville International Airport. (See Appendix 2.3.1.) The analysis indicated that the typical storm type and duration for Louisville rainfall events is the 3-hour duration cloudburst event, especially for events over the two-year recurrence interval.

MSD compared the typical Natural Resources Conservation Service Type II 24-hour rainfall distributions with the 3-hour cloudburst distributions to determine the best synthetic rainfall event to use for further validation and additional analyses. The Natural Resources Conservation Service distributions resulted in unrealistic model results that did not match calibration and validation data from storm events of similar recurrence intervals. The results typically showed higher overflow volumes, longer overflow durations, and more modeled overflow points that did not correspond with field data. The cloudburst storm overwhelmingly showed a closer resemblance to overflow recurrence intervals, approximated overflow volumes, and documented overflow locations that had been recorded over the past five years. Because of this approximation of typical events, the cloudburst storm distribution was selected for the development of overflow abatement solutions.

2.3.5.3 Model QA/QC Process

As mentioned earlier, calibrated and validated models were also subjected to a QA/QC process as discussed in the Modeling Guidelines. This QA/QC peer review involved a "swapping" of models based on a pre-determined assignment list. The process involved reviewing dry-weather and wet-weather flow surveys, comparing results for calibration storm, and reporting discrepancies in a QA/QC checklist and comments form. Reviews were then returned to the model development teams for responses and revisions. In some cases, recalibration was necessary. Table 2.3.2 is a sample of the QA/QC checklist used by modelers to verify and validate model accuracy. Full Model QA/QC documents are provided in Appendix 2.3.3.

TABLE 2.3.2

QA/QC CHECKLIST SAMPLE

GENERAL REQUIREMENTS

ITEM	OK	SEE COMMENT
Model Development		
1. Standard Data Flags – Ensure data flags have been properly used. (Section 3.4.1)	☐	
2. Rainfall Data – Check the rainfall data to ensure the PIXEL number has been used for the profile ID (Section 3.4.2). Ensure pixels cover the entire modeling catchment.	☐	
3. Rainfall Data – Check rainfall data units. Rainfall data should be in inches/hour.	☐	
4. Model Building – Check the unique IDs used for nodes and links (Table 3-2 Section 3.4.3).	☐	
5. Model Building – Check pipe invert and manhole rim elevations. Generally these should range from 400ft to 800ft above sea level for Louisville.	☐	
6. Model Building - Run the network validation and check to see if there are any errors or warnings that need to be addressed.	☐	
7. Model Building – Check the simulation parameters. Generally the "Simulation: Tolerance for Volume Balance" parameter should be set to 0.01 for model stabilization. (Section 3.4.6)	☐	
8. Standard Naming Convention – Check naming convention used for groups listed in the Guidelines. (Section 3.4.8)	☐	
Hydrologic Parameters		
1. Runoff – Runoff Volume Type should be set to Fixed for all Runoff Surfaces. Can be set to SCS only if in a rural area. (Section 4.1.1)	☐	
2. Runoff – Routing Model should be set to SWMM for all Runoff Surfaces (Section 4.1.1)	☐	
3. Evaporation & Other Losses – For single storm event analysis evaporation losses should be set to zero. See Guidelines for continuous annual simulations. (Section 4.4)	☐	
4. RDII – Check to ensure the model has the proper number of dummy subcatchments to simulate the fast, medium, and slow response of for RDII. A minimum of two are required. (Section 4.5)	☐	
5. Subcatchment Areas – Check for large subcatchment areas. Ensure these areas represent the contributing area to the sewer system. For large parcels the subcatchments should only be drawn around the contributing area and not the entire parcel.	☐	
Hydraulic Parameters		
1. Conduit Data – Pipe shapes should be predominately circular except in the CSS area.	☐	
2. Datum shift – Spot check 5 pre-2002 and 5 post-2002 constructed conduits and manholes to ensure the -0.5 feet datum shift from NGVD29 to NAVD88 was properly applied. (Section 5.1)	☐	
3. Conduit Data – Check for elevations of zero, adverse slopes, and non-standard pipe diameters. (Section 5.1)	☐	
4. Conduit Data – Manning's N values should be set 0.013 in the Separate Sewer System and 0.013 – 0.016 in the Combined Sewer System based upon pipe material. (Section 5.1)	☐	
5. Conduit Data – Headloss Types should be set to 'normal'. (Section 5.1)	☐	
6. Node Data - All junction chambers and shafts should have a diameter of 4.0 feet. For pipe diameters greater than 4.0 feet the chamber diameter should equal the pipe diameter. (Section 5.2)	☐	

2.3.5.4 Modeled Overflow Points (MOPs)

After validation and peer review, the models were simulated again at the 1.82-inch cloudburst storm level to note any modeled SSOs that were not associated with known SSOs. These SSOs were designated as MOPs. MOP locations were targeted for further analysis and field investigations. Section 2.4.2 describes the MOP investigation and validation procedures.

2.3.5.5 System Deficiencies

Once models were calibrated and validated, system deficiencies were determined for various levels of protection. The system was characterized by SSOs, surcharged pipes, and areas at or near capacity for each analyzed level, including peak flow rates, time to peak, and total SSO volumes. System deficiencies noted include hydraulic restrictions, hydraulic jumps, bottlenecks, pump limitations, flow monitoring limitations, insufficient slopes, and non-standard diameters. System deficiencies can be divided into two categories: 1) construction and 2) hydraulic, as explained below.

Construction Deficiencies

Construction deficiencies are related to operation and maintenance issues. Deficiencies may not directly cause SSOs or hydraulic issues but they require additional maintenance and, therefore, contribute to conditions that can promote the formation of SSOs. The InfoWorks Engineering Tool includes a variety of tests to identify engineering deficiencies such as pipe slopes (which can promote silting), pipes with insufficient soil cover (which may be damaged by traffic), and excessively long pipes (which are difficult to access for inspection and cleaning).

Hydraulic Deficiencies

Hydraulic deficiencies are related to physical limitations of the system. Such systems may meet specific Engineering Standards for normal flow, but are insufficient for the flows observed in the field. These deficiencies could include bottlenecks, hydraulic jumps, and surcharged pipes. While InfoWorks can identify numerous minor reductions in flow that have no impact on sewer performance, only hydraulic restrictions that result in surcharging under modeled flow are flagged as restrictions.

Hydraulic deficiencies are identified through several features integral to InfoWorks. This will take advantage of the rigorous examination of the data performed during the model construction. For example, hydraulic jumps are marked as part of the surcharge identifier. Other deficiencies require modeler evaluation. For example, pump station limitations are highlighted by surcharging upstream of the pump station, but requires the modeler to confirm the pump station capacity as the true restriction.

2.3.5.6 Model Branching

Prior to the solution development process, the models were subdivided into “branches.” These branches were analyzed separately, beginning at the most upstream branches and proceeding downward toward the sewershed outlet or WQTC. During solution development, costs, benefits and benefit-cost ratios were determined for each branch separately. Once a preferred solution was determined for upstream branches, development proceeded downstream.

Ideally, each branch would address a separate hydraulic issue that caused SSOs and surcharging. In practice, branches were set by grouping hydraulically connected SSOs, surcharging and system deficiencies. These groupings often contained several SSOs and often two or more groupings would be in close proximity.

Section 2.5 provides details on the branch selection for each model area. Figures 2.3.2 through 2.3.11 at the end of the chapter provide maps of each modeled area and respective branch boundaries.

2.3.5.7 RDI/I Reduction

RDI/I reduction, identified by the Wet Weather Stakeholder Group as a critical component of solution development, was an integral part of every solution. MSD developed a method to project estimated RDI/I reduction for the entire MSD service area. Appendix 2.3.4, RDI/I Method and Modeling Techniques Technical Paper, provides a technical paper outlining this application and the modeling techniques.

The RDI/I reduction projections were:

- Applied to all models prior to solution evaluation.
- Based on flow monitoring results, namely peaking factors at flow monitoring basins. The peaking factors were calculated prior to modeling by comparing monitored flow to average flow determined from a period of dry weather.
- Applied only in areas with high peaking factors (greater than four).
- Conservative in that RDI/I reduction was set at a maximum of 25 percent reduction and then only at areas with peaking factors greater than 14.

It should be noted that the projected RDI/I reduction used in the models is based on estimated values. The actual RDI/I reduction will be based on the type and comprehensiveness of the rehabilitation effort. This is not to say that actual RDI/I reduction exceeding the projected reduction values used in the models cannot be accomplished. It is expected that they will in many cases. Such successful RDI/I reduction projects will provide capacity for areas where reduction is not as successful. It is, however, prudent that overly optimistic values are not used in planning and design. This is especially important in transport-based solutions where the diameter of installed piping cannot readily be changed once it is installed. The projected RDI/I reduction applied to each model is listed in the Section 2.5.

2.3.5.8 I/I Program

MSD will execute an on-going I/I Program for systemic improvements in the collection system during implementation of the Final SSDP. At the behest of Stakeholders MSD committed to use RDI/I removal as the first approach to eliminate SSOs. MSD recognizes that, based on past I/I Program Projects, the degree of RDI/I removal is often difficult to predict and success is not always assured. Accordingly, MSD has committed to achievable levels of RDI/I removal in areas where success is most likely.

Projected RDI/I removal was applied to all hydraulic models prior to solution development and optimization. Details of this approach are found in Appendix 2.3.4. Once optimized solutions for all SSOs had been developed, RDI/I reduction was removed from the models. The models were re-evaluated and solutions were re-sized at the 1.82-inch cloudburst storm level. The cost differential between the two sets of solutions, one with and one without RDI/I reduction, was used to determine appropriate I/I Program costs, as presented in Chapter 3, Appendix 3.1.1, I/I Program Documentation. It is estimated that the annual cost would average $1.6 million. This cost does not include programmatic needs for inspection and rehabilitation related to associated programs such as CMOM, SCAP, and the Nine Minimum Controls (NMCs). To provide contingency and to account for the costs to accommodate associated programs, the annual cost of the I/I program was set at $3 million.

Appendix 3.1.1 (Table 6) lists projects dependant on RDI/I reduction as part of the SSO elimination solution. Appropriate rehabilitation for these projects will take place as part of the I/I Program prior to actual capital construction of these solutions. The earliest I/I projects will likely concentrate on areas solely dependent on RDI/I removal (such as Branch MSD1086 in Hite Creek); these projects already have funds allocated for RDI/I removal. Other early candidates include areas with the highest peaking factors and thus the highest potential for RDI/I reduction. The actual schedule will be determined by MSD in conjunction with the CMOM Program, SCAP, and other associated programs.

Given the uncertainty of RDI/I removal, monitoring and adapted management techniques are critical to success of the I/I Program. Pre- and post rehabilitation flow monitoring will take place as part of the Final SSDP (refer to Volume 2, Section 1.3.1 for a description of this program) and will include areas in the I/I program. SSOs will also be monitored under SORP guidelines (refer to Section 1.3.1.5). Post-construction monitoring will be used to demonstrate the impacts of I/I improvements on RDI/I reduction. As SSOs are eliminated they will be removed from the I/I Program. If flow monitoring and the SORP program show that RDI/I removal has been effective but insufficient, additional RDI/I removal may be implemented as part of the I/I Program or the CMOM Program. If flow monitoring and the SORP program indicate that RDI/I removal has not been effective, additional construction alternatives may occur at the SSO.

2.3.5.9 Capital Improvement Projects

All MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. In some cases, the project was expanded and lengthened; in others, the project was shortened. In all cases, some portion of the capital project was included in the optimized solution, although this was not a requirement. The Capital Improvement Projects used in solution development are listed for each modeled area in Section 2.5.

2.3.5.10 Build-out Development

In preparing solutions, potential future development was considered. Consequently, MSD developed a method to determine areas likely to be developed and added to existing systems.

In general, build-out was applied as additional flow using the following criteria:

- Upstream of SSOs
- Drained by gravity to the SSO
- Limited to open areas outside of 100-year floodplain, parks and recreational areas
- Limited to buildable areas (no steep slopes or shallow bedrock)
- Developable in phases consistent with planning documents
- Single-family home equivalents, with peaked wastewater flows per MSD's Design Manual
- Flow added to the existing system at an appropriately sized interceptor
- Peak flow added to the model to coincide with peak rainfall
- Additional flows from all other areas would fall under the SCAP requirements

Appendix 2.3.5, Build-out Method and Modeling Techniques, provides the full reports describing the build-out potential and the techniques used for determining the areas. Specific build-out parameters used in solution development are listed for each modeled area in Section 2.5.

2.3.5.11 Future Model Updates

Following construction, calibration, and validation of models under the Final SSDP program, periodic updates to the model will be conducted. Every 12 months, each model will be reviewed internally by MSD to document any changes to the system that have occurred. Changes include new sewers, pump station eliminations, pump station upgrades, capacity upgrades, etc. With the results from this review, MSD will proceed with updating any significant changes in the sewer models. The need for an update will vary for each model due to the unique characteristics of each model. Appropriate documentation will take place for all model updates. The scale of the necessary documentation will be related to the scale of the changes to the model, the length of time since the last full model report was prepared, and the end use of the model.

2.4 SSO CHARACTERIZATION

This section discusses the initial SSO list and the process for the validation of MOPs by field investigation. It also presents the final SSO list used for Final SSDP solution development.

2.4.1 Initial SSOs

Identification, validation and characterization of SSOs are a continuous process. Management of the data associated with these activities is described in the SORP.

In the Spring of 2007, flow monitoring data collected throughout the MSD collection system along with continuous rainfall data from the MSD rainfall network, were used for initial calibration of the models. The calibrated models were then validated against 126 "initial" SSOs: those known to be active, known SSOs at the beginning of the modeling process in the Fall of 2007.

For each initial SSO, the following data was developed:

- **The 24-hour "threshold rainfall" volume**. This threshold rainfall was determined by noting the minimum (non-zero) 24-hour rainfall for each SSO event at each initial SSO. The rainfall was derived from the nearest rain gauge and centered on the time the SSO was first reported to overflow.
- **Average reported volume for each initial SSO**. This data is not as dependable as threshold rainfall since SSO volumes are estimated and reported based on when the SSO was first discovered until it ceases. This data was not used in calibration. MSD used this data for general guidance in the validation phase after calibration was performed to ensure models were predicting known overflows within a reasonable range of the reported volume. Refer to Section 2.3.5.2 for a description of the Model Validation process.

As described later in this section, MOPs that became validated by field investigation were added to the initial SSO list and used in further model validation.

2.4.2 MOP Validation Process

Early modeling based on initial SSOs indicated that SSOs might occur at locations other than documented SSOs. A separate category, known as MOPs, was created to classify these SSOs. A MOP corresponds to a particular manhole or pump station location.

MSD's goal was to verify the existence (or lack thereof) of the MOPs through field investigations. In particular, MSD focused on "targeted" MOPs, with the following characteristics:

- Modeled overflow volumes greater than 10,000 gallons during a 1.82-inch cloudburst storm
- Not hydraulically connected to a documented SSO

The following subsections summarize the field investigation process.

2.4.2.1 Investigation Procedures

The following steps briefly describe the investigation procedures developed by MSD for validating MOPs:

- Investigation teams attended MSD training for inspecting manholes and how to document findings.
- Seventy-one targeted MOPs were divided among teams by geographical location.
- During and immediately following three significant rain events in March, April, and May 2008, investigation teams performed the following:

- For each MOP, the surrounding area was inspected for sewer debris and other waste.
- Each MOP manhole, if possible, was opened, checked, and marked with chalk for future investigations. The chalk was used to assist in future inspections for determining if surcharge conditions occurred within the manhole.
- Upstream and downstream manholes were investigated if the MOP manhole could not be accessed or flow conditions in the MOP manhole could not be determined.
- Data was documented in work orders provided by MSD.
- MSD Customer Service was notified if an active overflow was observed.
- Overflow Report Forms were completed for any observed overflow.

2.4.2.2 MOP Classification

Based on field investigation findings, MOPs were classified into one of six categories. A summary of each category is outlined in the following.

1. Documented - An overflow was witnessed. MOP locations coded as documented SSOs require solution development by the modelers and added to the documented SSO list.

2. Suspected - Evidence found indicating an overflow had occurred. MOP locations coded as suspected overflows require solution development by the modelers and are added to the suspected SSO list.

3. Surcharged - Evidence found indicating manhole surcharging but not an overflow. Solution required. MOP locations coded as surcharged should remain a MOP status and will require solution development by the modelers according to surcharge criteria specified in the System Capacity Assurance Plan, described in Volume 1.

4. Remediated – Manhole was found to have a bolt-down lid. No solution was required. These manholes are all located along major streamlines or within the 100-year floodplain. Upstream and downstream manholes were investigated and also found to have bolt-down lids.

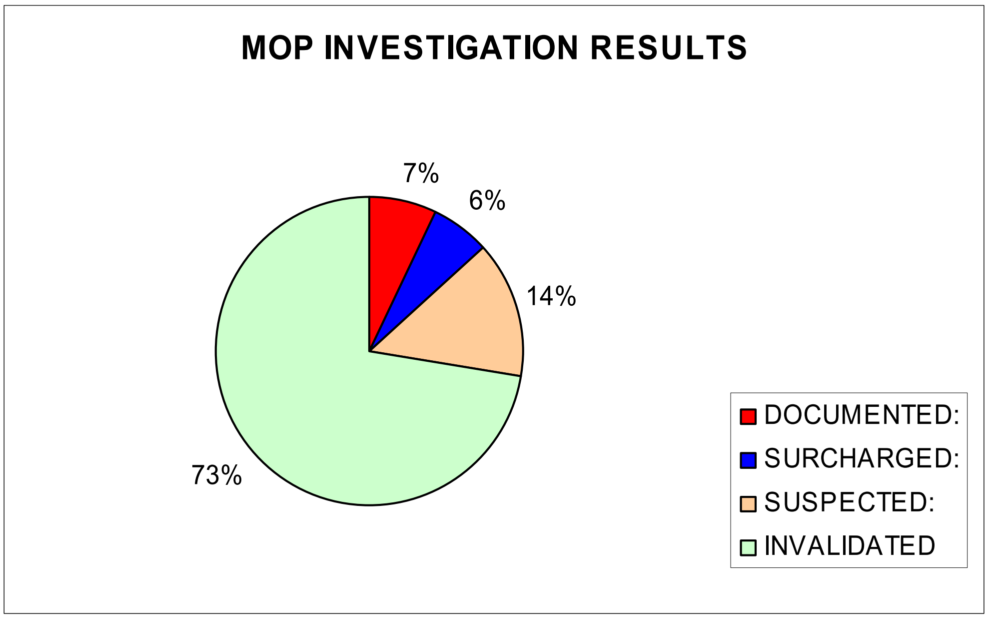
5. Invalidated - No problems found and no solution was required. Modeling teams were provided a list of invalidated MOPs and were directed to adjust I/I factors accordingly until the MOP locations have been successfully eliminated from the hydraulic models.

6. Unconfirmed - Could not locate the MOP manhole in the field, but upstream/downstream manholes displayed no problems. No solution required. These locations had upstream and/or downstream manholes that were inspected to determine flow conditions. All respective manholes displayed good flowing conditions; therefore, the unconfirmed MOP has become invalidated.

2.4.2.3 Specific Findings

On March 20 and 21, 2008, two-person teams performed extensive field manhole inspections following the storm event that ended on March 19. Additionally, on April 4-5 and May 9, 2008, inspection teams revisited and field-investigated all invalidated and unconfirmed MOPs following the April 3 and 4 rain event that produced approximately four inches of rain in a 24-hour period and the May 8 rain event of similar magnitude. This was performed as follow-up reconnaissance and confirmation that invalidated MOPs were accurately categorized and unconfirmed MOPs were given a second and even third attempt to locate. In total, 211 manholes were investigated during the MOP investigation process. Detailed results from these investigations are included in Appendix 2.4.1, MOP Investigation Findings. Figure 2.4.1 summarizes the investigation results.

FIGURE 2.4.1 MOP INVESTIGATION SUMMARY



2.4.2.4 Re-validation of Models

After the final set of validated SSOs was developed, it was necessary to re-validate the hydraulic models to these SSOs. After this validation process was completed, the final list of targeted SSOs was compiled for project development. This list is discussed in the following section.

2.4.3 SSOs Targeted for Solution Development

A total of 173 SSO locations were validated within the MSD system and are considered in the Final SSDP projects (refer to Volume 3, Chapter 3). Table 2.4.2 summarizes the typical volume, receiving stream, model region, and service area of each SSO. The SSO volume information was averaged based on actual field investigation and was used to estimate life-cycle costs such as pumping, fines, and cleanup.

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
1	MSD0199-LS	Lucas Lane	Berrytown	Goose Creek	Berrytown	LS	5,000
2	28984	Plumwood #1	Cedar Creek	Cedar Creek	Cedar Creek	Manhole	21,600
3	28998	Plumwood #2	Cedar Creek	Cedar Creek	Cedar Creek	Manhole	21,600
4	63094	Plumwood #4	Cedar Creek	Cedar Creek	Cedar Creek	Manhole	50
5	63095	Plumwood #5	Cedar Creek	Cedar Creek	Cedar Creek	Manhole	13
6	67997	7906 Gainsborough Court	Cedar Creek	Little Cedar Creek	Cedar Creek	Manhole	25
7	67999	7904 Shaw Court	Cedar Creek	Little Cedar Creek	Cedar Creek	Manhole	Suspected- no data
8	70158	Plumwood #3	Cedar Creek	Cedar Creek	Cedar Creek	Manhole	378,333
9	81316	Fairmount Road #1	Cedar Creek	Big Run	Cedar Creek	Manhole	500
10	86423	8314 Casualwood Way	Cedar Creek	Little Cedar Creek	Cedar Creek	Manhole	MOP - No data
11	88545	11101 Cambridge Commons Drive	Cedar Creek	Big Run	Cedar Creek	Manhole	Suspected- no data
12	89195	8104 Kimberly Way	Cedar Creek	Little Cedar Creek	Cedar Creek	Manhole	MOP - No data
13	89197	8104 Kimberly Way	Cedar Creek	Little Cedar Creek	Cedar Creek	Manhole	MOP - No data
14	97362	Fairmount Road #2	Cedar Creek	Big Run	Cedar Creek	Manhole	212,100
15	MSD1080-LS	Running Fox	Cedar Creek	Little Cedar Creek	Cedar Creek	LS	36,940
16	94187	Wet Well for St. Rene Road PS	Chenoweth Hills	Chenoweth Run	Chenoweth Hills	Manhole	4,380
17	33003	815 Tucker Station Road	Floyds Fork	Pope Lick	Floyds Fork	Manhole	Suspected- no data
18	65531	12400 Brierly Hill Place	Floyds Fork	Pope Lick	Floyds Fork	Manhole	Suspected- no data
19	MSD0165-PS	Olde Copper Court	Floyds Fork	Floyds Fork	Floyds Fork	LS	2,320
20	MSD0166-PS	Ashburton	Floyds Fork	Floyds Fork	Floyds Fork	LS	No Data
21	MSD0263	Chenoweth Hills WQTC	Floyds Fork	Chenoweth Run	Jeffersontown	Treatment Plant	2,767
22	MSD1105-PS	Eden Care	Floyds Fork	Floyds Fork	Floyds Fork	LS	200
23	90776	Floydsburg Road #1	Hite Creek	Floyds Fork	Hite Creek	Manhole	30,700
24	91087	Near Meadow Stream PS	Hite Creek	South Fork Harrods Creek	Hite Creek	Manhole	405,001
25	108956	Floydsburg Road #2	Hite Creek	Floyds Fork	Hite Creek	Manhole	75
26	108957	Floydsburg Road #3	Hite Creek	Floyds Fork	Hite Creek	Manhole	85,500
27	108958	Floydsburg Road #4	Hite Creek	Floyds Fork	Hite Creek	Manhole	13,000
28	MSD1082-PS	Meadow Stream	Hite Creek	Floyds Fork	Hite Creek	LS	51,000
29	MSD1085-PS	Kavanaugh Rd	Hite Creek	Hite Creek	Hite Creek	LS	176,000
30	MSD1086-PS	Floydsburg Road	Hite Creek	Floyds Fork	Hite Creek	LS	2,502

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
31	62769	Fox Hill Road/ Fox Hunt Court	Hunting Creek North	Harrods Creek	Hunting Creek North	Constructed	No data
32	MSD1055-LS	Gunpowder	Hunting Creek North	Harrods Creek	Hunting Creek North	Pumped	17,199
33	MSD1060-LS	Riding Ridge	Hunting Creek North	Harrods Creek	Hunting Creek North	Pumped	4,700
34	MSD0292	Hunting Creek South WQTC	Hunting Creek South	Harrods Creek	ORFM	Treatment Plant	117,436
35	MSD1063-PS	Deep Creek	Hunting Creek South	Harrods Creek	Hunting Creek South	LS	15,623
36	MSD1065-PS	Fairway View	Hunting Creek South	Harrods Creek	Hunting Creek South	LS	19,500
37	27969	4304 Rivanna Dr	Jeffersontown	Fern Creek	Jeffersontown	Manhole	Suspected- no data
38	28173	Watterson Trail	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	46,028
39	28249	Charlane Parkway/St Edwards Drive	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	14,676
40	28250	Charlane Parkway Near the Street	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	31,422
41	28336	Parking Lot Charlane Parkway	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	247,618
42	28340	Charlane Parkway at Pool	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	36,804
43	28390	10025 Grassland Road	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	MOP - No data
44	28391	Grassland #3	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	387,000
45	28392	Grassland #2	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	2,160,000
46	28395	Grassland #1	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	251,378
47	28413	3317 Dell Road	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	No Data
48	28414	3322 Dell Road	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	55,012
49	28415	3406/3404 Dell Road	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	143,920
50	28416	Marlin Drive	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	78,000
51	28417	Locust Avenue/Marlin Drive	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	15,000
52	28711	9510 Taylorsville Road	Jeffersontown	Avoca Creek	Jeffersontown	Manhole	Suspected- no data
53	28719	Intersection of Gleeson and Wendell	Jeffersontown	Avoca Creek	Jeffersontown	Manhole	MOP - No data
54	31733	10001 Grassland Road	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	Suspected- no data
55	64096	Chenoweth Run #1	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	51
56	64505	3200 Ruckreigel Pky	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	Suspected- no data

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
57	86052	4706 Chenoweth Run	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	Suspected- no data
58	92061	11804 Chippewa Ridge Lane	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	3,917
59	104289	3620 Charlane Pky	Jeffersontown	Chenoweth Run	Jeffersontown	Manhole	Suspected- no data
60	IS028-SI	Jeffersontown WQTC Siphon	Jeffersontown	Chenoweth Run	Jeffersontown	Constructed	113,000
61	MSD0151-PS	Monticello Place	Jeffersontown	Fern Creek	Jeffersontown	LS	10,000
62	MSD0196-PS	Chenoweth Run	Jeffersontown	Chenoweth Run	Jeffersontown	LS	212,117
63	MSD0255	Jeffersontown WQTC	Jeffersontown	Chenoweth Run	Jeffersontown	Treatment Plant	1,800,658
64	MSD1169-LS	Lake Forest	Lake Forest	Floyds Fork	Lake Forest	LS	MOP - No data
65	00746	Manhole Adjacent to Anchor Estates PS #1	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Pumped	10,762
66	01106	Vannah PS Wetwell Manhole	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Constructed	No Data
67	01793	9 Muirfield Place	Morris Forman	Middle Fork Beargrass Creek	Southeastern Diversion	Manhole	109,000
68	02932	Oxmoor #1	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	1,203,000
69	02933	Oxmoor #2	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	150,000
70	02935	Oxmoor #3	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	3,420
71	08537	Northern Ditch Blow-off	Morris Forman	Greasy Ditch	Middle Fork	Constructed	No data
72	08717	Fincastle #2	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	100
73	13931	Camp Taylor #4	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	6,000
74	13943	Camp Taylor #3	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	250
75	16649	Wickland Road/ Sutherland Drive	Morris Forman	South Fork Beargrass Creek	Southeastern Diversion	Constructed	1,078,972
76	22436	Manhole Adjacent to West Goose Creek PS	Morris Forman	Goose Creek	ORFM	Pumped	30,275

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
77	23211	Peabody Lane #1	Morris Forman	South Fork Beargrass Creek	Middle Fork	Constructed	2,309,980
78	23212	Peabody Lane #2	Morris Forman	South Fork Beargrass Creek	Middle Fork	Manhole	9,720
79	24472	501 Mockingbird Valley Road	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	MOP - No data
80	25676	Alcona Lane	Morris Forman	South Fork Beargrass Creek	Southeastern Diversion	Manhole	288,969
81	26650	Briarbridge Ln at South Fork Beargrass Creek	Morris Forman	South Fork Beargrass Creek	Southeastern Diversion	Manhole	150
82	26651	Klondike Ln at South Fork Beargrass Creek	Morris Forman	South Fork Beargrass Creek	Southeastern Diversion	Manhole	2,511,000
83	26752	Brownsboro Road at Mockingbird Valley #1	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	25
84	27005	Bridge #6 - Cherokee Park	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	2,152,664
85	36763	3520 Fincastle Road	Morris Forman	Camp Taylor Ditch	Combined	Manhole	Suspected- no data
86	40870	Muddy Fork PS #1	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	41,800
87	40871	Muddy Fork PS #2	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	150,067
88	40872	Muddy Fork PS #3	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	183,400
89	41374	Brownsboro Road at Mockingbird Valley #2	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	100
90	41416	3202 Brownsboro Road	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Manhole	Suspected- no data
91	42680	Barbour Lane #1	Morris Forman	Little Goose Creek	ORFM	Pumped	162,000
92	43472	Near Saurel Drive PS	Morris Forman	Goose Creek	Middle Fork	Manhole	118
93	44396	Fincastle #4	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	79,500

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
94	44397	Fincastle #3	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	41,420
95	45835	Beargrass Road near Big Rock	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	456,021
96	46891	Goose Creek PS Wet Well	Morris Forman	Goose Creek	Middle Fork	Manhole	246,000
97	47250	1645 Rangeland Rd	Morris Forman	No Data	Southeastern Diversion	Capacity	MOP - No data
98	47583	Oxmoor #4	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	2,557,520
99	47593	Near LG&E Power Station	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	359,960
100	47596	7410 Steeplecrest Circle	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	Suspected- no data
101	47603	Kindercare #1	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	120
102	47604	Kindercare #2	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	17,083
103	51160	Peabody Lane #3	Morris Forman	South Fork Beargrass Creek	Middle Fork	Manhole	55,500
104	51161	Brooklawn	Morris Forman	South Fork Beargrass Creek	Middle Fork	Manhole	438,000
105	51221	Watterson Expressway at South Fork Beargrass Creek	Morris Forman	South Fork Beargrass Creek	Middle Fork	Constructed	13,500
106	51594	Trevilian Way	Morris Forman	South Fork Beargrass Creek	Southeastern Diversion	Manhole	51
107	55665	Hazelwood PS wetwell	Morris Forman	Upper Mill Creek	Combined	Manhole	28,000
108	62418	Goose Creek PS Near Goose Creek	Morris Forman	Goose Creek	Middle Fork	Manhole	128,000
109	65633	Barbour Lane #2	Morris Forman	Little Goose Creek	ORFM	Manhole	102,125
110	65635	Barbour Lane #3	Morris Forman	Little Goose Creek	ORFM	Manhole	25,500

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
111	66349	Fincastle #1	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	15
112	90700	Christian Court	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	5,400
113	91629	Old Westport Road at Goose Creek PS #2	Morris Forman	Goose Creek	Middle Fork	Manhole	15,750
114	91630	Old Westport Road at Goose Creek PS #3	Morris Forman	Goose Creek	Middle Fork	Manhole	5,250
115	96020	Leland Road	Morris Forman	Cherrywood Creek	ORFM	Manhole	20
116	104223	Camp Taylor #1	Morris Forman	South Fork Beargrass Creek	Combined	Manhole	40
117	104231	Camp Taylor #2	Morris Forman	Camp Taylor Ditch	Combined	Manhole	1,217
118	105936	Old Westport Road at Goose Creek PS #1	Morris Forman	Goose Creek	Middle Fork	Manhole	10,927
119	00056-W	Anchor Estates #1 Wetwell	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Manhole	11,929
120	08935-SM	Middle Fork at Breckenridge Lane	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Constructed	3,020,300
121	21628-W	Devondale Wet Well Manhole (PS Overflow)	Morris Forman	Goose Creek	Middle Fork	Pumped	58,013
122	24152-W	3733 Canoe Lane (Wet Well for Canoe Ln PS)	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Constructed	60,750
123	IS021A-SI	Bowman Field Siphon	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	Constructed	No data
124	MSD0007-PS	Mockingbird Valley	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Constructed	10,840
125	MSD0010-PS	Winton	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Constructed	45
126	MSD0023-PS	Mellwood Avenue	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Constructed	287,472
127	MSD0024-PS	Canoe Lane	Morris Forman	Muddy Fork Beargrass Creek	ORFM	LS	15,769
128	MSD0042-PS	Sonne Avenue	Morris Forman	Paddy Run	Combined	Pumped	156,075
129	MSD0057-LS	Anchor Estates #2	Morris Forman	Middle Fork Beargrass Creek	Middle Fork	LS	14,519

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
130	MSD0095-PS	Derington Court	Morris Forman	Goose Creek	ORFM	Pumped	18,875
131	MSD0123-PS	West Goose Creek	Morris Forman	Goose Creek	ORFM	LS	36,750
132	MSD0183-PS	Glenview Hills	Morris Forman	Ohio River	ORFM	LS	73,733
133	MSD0192-PS	Barbour Lane	Morris Forman	Little Goose Creek	ORFM	LS	38,581
134	MSD0193-PS	New Market	Morris Forman	Muddy Fork Beargrass Creek	ORFM	LS	16,333
135	MSD1044-PS	Phoenix Hill	Morris Forman	Muddy Fork Beargrass Creek	ORFM	Pumped	2,252
136	28729	9100 Marian Ct (Wet Well for Marian Ct PS)	No Plant	Avoca Creek	Jeffersontown	Constructed	No data
137	21229-W	Avanti Way at Fernview Road	No plant	Little Cedar Creek	Pond Creek	Constructed	No data
138	MSD0149-PS	Raintree	No Plant	Avoca Creek	Jeffersontown	Constructed	MOP - No data
139	MSD0263A-PS	Chenoweth Hills WQTC PS	No Plant	Chenoweth Run	Jeffersontown	LS	108,767
140	04498	820 Echo Bridge Road	Derek R. Guthrie	Mill Creek	Mill Creek	Manhole	Suspected- no data
141	04542	Fern Lea PS Wet Well	Derek R. Guthrie	Heatherfield Ditch	Mill Creek	Manhole	91,500
142	17724	1096 Springview Drive	Derek R. Guthrie	Pond Creek	Pond Creek	Manhole	33
143	19360	Rockwood Dr / Monaco	Derek R. Guthrie	Northern Ditch	Pond Creek	Manhole	Suspected- no data
144	19369	5221 Layne Road	Derek R. Guthrie	Northern Ditch	Pond Creek	Manhole	Suspected- no data
145	25477	6101 Price Lane Road	Derek R. Guthrie	Fishpool Creek	Pond Creek	Manhole	Suspected- no data
146	25478	6006 Cooper Chapel Road	Derek R. Guthrie	Fishpool Creek	Pond Creek	Manhole	Suspected- no data
147	25480	6112 Cooper Chapel Rd	Derek R. Guthrie	Fishpool Creek	Pond Creek	Manhole	6,500
148	25484	Near Lantana PS	Derek R. Guthrie	Pennsylvania Run	Pond Creek	Manhole	180,875
149	27116	10306 Caven Avenue	Derek R. Guthrie	Mud Creek	Pond Creek	Manhole	Suspected- no data
150	29933	6926 Sandstone Blvd	Derek R. Guthrie	Fern Creek	Pond Creek	Manhole	Suspected- no data
151	29943	6906 Sandstone Blvd	Derek R. Guthrie	Fern Creek	Pond Creek	Manhole	Suspected- no data
152	29948	Sandstone Blvd	Derek R. Guthrie	Fern Creek	Pond Creek	Manhole	75
153	31083	6924 Sandstone Blvd	Derek R. Guthrie	Fern Creek	Pond Creek	Manhole	Suspected- no data
154	31084	6916 Sandstone Blvd	Derek R. Guthrie	Fern Creek	Pond Creek	Manhole	Suspected- no data
155	35309	Marjorie Drive	Derek R. Guthrie	Manslick Branch	Pond Creek	Manhole	10,825
156	36419	10601 Leven Blvd	Derek R. Guthrie	Pennsylvania Run	Pond Creek	Manhole	Suspected- no data
157	60679	Manhole Adjacent to Cinderella PS	Derek R. Guthrie	Fishpool Creek	Pond Creek	Manhole	8,100
158	70212	1095 Springview Drive	Derek R. Guthrie	Fishpool Creek	Pond Creek	Manhole	Suspected- no data

TABLE 2.4.2

SSOS TARGETED FOR FINAL SSDP SOLUTION DEVELOPMENT

No.	SSO ID	SSO Name/ Address	Service Area	Receiving Stream	Model Region	Overflow Type	Avg Per Incident (gal)
159	79076	6308 Hanses Drive	Derek R. Guthrie	Blue Spring Ditch	Pond Creek	Manhole	Suspected- no data
160	92098	7801 Edsel Lane (Upstream of Edsel Lane PS)	Derek R. Guthrie	Fern Creek	Pond Creek	Pumped	3,600
161	93719	Wet Well for Lantana PS	Derek R. Guthrie	Pennsylvania Run	Pond Creek	Manhole	5,625
162	04699-W	East Rockford PS	Derek R. Guthrie	Mill Creek	Mill Creek	Pumped	No data
163	81814-W	Pioneer Road PS	Derek R. Guthrie	Mill Creek	Mill Creek	Pumped	32,750
164	MSD0047-PS	Fern Lea	Derek R. Guthrie	Mill Creek	Mill Creek	Pumped	141,083
165	MSD0050-PS	Garrs Lane	Derek R. Guthrie	Mill Creek	Mill Creek	Pumped	72,000
166	MSD0101-PS	Lantana Drive PS #1	Derek R. Guthrie	Pennsylvania Run	Pond Creek	LS	22,300
167	MSD0130-PS	Cooper Chapel	Derek R. Guthrie	Fishpool Creek	Pond Creek	Constructed	4,442
168	MSD0133-PS	Caven Avenue	Derek R. Guthrie	Mud Creek	Pond Creek	Pumped	15,250
169	MSD0180-PS	Government Center	Derek R. Guthrie	Pennsylvania Run	Pond Creek	LS	12,381
170	MSD1010-PS	Lea Ann Way	Derek R. Guthrie	Northern Ditch	Pond Creek	Pumped	3,024,040
171	MSD1013-PS	Cinderella	Derek R. Guthrie	Fishpool Creek	Pond Creek	LS	71,356
172	MSD1019-PS	Leven	Derek R. Guthrie	Pennsylvania Run	Pond Creek	Pumped	Suspected- no data
173	MSD1048-PS	Edsel	Derek R. Guthrie	Fern Creek	Pond Creek	LS	91,500
PS- pump station, LS – lift station, CO- cleanout, SI-siphon, W-wet well, MOP – Modeled Overflow Point							

2.5 FINAL SSDP WATERSHED MODEL DEVELOPMENT

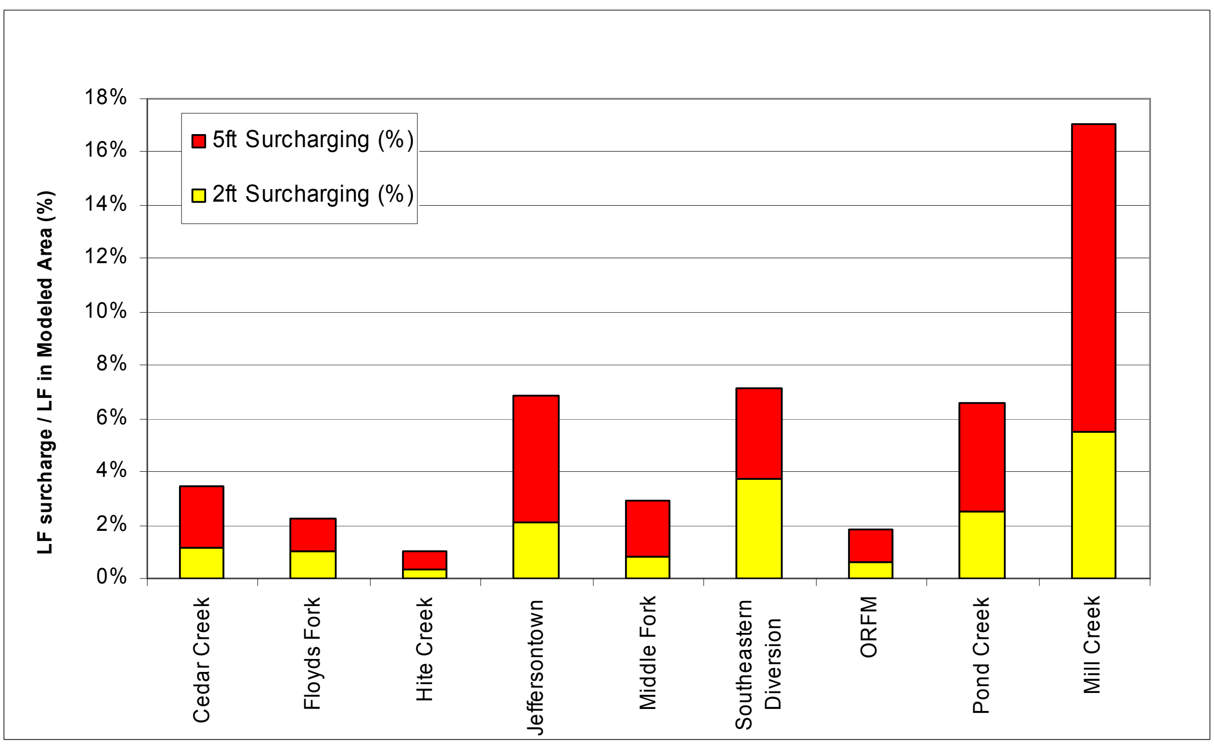
This section provides an overview of existing sewer system deficiencies and individual watershed model development, including validation, RDI/I reduction, build-out potential, and branching. System deficiencies include surcharged pipes and hydraulic bottlenecks. System deficiencies were analyzed and considered for determining causes of SSOs and SSO solution projects.

2.5.1 Surcharged Pipe Criteria

For the Final SSDP, surcharged pipes were categorized and analyzed using two criteria: 1) two feet below the manhole rim; and 2) five feet below the manhole rim. This criterion was formulated based on SCAP methodology. According to the SCAP, a wet weather surcharge condition is defined as a water surface level within the sewer that is less than two feet from the manhole rim elevation. If the sewer system is in a residential area with historical capacity-related backup complaints, then a surcharge condition is considered to be a water surface level within five feet of the manhole rim. Based on this data, models were analyzed at the 1.82-inch cloudburst storm under existing system conditions to determine surcharge levels.

Figure 2.5.1 shows surcharge percentages for each modeled watershed area during the 1.82-inch cloudburst storm under existing sewer system conditions. Mapping related to these evaluations are found in Appendix 2.5.1.

FIGURE 2.5.1 TOTAL SURCHARGING PERCENT BY MODELED AREA



2.5.2 Hydraulic Bottlenecks

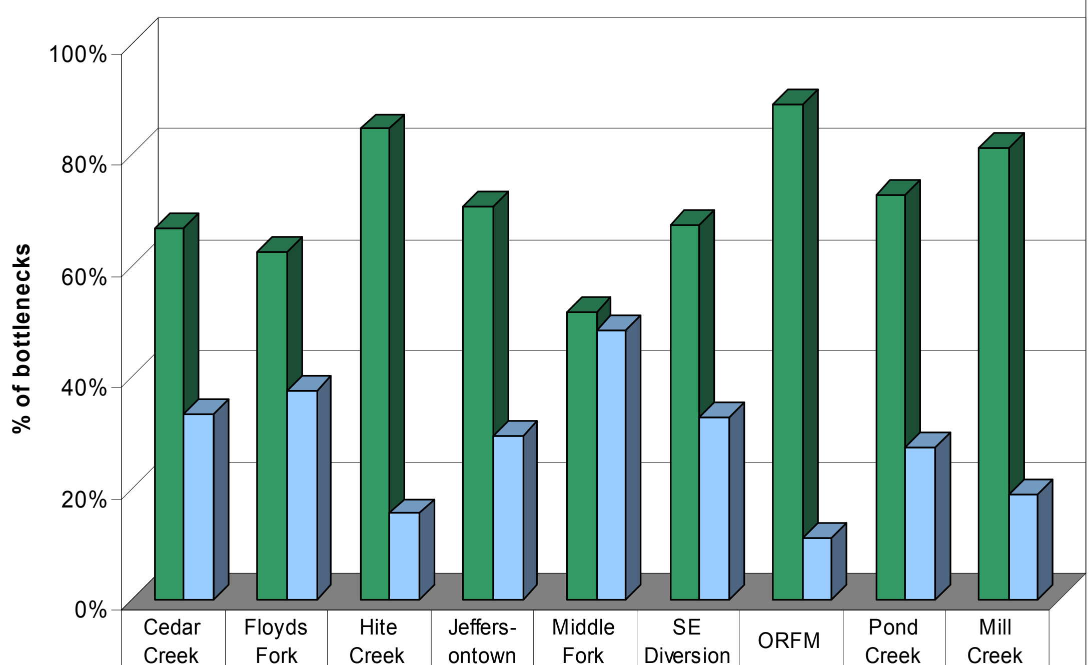
A hydraulic bottleneck is characterized by upstream system capacity that is greater than the downstream system capacity as identified by the model. The number of hydraulic bottlenecks by modeled watershed area is summarized in Table 2.5.1 and Figure 2.5.2. Most of the bottlenecks were found in the collection system, with the exception of Middle Fork where many of the bottlenecks were found in interceptor pipe (12-inch diameter and greater). Mapping related to these evaluations are found in Appendix 2.5.1, Surcharge/Bottleneck Maps.

TABLE 2.5.1

NUMBER OF SEPARATE SSS BOTTLENECKS BY MODELED AREA

Modeled Bottlenecks	
Modeled Area	**Number of Bottlenecks**
Cedar Creek	18
Floyds Fork	8
Hite Creek	13
Jeffersontown	136
Middle Fork	64
Southeastern Diversion	58
ORFM	91
Pond Creek	92
Mill Creek	48
Total	**516**

FIGURE 2.5.2 SUMMARY OF SEPARATE SSS BOTTLENECKS IN MODELED AREA



	Cedar Creek	Floyds Fork	Hite Creek	Jeffers-ontown	Middle Fork	SE Diversion	ORFM	Pond Creek	Mill Creek
Collectors (6" - 10")	67%	63%	85%	71%	52%	67%	89%	73%	81%
Interceptors (12" - 72")	33%	38%	15%	29%	48%	33%	11%	27%	19%

2.5.3 Cedar Creek Model Development

This section provides a summary of the Cedar Creek watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.3.1 SSO Descriptions for Cedar Creek

Cedar Creek is divided into five branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.3 for a map of the Cedar Creek branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 70158 addresses five SSOs: 28984, 28998, 63094, 63095, and 70158. The SSOs are due to shallow invert levels and a hydraulic bottleneck where a 15-inch diameter sewer line combines with a 10-inch diameter sewer line, which both flow into an 8-inch diameter line. The contributing area is single-family residential.

Branch 81316 addresses two SSOs: 81316 and 97362. These SSOs are just upstream of the Fairmount Road Pump Station, MSD1022-PS. The SSOs are most likely caused by upstream flows greater than the available pump station wet weather capacity. The area surrounding the SSO is residential with open spaces.

Branch 67997 addresses five SSOs: 67997, 67999, 86423, 89195, and 89197. During wet weather, the interceptor is unable to handle peak wet weather flow rates, and lower elevation manholes that are below the hydraulic grade line are shown to overflow in the model. Peak wet weather flow is the anticipated, calculated, or monitored maximum flow within the sewer system during an actual or synthetic rainfall event. The contributing area is single-family residential.

Branch MSD1025 addresses one SSO: 88545. This SSO is just upstream of the Bardstown Road Pump Station, MSD1025-PS. It is most likely caused by upstream flows greater than the available pump station wet weather capacity. The contributing area is single-family residential.

Branch MSD1080 addresses one SSO: MSD1080-LS (Running Fox Lift Station). The SSO is located in the Fox Ridge Subdivision off Beulah Church Road. It is likely caused by upstream flows greater than the available pump station wet weather capacity. The contributing area is single-family residential.

2.5.3.2 Validation for Cedar Creek

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were five validated SSOs in the Cedar Creek model: 28984, 28998, 70158, 81316, and 97362. 28984, 28998, and 70158 are hydraulically connected with each other and were validated by modeled SSOs at 28998, 63094, and 63095. Similarly, SSOs 81316 and 97362 are hydraulically connected and were validated by a single modeled SSO at 97365.

2.5.3.3 RDI/I Reduction for Cedar Creek

The RDI/I reduction process for Cedar Creek follows the procedures described in Section 2.3.5.7. Table 2.5.2 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Cedar Creek. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.2

CEDAR CREEK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
81316	2.3	0%
87001	2.6	1%
74696	3.1	3%
83010	3.1	3%
89176	3.2	3%
63095	3.4	4%
64023	3.8	5%
98027	8.0	23%
Average Projected RDI/I Reduction		**5.3%**

2.5.3.4 Build-out for Cedar Creek

In preparing solutions, potential future development (build-out) was considered. Build-out was only applied as additional flow upstream of known or suspected SSOs. The build-out process for Cedar Creek followed the procedures described in Section 2.3.5.10 and results are listed in Table 2.5.3. There are five general locations where additional flow was applied to the model to represent future development and corresponding flows.

TABLE 2.5.3

CEDAR CREEK PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
70158	28278	1,353
70158	28298	5,727
70158	28981	31,274
70158	28985	3,424
70158	28976	4,421
Total Future Projected Additional Flows		**46,129**

2.5.3.5 Capital Improvement Projects for Cedar Creek

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There was one Capital Improvement Project integrated into the Cedar Creek hydraulic model.

MSD Project C94086: Fern Hill Subdivision Interceptor No. 8. The project takes flow from Holly Oaks Pump Station (MSD0161-PS) and Exhibition Court Pump Station (MSD1052-PS) to the Fern Creek / Nottingham Interceptor No. 6 near Stonybrook Drive and Hurstbourne Parkway, eliminating the SSOs at these pump stations. The Holly Oaks and Exhibition Court Pump Stations were eliminated.

2.5.4 Floyds Fork Model Development

This section provides a summary of the Floyds Fork watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.4.1 SSO Descriptions for Floyds Fork

Floyds Fork is divided into three branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.4 for a map of the Floyds Fork branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 1 addresses two SSOs: 33003, 65531, and several surcharged areas. These SSOs are located in Douglas Hills Subdivision on Tucker Station Road. The SSO 33003 occurs at a manhole that is part of a 15-inch interceptor that runs parallel to Tucker Station Road. The SSO 65531 occurs at a manhole that is part of the same 15-inch interceptor as 33003. The SSOs are located in a residential area along a stream, and are likely caused by inability of the interceptor to convey upstream flow.

Branch 2 addresses one SSO: MSD1105-PS (Eden Care Pump Station). The SSO is located in Martin C.B. Farm Subdivision off Blankenbaker Parkway next to the Eden Terrace Retirement Community. It is likely caused by upstream flows greater than the available pump station wet weather capacity.

Branch 3 addresses two SSOs: MSD0165-PS (Olde Copper Ct. Pump Station) and MSD0166-Pump Station (Ashburton Pump Station). These SSOs are located in Copperfield Subdivision near Beckley Station. In this branch, the Ashburton Pump Station pumps to a gravity line that drains into the Olde Copper Court Pump Station. The Olde Copper Court Pump Station is located alongside a small creek that is downhill from a residential area. The Ashburton Pump Station is located alongside a small creek that is downhill from a residential area. Both SSOs are most likely caused by upstream flows greater than the available pump station wet weather capacity.

2.5.4.2 Validation for Floyds Fork

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2) with the exception of SSO 65531. However, this SSO is hydraulically connected to SSO 33003. There were five validated SSOs in the Floyds Fork modeled area.

2.5.4.3 RDI/I Reduction for Floyds Fork

The RDI/I reduction process for Floyds Fork follows the procedures described in Section 2.3.5.7. Table 2.5.4 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Floyds Fork. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.4

FLOYDS FORK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
96911A	2.1	0%
99901	2.6	1%
46316	3.6	5%
97793	4.6	9%
84509	4.9	10%
46327	5.0	11%
97804	5.3	12%
108245A	6.6	17%
Average Projected RDI/I Reduction		**8.0%**

2.5.4.4 Build-out for Floyds Fork

In preparing solutions, potential future development (build-out) was considered. Build-out was only applied as additional flow upstream of known or suspected SSOs. The build-out process for Floyds Fork follows the procedures described in Section 2.3.5.10 and listed in Table 2.5.5. There are two general locations where additional flow was applied to the model to represent future development and corresponding flows.

TABLE 2.5.5

FLOYDS FORK PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
Branch 1	33003	79,200
Branch 2	MSD1105-PS	5,500
Total Future Projected Additional Flows		**84,700**

2.5.4.5 Capital Improvement Projects for Floyds Fork

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design.

Middletown Recapture. This project eliminates the Berrytown, Starview, Middletown Industrial, and Chenoweth Run WQTCs by connecting to the Old Henry Road Force Main which delivers wastewater to the Floyds Fork WQTC. Additionally, a new Lake Forest Pump Station will be constructed to deliver the flow from these WQTCs to the Old Henry Road Force Main. Construction is expected to be complete by late 2011.

2.5.5 Hite Creek Model Development

This section provides a summary of the Hite Creek watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.5.1 SSO Descriptions for Hite Creek

Hite Creek is divided into three branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.5 for a map of the Hite Creek branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch MSD1082 addresses two SSOs: 91087 and MSD1082-PS (Meadow Stream Pump Station). Meadow Stream Pump Station is on the south end of the city of Crestwood near I-71. The SSOs are located in a residential area along South Fork Beargrass Creek, and are likely caused by upstream flows greater than the available pump station wet weather capacity.

Branch MSD1085 addresses one SSO: MSD1085-PS (Kavanaugh Rd. Pump Station). The SSO is located on the southwest side of Crestwood, downstream of Cherry Lane Pump Station and Kavanaugh Rd. Pump Station. The site of the SSO occurrence is between two homes, and the area surrounding the SSO is residential with open spaces. This SSO is likely caused by upstream flows greater than the available pump station wet weather capacity.

Branch MSD1086 addresses five SSOs: 90776, 108596, 108957, 108958, and MSD1086-PS (Floydsburg Rd. Pump Station). These SSOs are located on the south end of Crestwood just west of Floydsburg Road. The SSOs are located at the Floydsburg Road Pump Station or just upstream of the pump station. The pump station is in an industrial area with some residential area. The SSOs are likely caused by upstream flows greater than the available pump station wet weather capacity.

2.5.5.2 Validation for Hite Creek

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were five validated SSOs in the Hite Creek model. SSOs MSD1086-PS, 90776, and 108956 (associated with MSD1086-PS) are hydraulically connected and were validated by a single modeled SSO at 90776.

Reported SSOs 11877 and 30520 at the Hite Creek WQTC were originally ranked in the top third of the reported SSO volumes, but were invalidated during the modeling process because the Hite Creek WQTC influent pumping station was relocated out of the 100-year floodplain which eliminated the problem. Under normal conditions, the WQTC's wet weather capacity is sufficient and there are no SSOs.

2.5.5.3 RDI/I Reduction for Hite Creek

The RDI/I reduction process for Hite Creek follows the procedures described in Section 2.3.5.7. Table 2.5.6 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Hite Creek. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.6

HITE CREEK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
00205	0.0	0%
29526	2.2	0%
30521	2.5	0%
40943	2.6	1%
29499	2.7	1%
91122	3.1	3%
MSD1082-PS	3.1	3%
90719	7.4	20%
Average Projected RDI/I Reduction		**3.5%**

2.5.5.4 Build-out for Hite Creek

In preparing solutions, potential future development (build-out) was considered. Build-out was only applied as additional flow upstream of known or suspected SSOs. The build-out process for Hite Creek follows the procedures described earlier in Section 2.3.5.10 and listed in Table 2.5.7. There are five general locations where additional flow was added to the model to represent future development and corresponding flows.

TABLE 2.5.7

HITE CREEK PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
MSD1085	90781	600
MSD1085	90811	2,000
MSD1085	102897	40,000
MSD1085	90877	64,300
MSD1086	90776	25,400
Total Future Projected Additional Flows		**132,300**

The addition of build-out flow was considered for one other location in the Hite Creek model, areas surrounding the Meadow Stream Pump Station. Future rates amounting to 1,579,200 gpd were so large that build-out flow significantly outweighed the reported SSO amount and would have been beyond the extent of the SSO solutions development. Although portions of this flow were added at upstream locations (listed above for Kavanaugh Road and Floydsburg Road), the majority was considered outside the scope of modeling SSO solutions.

2.5.5.5 Capital Improvement Projects for Hite Creek

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There were no Capital Improvement Projects integrated into the Hite Creek hydraulic model.

2.5.6 Jeffersontown Model Development

This section provides a summary of the Jeffersontown watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.6.1 SSO Descriptions for Jeffersontown

Jeffersontown is divided into five branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Branch 1A is a sub-section of Branch 1, created to minimize the extreme size of the branch. They were analyzed separately but combined for project solution development. Refer to Figure 2.5.6 for a map of the Jeffersontown branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 1 addresses nine SSOs: 28173, 28390, 28391, 28392, 28395, 31733, 64505, MSD0025 (Jeffersontown WQTC), and ISO28-SI (Jeffersontown Siphon). The SSOs are upstream of the Jeffersontown WQTC, which is on Chenoweth Run north of Taylorsville Road. Many of the SSOs in this branch are caused by insufficient wet weather capacity in the Jeffersontown Interceptor to convey excess flow downstream. The SSO ISO28-SI is most likely caused by upstream flows greater than the available Jeffersontown WQTC wet weather capacity. The contributing area is a mix of single-family residential, industrial, and commercial.

Branch 1A addresses five SSOs: 64096, 86052, 92061, MSD0196-PS (Chenoweth Run Pump Station), and MSD0263A-PS (Chenoweth Hills WQTC Pump Station). This branch has 38,200 LF of sewer in the Chenoweth Hills WQTC service area. The SSOs 64096, 86052 and MSD0196-PS are likely caused by upstream flows greater than the available Chenoweth Run Pump Station wet weather capacity. The SSO 92061 is likely caused by upstream flows greater than the available Chippewa Pump Station wet weather capacity. The SSO MSD0236A-PS is likely caused by upstream flows greater than the available Chenoweth Hills WQTC wet weather capacity. The contributing area is single-family residential.

Branch 2 addresses ten SSOs: 28249, 28250, 28336, 28340, 28413, 28414, 28415, 28416, 28417, and 104289. The SSOs are caused by the gravity lines having insufficient wet weather capacity. The contributing area is single-family residential.

Branch 3 addresses four SSOs: 28711, 28719, 28729, and MSD0149-PS (Raintree Pump Station). The SSOs 28711 and 28719 are caused by the insufficient wet weather capacity of the interceptor. The SSOs 28729 is likely caused by upstream flows greater than the available Marian Court Pump Station wet weather capacity. MSD0149-PS is likely caused by upstream flows greater than the available Raintree Pump Station wet weather capacity. Both pump stations have constructed overflow pipes in the wet well that were constructed before MSD acquired the system in 1990. The contributing area is single-family residential.

Branch 4 addresses two SSOs: 27969 and MSD0151-PS (Monticello Place Pump Station). The SSOs are likely caused by upstream flows greater than the available Monticello Place Pump Station wet weather capacity. The contributing area is single-family residential.

2.5.6.2 Validation for Jeffersontown

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were 28 validated SSOs in the Jeffersontown model.

2.5.6.3 RDI/I Reduction for Jeffersontown

The RDI/I reduction process for Jeffersontown follows the procedures described in Section 2.3.5.7. Table 2.5.8 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Jeffersontown. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.8

JEFFERSONTOWN PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
46300	2.5	0%
93434	2.5	0%
86162	2.9	2%
42026	3.0	2%
42275	3.2	3%
28111-SM	3.4	4%
64096	3.4	4%
27668	3.6	5%
31742	3.6	5%
42273-X	3.9	6%
28564	4.1	7%
28602	4.1	7%
28173	4.2	7%
29386	4.4	8%
28553	4.8	10%
104337	5.0	10%
86057	5.1	11%
28351	6.9	18%
42268	29.7*	25%
Average Projected RDI/I Reduction		**7.1%**
*Note: High peaking factor due to minimal dry weather flow		

2.5.6.4 Build-out for Jeffersontown

In preparing solutions, potential future development (build-out) was considered. This build-out evaluation assumed that the Consent Decree requirements limiting new flows to the Jeffersontown system have been removed by improvements to the system that eliminate the practice of “blending” during wet weather. This will be accomplished either by eliminating the Jeffersontown WQTC or by expanding and upgrading the WQTC to take all wet weather flows through full secondary treatment. The elimination or expansion of the Jeffersontown WQTC is required by the Consent Decree to be completed no later than December 31, 2015. For the purpose of this IOAP it is assumed that after that time adequate conveyance and treatment capacity will be provided to allow development in the current Jeffersontown WQTC service area to proceed in accordance with Louisville Metro land-use plans.

The build-out process for Jeffersontown follows the procedures described in Section 2.3.5.10 and the result is listed in Table 2.5.9. There is one general location where additional flow was added to the model to represent future development and corresponding flows. The build-out potential occurs in areas that would require pumping the flow to the Jeffersontown WQTC; therefore, a build-out inflow hydrograph was created and applied at the WQTC. No additional flow will be allowed to Jeffersontown WQTC until blending is eliminated at the plant; unless the process outlined in the Amended Consent Decree is followed.

TABLE 2.5.9

JEFFERSONTOWN PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
Branch 1	MSD0255	1,180,000
Total Future Projected Additional Flows		**1,180,000**

2.5.6.5 Capital Improvement Projects for Jeffersontown

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There was one Capital Improvement Project integrated into the Jeffersontown hydraulic model.

Rehl Road Recapture. Construct 14,250 LF of 15”-21” interceptor, 9,500 LF of 16” force main, and a regional 4.3 MGD peak flow pumping facility located near Rehl Road and Pope Lick Road. This is intended to serve 212 acres in Jefferson County proposed to be developed. Construction is complete and the interceptor, pump station, and force main are in use.

2.5.7 Middle Fork Model Development

This section provides a summary of the Middle Fork watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.7.1 SSO Descriptions for Middle Fork

Middle Fork is divided into four branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.7 for a map of the Middle Fork branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 1 addresses 19 SSOs: 02932, 02933, 02935, 08537, 23211, 23212, 27005, 45835, 47583, 47593, 47596, 47603, 47604, 51221, 51161, 51160, 90700, 08935-SM, and ISO21A-SI. Most of the SSOs are gravity SSOs to the Middle Fork of Beargrass Creek from manhole rims. They are caused by excess wet weather flows and partially by the condition of the interceptor under I-264. The SSO 08935-SM near the Upper Middle Fork Lift Station is a constructed overflow structure to Middle Fork Beargrass Creek along the Middle Fork Interceptor, and it overflows when the downstream interceptor becomes surcharged. It is located in a commercial area. The SSO ISO21A-SI is a constructed overflow structure to Middle Fork Beargrass Creek upstream of an inverted siphon and it overflows when the downstream interceptor and siphon become surcharged. The SSO 08537 is a constructed overflow structure that does not overflow during regular wet weather events. This overflow structure, better known as the Northern Ditch Blowoff, is located along the Northern Ditch Interceptor. The upstream contributing area consists of industrial, commercial, and residential area.

Branch 4 addresses seven SSOs: 21628-W, 43472, 46891, 62418, 91629, 91630, and 105936. The SSO 21628-W is a gravity manhole SSO near the Devondale Pump Station in a residential area, and it is most likely caused by upstream flows greater than the available Devondale Pump Station wet weather capacity. The SSO 43472 is a gravity manhole SSO in a residential area and is most likely caused by upstream flows greater than the available Saurel Road Pump Station wet weather capacity. The other SSOs in this branch are gravity SSOs from manhole rims that overflow to Goose Creek; they are likely caused by upstream flows greater than the available Goose Creek Pump Station wet weather capacity.

Branch 6 addresses four SSOs: 00056-W (Anchor Estates #1 Pump Station), 00746, 01106 (Vannah Way Pump Station), and MSD0057-LS (Anchor Estates #2 Lift Station). The SSO 01106 is a constructed overflow structure in the wet well that overflows to a storm sewer and is most likely caused by upstream flows greater than the available Vannah Way Pump Station wet weather capacity. The SSOs 00056-W and 00746 are gravity manholes located in a residential area and are most likely caused by upstream flows greater than the available Anchor Estates #1 Pump Station wet weather capacity. The SSO MSD0057-LS occurs at a gravity manhole in a residential area, and is likely caused by upstream flows greater than the available Anchor Estates # 2 Pump Station wet weather capacity.

Branch 7 addresses one SSO: 01793. This manhole is located in the Hurstbourne subdivision near Hurstbourne Country Club. The SSO at this manhole was assumed to be caused by backwater conditions in the Lower Middle Fork Interceptor due to insufficient capacity in the interceptor. In 2005, the force main at the Hurstbourne Pump Station was re-routed to relieve flow to the interceptor and the SSO did not occur again and, therefore, was believed to be eliminated. In March 2008, however, the SSO reappeared and is now assumed to be caused by insufficient wet weather capacity.

There are other SSOs in Middle Fork that are being addressed by Interim SSDP projects; these locations are described below.

SSOs 21153, 21101, 21061, 21156, and 21089 are locations that are pumped from the sanitary sewer during wet weather. These SSOs are in the Beechwood Village neighborhood and the contributing area is single family residential. The pumps are activated to eliminate residential basement backups. The cause of the overflows are downstream surcharging and significant I/I. These locations are addressed by Interim SSDP projects, namely the Beechwood Village and Sinking Fork Relief Interceptor projects.

SSOs 25012, 63319, and 21103 are gravity SSOs through manhole rims that occur during wet weather. The contributing area is mostly single family residential. The cause of the overflows are downstream surcharging and significant I/I. These locations are addressed by Interim SSDP projects, namely the Beechwood Village and Sinking Fork Relief Interceptor projects.

2.5.7.2 Validation for Middle Fork

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were 31 validated SSOs in the Middle Fork modeled area. There was one unvalidated SSO at manhole 01793; this area was investigated by MSD Infrastructure & Flood Protection group to determine if a downstream blockage had occurred. Investigation did not identify any blockages downstream of the manhole; therefore, this SSO will be targeted for I/I reduction and an SSES will be performed upstream of the manhole.

2.5.7.3 Sedimentation for Middle Fork

Based on validation results and a review of the interceptor condition assessment, sedimentation was needed in the model for the Middle Fork SSO validation. Sediment amounts, which are listed in Table 2.5.10, were added in the pipes downstream of the listed manhole ID in the hydraulic model. The majority of these blockages have since been removed through cleaning and rehabilitation projects completed in late 2008.

TABLE 2.5.10

MIDDLE FORK SEDIMENTATION

Sedimentation for SSO Validation	
Site (Manhole ID)	**Sediment Depth (Upstream Pipe Diameter)**
63324	4 inches (18 inches)
63321	6 inches (18 inches)
45443	6 inches (27 inches)
21156	6 inches (27 inches)
21150	8 inches (21 inches)
21155	8 inches (27 inches)
Average Sediment Depth	**6.3 inches**

2.5.7.4 RDI/I Reduction for Middle Fork

The RDI/I reduction process for Middle Fork follows the procedures described in Section 2.3.5.7. Table 2.5.11 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Middle Fork. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.11
MIDDLE FORK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
24551	2.2	0%
45835	2.4	0%
48763	2.4	0%
02933	2.5	0%
48758	2.5	0%
45449	2.8	2%
65746	2.8	1%
01793	2.9	2%
21150	3.1	3%
62425	3.1	3%
96675	3.5	4%
45381	3.6	5%
45440	3.7	5%
71004	3.7	5%
01268	3.8	6%
47098	3.8	6%
22610	4.0	6%
25012	4.4	8%
91629	5.5	13%
21155	5.6	13%
Average Projected RDI/I Reduction		**4.1%**

2.5.7.5 Build-out for Middle Fork

There was no build-out applied to the Middle Fork watershed model for future development flows because the area is fully developed.

2.5.7.6 Capital Improvement Projects for Middle Fork

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There was one Capital Improvement Project integrated into the Middle Fork hydraulic model.

<u>MSD Project F05039: Woodlawn Road Pump Station Relocation</u>. The project will construct 2,200 LF of gravity interceptor from the existing pump station site to the existing Muddy Fork interceptor at Foeburn Lane, as well as a diversion structure. In coordination with the widening of Westport Road the project will eliminate the existing Woodlawn Park Pump Station, which will help relieve SSO conditions at Falgate Court and in the Beechwood Village system. The project is currently under design.

2.5.8 Southeastern Diversion Model Development

This section provides a summary of the Southeastern Diversion watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.8.1 SSO Descriptions for the Southeastern Diversion

Southeastern Diversion was originally divided into eight branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Only four branches remain after modifications have taken place to the model and the SSO list and modeling process throughout the Final SSDP process. Refer to Figure 2.5.8 for a map of the Southeastern Diversion branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 3 addresses one SSO: 47250. It is an SSO that was modeled and field verified as significantly surcharged. This manhole is on a 12-inch diameter sewer line located on a Jefferson County School property. The contributing area is mixed with single and multi-family residential. The SSO is likely caused because the entire interceptor in the local 12-inch collection system is surcharged and cannot convey peak discharges during wet weather.

Branch 4 addresses three SSOs: 25676, 26650, and 26651. The other SSOs in this branch (18134, 18298, 18302, 18318-W, 49224, 49236, 49672, and 49673) are addressed in the Interim SSDP projects. The SSOs have a mixed contributing landuse area of residential and commercial. The SSOs are likely caused due to surcharging in the Beargrass Interceptor during wet weather.

Branch 5 addresses one SSO: 16649. SSO 16649 is a constructed overflow structure in the Sutherland neighborhood, and it occurs when the local 10-inch diameter sewer becomes surcharged. The contributing area is mostly single-family residential.

Branch 6 addresses one SSO: 51594. Early field investigation of Manhole 51594 suggested that this manhole had a downstream blockage coupled with the Beargrass Interceptor surcharge effects causing the SSO. The Interceptor Condition Assessment Phase 1 project noted numerous obstructions and root masses in the Beargrass Interceptor near this location. The contributing area is mostly single-family residential.

There are other SSOs in Southeastern Diversion that are being addressed by a combination of the Interim SSDP projects, maintenance activities, and other branch solutions. These locations are described below.

SSOs 08426, 08427, 08430, 08431, 30701, 30702, 49647, and 63779 are SSOs along the Buechel Branch Trunk. These are known as the Pruitt Court SSOs. The contributing area is mostly residential with some commercial and industrial. There are two main causes of these SSOs: downstream surcharging in the Southeastern Diversion Structure and excessive blockages per the Interceptor Condition Assessment and model validation activities. These SSOs will be addressed by Interim SSDP projects and maintenance activities.

SSOs 23211, 23212, 51160, 51161, and 51221 are SSOs at or near the confluence of the Goldsmith Lane Trunk and the Beargrass Interceptor. The Goldsmith Lane Trunk and Beargrass Interceptor exceed capacity during wet weather. SSO 23211 was originally a constructed overflow structure but has since been welded shut. In addition, the Upper Middle Fork Lift Station currently flows through this location; it peaks at 6.6 mgd for a period of nearly 48 hours during a 1.82-inch rainfall event. Due to the significant I/I at the Upper Middle Fork Lift Station, SSOs occur at these locations. These locations will be addressed by Interim SSDP projects and the solution involving the diversion of the Upper Middle Fork Lift Station to the Hikes Lane Interceptor in Middle Fork Branch 1.

SSOs 72571-X, 30680, and 30681 will also be addressed by Interim SSDP projects. SSO 72571-X is better known as the Southeastern Diversion structure which is a constructed overflow structure. SSOs 30680 and 30681 are several manholes upstream of the Southeastern Diversion structure along the Buechel Branch Trunk. These manholes overflow due to local I/I and surcharging at the Southeastern Diversion. SSO 72751-X overflows due to two influent interceptors (30-inch and 33-inch) that flow into the structure and only one interceptor exiting (30-inch) the structure. There is an additional 60-inch interceptor exiting the structure but the gate is left mostly closed due to downstream operational restrictions.

SSOs 18471, 18483, 18505, and 18595 are locations that are pumped from the sanitary sewer during wet weather. These overflows are in the Hikes Point area and the contributing area is single family residential. The pumps are activated to eliminate residential basement backups. The cause of the overflows are downstream surcharging and significant I/I. These locations are addressed by Interim SSDP projects, namely the Hikes Lane Interceptor project.

SSO 17571 is an overflow that is pumped from the sanitary sewer during wet weather. This overflow is near the Hikes Point area and the contributing area is single family residential. The pump is activated to eliminate residential basement backups. The cause of the overflow is downstream surcharging and significant I/I. This location is addressed by Interim SSDP projects.

SSOs MSD0012-PS and 18434 are located in the Hikes Point area and the contributing area is single family residential. MSD0012-PS is known as the Highgate Springs Pump Station, which overflows to Beargrass Creek during extreme wet weather. This was constructed as a wet weather relief to eliminate basement backups. SSO 18434 is located a few manholes upstream. The cause of these overflows is due to surcharging in the Beargrass Interceptor and significant I/I. These locations are addressed by Interim SSDP projects, namely the Hikes Lane Interceptor project.

SSOs 18134, 18298, 18302, 18370, 18318-W, 49224, 49236, 49672, and 49673 are overflows along the Beargrass Interceptor between the Southeastern Diversion and the Highgate Springs Pump Station. The contributing area is mostly residential with some commercial and industrial. The main cause of these SSOs is downstream surcharging at the Southeastern Diversion Structure and excessive wet weather flow in the Beargrass Interceptor. These locations are addressed by Interim SSDP projects, namely the Hikes Lane Interceptor project.

2.5.8.2 Validation for the Southeastern Diversion

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were two validated SSOs in the Southeastern Diversion modeled area. There are three unvalidated SSOs at manholes 18134, 18370, and 51594. Manholes 18134 and 18370 are in the tributaries upstream of the Beargrass Interceptor in the Hikes Point area that will be addressed with the new Hikes Lane Interceptor (Interim SSDP project). The Interceptor Condition Assessment Phase 1 project noted numerous obstructions and root masses in the Beargrass Interceptor near Manhole 51594. This part of Beargrass Interceptor will be recommended for the next phase of the Beargrass Interceptor rehabilitation work.

2.5.8.3 Sedimentation for the Southeastern Diversion

Based on validation results and a review of the interceptor condition assessment, sedimentation was needed in the model for the Southeastern Diversion SSO validation. Sediment amounts that are listed in Table 2.5.12 were added in the pipes downstream of the listed manhole ID in the hydraulic model. The majority of these blockages have since been removed through cleaning and rehabilitation projects completed in late 2008.

TABLE 2.5.12

SOUTHEASTERN DIVERSION SEDIMENTATION

Sedimentation for SSO Validation					
Site (Manhole ID)	**Sediment Depth (Upstream Pipe Diameter)**	**Site (Manhole ID)**	**Sediment Depth (Upstream Pipe Diameter)**	**Site (Manhole ID)**	**Sediment Depth (Upstream Pipe Diameter)**
72555	18 inches (36")	51147	8 inches (42")	49245-T	6 inches (33")
30703-T	15 inches (30")	51221	8 inches (42")	72552	6 inches (21")
30704	14 inches (30")	72353-T	8 inches (42")	49468	6 inches (27")
08535C-T	14 inches (72")	72354	8 inches (42")	22574	6 inches (30")
50682	13 inches (36")	72396-T	8 inches (42")	22576	6 inches (30")
51186-T	13 inches (36")	73168	8 inches (42")	49664	6 inches (30")
51147-T	13 inches (42")	51232	8 inches (36")	49778	6 inches (30")
30683-T	11 inches (30")	63832	8 inches (36")	54003	6 inches (30")
30703	11 inches (30")	30720	7 inches (30")	66205	6 inches (30")
30705	11 inches (30")	24299	7 inches (39")	28080T	5 inches (24")
50648	11 inches (30")	26640	7 inches (33")	49446	5 inches (24")
68190	11 inches (21")	18465-T	7 inches (33")	19255	5 inches (27")
51221-T	10 inches (42")	51175	7 inches (36")	49779	5 inches (27")
49767	10 inches (21")	51187-T	7 inches (36")	49781	5 inches (27")
51222	9 inches (42")	51191	7 inches (36")	49807	5 inches (27")
23249C-AG	9 inches (48")	51203	7 inches (36")	49818	5 inches (27")
51189	9 inches (36")	26645	7 inches (27")	49703	5 inches (24")
51192-T	9 inches (36")	30683SM	7 inches (30")	25345	4 inches (18")
51194	9 inches (36")	18465	6 inches (33")	112639	4 inches (21")
49473	9 inches (27")	18704	6 inches (21")	30714	4 inches (21")
24299-T	8 inches (39")	26642	6 inches (33")	30715	4 inches (21")
30685	8 inches (33")	48885	6 inches (33")	49459	4 inches (21")
49244-T	8 inches (33")	48886	6 inches (33")	49710	4 inches (18")
49810	8 inches (27")	48894	6 inches (33")	19769	3 inches (18")
				Average Sediment Depth	**7.7 inches**

2.5.8.4 RDI/I Reduction for the Southeastern Diversion

The RDI/I reduction process for Southeastern Diversion follows the procedures described in Section 2.3.5.7. Table 2.5.13 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of the Southeastern Diversion. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

There were 32 flow monitoring locations in the Southeastern Diversion modeled area. There were six flow monitoring locations that the RDI/I reduction was adjusted from what MSD provided. These were HP22, HP24, HP25A, HP31, HP32, and HP33. These were adjusted by taking an average of adjacent flow monitoring basins. This was done because the flow monitors either had volume-balancing problems or were highly influenced by an upstream pump station. There were two instances where MOPs were invalidated so the RDI/I were redistributed.

TABLE 2.5.13
SOUTHEASTERN DIVERSION PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction			
Basin	**Flow Monitoring Location (Manhole ID)**	**Average Peaking Factor**	**Projected RDI/I Reduction**
Buechel Branch	25330	2.5	0%
Buechel Branch	51762	2.8	1%
Buechel Branch	25331	3.2	3%
Buechel Branch	49641	3.4	4%
Buechel Branch	25370	3.7	5%
Buechel Branch	49467	4.0	6%
Buechel Branch	68191	27.8*	25%
Hikes Point	16762	1.3	0%
Hikes Point	27293	1.4	0%
Hikes Point	49323	2.1	0%
Hikes Point	30684	2.2	0%
Hikes Point	48894	2.5	0%
Hikes Point	104816	2.5	0%
Hikes Point	18429	2.9	2%
Hikes Point	18434	2.9	2%
Hikes Point	26648	3.1	3%
Hikes Point	49546	3.4	4%
Hikes Point	49518	3.6	5%
Hikes Point	18475	4.1	7%
Hikes Point	71738	4.9	10%
Hikes Point	26642	5.3	12%
Hikes Point	104818	7.1	19%
Hikes Point	48864	7.9	23%
Hikes Point	73087	16.1*	25%
Hikes Point	23214	22.1*	25%
Hikes Point	43711	281.3*	25%
Northern Ditch	54546	4.0	6%
Northern Ditch	23278	5.0	11%
Northern Ditch	23288	5.2	11%
Northern Ditch	08531	5.7	14%
Northern Ditch	23275	5.9	14%
Northern Ditch	80515	6.6	17%
Average Projected RDI/I Reduction			**8.8%**

*Note: High peaking factor due to minimal dry weather flow

2.5.8.5 Build-out for the Southeastern Diversion

There was no build-out applied to the Southeastern Diversion watershed model for future development flows because the area is fully developed.

2.5.8.6 Capital Improvement Projects for the Southeastern Diversion

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There were three Capital Improvement Projects integrated into the Southeastern Diversion hydraulic model.

MSD Project B00234: Cavelle Avenue Sanitary Sewer. The assessment project consists of 15 residential properties in which property owners currently use on-site disposal systems. The project will construct approximately 560 LF of separate SSS.

MSD Project B98235: Newburg Road at Tartain Road Sanitary. The assessment project consists of five residential properties in which property owners currently use on-site disposal systems. The project will construct approximately 1,200 LF of gravity sewers. Alternatives to conventional sewers will be considered.

MSD Project E98307: Taylorsville Road at Six Mile Lane. The assessment project consists of 12 residential properties in which property owners have requested service in this unsewered area of Jeffersontown. The project will construct approximately 1,700 LF of separate SSS for the properties.

2.5.9 Ohio River Force Main Model Development

This section provides a summary of the ORFM watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.9.1 SSO Descriptions for the Ohio River Force Main

The ORFM area is divided into four branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.9 for a map of the ORFM branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 1 addresses nine SSOs: 24152-W, 24472, 26752, 41374, 41416, MSD0007-PS (Mockingbird Valley Pump Station), MSD0010-PS (Winton Ave. Pump Station), MSD0023-PS (Mellwood Ave Pump Station), and MSD0024-PS (Canoe Ln Pump Station). The SSOs at MSD0007-PS, MSD0010-PS, Mellwood Avenue Pump Station (24472 and MSD0023-PS), and Canoe Lane Pump Station (24152-W and MSD0024-PS) are likely caused by upstream flows greater than the available pump station wet weather capacity. The SSOs at 26752, 41374, and 41416 are caused by insufficient wet weather capacity of the interceptor upstream of Mockingbird Valley Pump Station. The contributing area is mostly single-family residential.

Branch 2 addresses one SSO: 96020. The SSO is caused by a hydraulic bottleneck in the 8" gravity line. The contributing area is mostly single-family residential.

Branch 3 addresses one SSO: MSD0095-PS (Derington Ct. Pump Station). The SSO is likely caused by upstream flows greater than the wet weather capacity of the Derington Court Pump Station. The contributing area is mostly single-family residential.

Branch 4 addresses 13 SSOs in the Prospect area: 22436, 40870, 40871, 40872, 42680, 65633, 65635, MSD0123-PS (West Goose Creek Pump Station), MSD1044-PS (Phoenix Hill Pump Station), MSD0183-PS (Glenview Hills Pump Station), MSD0192-PS (Barbour Ln Pump Station), MSD0193-PS (New Market Pump Station), and MSD0292 (Hunting Creek South WQTC). The SSOs at 22436 and MSD0123-PS are caused by the head in the ORFM limiting the Goose Creek Pump Station and the insufficient wet weather capacity at the pump station to convey flow. The SSOs at 40870, 40871, and 40872 are caused by the head in the ORFM limiting the Muddy Fork Pump Station. The SSOs at 42680, 65633, 65635, and MSD0192-PS are caused by insufficient wet weather capacity at the Barbour Lane Pump Station to convey wet weather flow. The SSOs at MSD0183-PS, MSD0193-PS, and MSD1044-PS are caused by the head in the ORFM and the insufficient capacities at the pump stations to convey the wet weather flow. The SSO at MSD0292 is likely caused by upstream flows greater than the wet weather capacity at the Hunting Creek South WQTC. The contributing area at all these locations is mostly single-family residential.

2.5.9.2 Validation for the Ohio River Force Main

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were 20 validated SSOs in the ORFM modeled area.

The SSO 22436 is currently a documented SSO but only validates to a 2.60-inch cloudburst storm; there is a possibility that excessive inflow exists in the small upstream system.

2.5.9.3 RDI/I Reduction for the Ohio River Force Main

The RDI/I reduction process for ORFM follows the procedures described in Section 2.3.5.7. Table 2.5.14 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of ORFM. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.14

OHIO RIVER FORCE MAIN PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
42675	2.2	0%
42742	2.2	0%
42788	2.2	0%
32191	2.5	0%
22433e	2.6	1%
66021	2.6	1%
44084	2.8	1%
48228	3.1	3%
27035	3.5	4%
43569	3.5	4%
40872	3.6	5%
22433w	4.4	8%
91799-10	4.7	10%
91799-12	4.8	10%
24077	6.3	16%
27435	6.3	16%
Average Projected RDI/I Reduction		**4.9%**

2.5.9.4 Build-out for the Ohio River Force Main

The build-out process for ORFM included Sewer Assessment Projects only. It follows the procedures described in Section 2.3.5.10 and are listed in Table 2.5.15. Additional flow was applied to the model to represent future flow based on the following assessment projects:

- D98333 - Upper River Road / Overbrook Area Sanitary Sewer Assessment Project
- D00252 – Indian Hills North - River Road Assessment Project
- D96177 – Riviera Area Sanitary Sewer Assessment Project
- D94203 – Future Upper Muddy Fork Pump Station (Boxhill Road Sanitary Sewer Assessment Project)
- D98331 – Cabin Way Sanitary Sewer Assessment Project
- D98334 – Orion / Hillsdale Sanitary Sewer Assessment Project
- D98338 – Ten Broeck Phase II Sanitary Sewer Assessment Project
- D98343 – Winchester Acres Sanitary Sewer Assessment Project
- D96179 – Wallbrook Subdivision Sanitary Sewer Assessment Project

TABLE 2.5.15

OHIO RIVER FORCE MAIN PROJECTED BUILD-OUT

Build-out Areas			
Branch	**Assessment ID**	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
Branch 1	D98333	40388	10,800
Branch 4	D00252	40866	22,400
Branch 4	D96177	110797	34,800
Branch 4	D94203	Upper Muddy	32,800
Branch 4	D98331	44109	2,400
Branch 4	D98334	66019	16,800
Branch 4	D98338	42726	2,800
Branch 4	D96179	24233	6,400
Branch 4	D98343	42726	16,000
Total Future Projected Additional Flows			**145,200**

2.5.9.5 Capital Improvement Projects for the Ohio River Force Main

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There were three Capital Improvement Projects integrated into the ORFM hydraulic model. There was also a capital project completed in 2005, which eliminated the Jarvis Lane Pump Station SSO; the constructed overflow structure was sealed and the force main was upsized. Additionally, in 2003, pump replacements occurred and a permanent generator was placed at Glen Oaks Pump Station, which eliminated the SSO.

<u>MSD Project F05039: Woodlawn Park Pump Station Relocation</u>. The project consists of diverting flow from the Middle Fork Modeling area to the Muddy Fork Interceptor. The project will construct 2,200 LF of gravity interceptor from the existing pump station site to the existing Muddy Fork interceptor at Foeburn Lane. In coordination with the widening of Westport Road the project will eliminate the existing Woodlawn Park Pump Station, which will help relieve sewer SSO conditions at Falgate Court and in the Beechwood Village system. The project was completed on March 31, 2009.

<u>MSD Project F06298: Canoe Pump Station Elimination</u>. The project consists of diverting flow from the Canoe Lane Pump Station and the Fairway Lane Pump Station to the existing Muddy Fork Interceptor. The Canoe Lane Pump Station will be eliminated. The flow currently goes to the Mellwood Pump Station, but it does not have the ability to accept all wet weather flow so this project will reduce flow to Mellwood Pump Station.

MSD directed project to upgrade Hillsdale, Barbour Lane, Glenview Hills, and New Market Pump Stations by a private party. The project includes replacing a 75 horsepower pump with a 200 horsepower pump in the Barbour Lane Pump Station; replacing the existing 8-inch force main with a 12-inch and replacing the existing pumps with two 107 horsepower pumps at Hillsdale Pump Station; replacing the existing pumps with two 65 horsepower pumps and replacing the 4-inch force main with a 6-inch force main at New Market Pump Station; installing a new wet well and two 65 horsepower pumps for Glenview Hills Pump Station. The construction plans for improvements are on file, MSD Record No. 15271.

2.5.10 Combined Sewer Overflow Area Model Development

The CSO hydraulic model provides solutions for the modeling of SSOs within the combined sewer system (CSS) combined sewer overflow (CSO) area boundary. Although they are located within the CSS boundary, they are included in the Final SSDP in order to develop elimination projects for the SSOs. This section provides a summary of the CSO area model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed.

2.5.10.1 SSO Descriptions for the CSO Model

The CSO area is divided into three branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.10 for a map of the CSO area branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 42007 addresses one SSO: MSD0042-PS (Sonne Pump Station). The SSO occurs at Sonne Pump Station which is a hauling operation site during wet weather conditions. This SSO is likely caused by upstream flows greater than the available Sonne Pump Station and force main capacity during wet weather or excess wet weather flow in the system caused by excessive I/I. This pump station was recently upgraded to 225 gpm from its original design peak flow capacity of 150 gpm. The pump station upgrade appears to eliminate the 1.27-inch cloudburst event overflows, but SSOs still occur for the 1.52-inch, 1.82-inch, 2.25-inch, and 2.60-inch cloudburst events. The contributing area is single-family residential.

Branch 30917 addresses nine SSOs: 08717, 13931, 13943, 36763, 44396, 44397, 66349, 104223, and 104231. This branch (known as Camp Taylor) is near the Camp Zachary Taylor Neighborhood Association and Subdivision, west of Poplar Level and the Louisville Zoo. The available sewer system information in this area is limited; therefore, an accurate cause of the SSO is unknown. It appears that the collection system is very old in some areas and the capacity is inadequate to handle excess wet weather flow.

Branch 55665 addresses one SSO: 55665 (Hazelwood Pump Station). The SSO occurs at Hazelwood Pump Station which is a hauling operation site during wet weather conditions. The SSO is most likely caused by excess wet weather flow in the system caused by excessive I/I. The contributing area is single-family residential.

2.5.10.2 Validation for the CSO Model

The Camp Taylor area was not modeled due to the lack of available data to build the hydraulic model. Record drawings were available but pertinent information was missing from the drawings. There was no flow monitoring data available to assess the system responses to various wet weather events. The alternative to modeling was to develop a regression equation using estimated SSO volume and total rainfall depth. The equation was applied to the total rainfall depth for various storm events to estimate the SSO volume.

The Sonne Pump Station (hauling operation site) is located within the CSO boundaries. The existing CSO model was expanded to include the service area for the Sonne Pump Station. Calibration of Sonne Pump Station was assumed to be part of the CSO model calibration. Validation was completed by using 1.27-inch, 1.52-inch, 1.82-inch, 2.25-inch, and 2.60-inch cloudburst storm events. Initial validation showed an SSO during the 1.27-inch cloudburst storm with original pump peak flow capacity. Based on pump upgrade information provided by MSD staff in June 2008, no SSO occurred during the 1.27-inch cloudburst storm event.

The Hazelwood Pump Station (hauling operation site) is located just outside of the CSO boundaries. The existing CSO model was expanded to include the service area for Hazelwood Pump Station. Calibration was based on estimated volume hauled and wet well level data. Validation runs reported SSO volumes at the pump station and upstream locations in the system.

2.5.10.3 RDI/I Reduction for the CSO Model

RDI/I reduction was not applied to the CSO area model.

2.5.10.4 Build-out for the CSO Model

There was no build-out applied to the CSO area model because the area is fully developed.

2.5.10.5 Capital Improvement Projects for the CSO Model

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. One Capital Improvement Project was considered when designing solutions for the branches in the CSO area.

<u>Sonne Pump Station Pump Replacement</u>. This project was completed in 2007. The Sonne Pump Station peak flow capacity was upgraded from 150 gpm to 225 gpm.

2.5.11 Small WQTC Model Development

This section provides a summary of the Small WQTC watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.11.1 SSO Descriptions for Small WQTCs

The small WQTC areas are divided into eight branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figures 2.5.11 through 2.5.13 for maps of the small WQTC branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Berrytown Branch 1 addresses one SSO: MSD0199-LS (Lucas Ln. Pump Station). The SSO is caused by limited Lucas Lane Pump Station wet weather capacity. It is located adjacent to a drainage ditch that drains to Goose Creek. The contributing area is single-family residential.

North Hunting Creek Branch 1 addresses one SSO: MSD1060-LS (Riding Ridge Lift Station). This SSO is likely caused by upstream flows greater than the available Riding Ridge Lift Station wet weather capacity. The contributing area is single-family residential.

North Hunting Creek Branch 2 addresses one SSO: MSD1055-LS (Gunpowder Lift Station). This SSO is likely caused by upstream flows greater than the available Gunpowder Lift Station wet weather capacity. The contributing area is single-family residential.

North Hunting Creek Branch 3 addresses one SSO: 62769, upstream of the Fox Harbor #2 Lift Station. This SSO is most likely caused by upstream flows greater than the available Fox Harbor #1 Lift Station (MSD1053-LS) and Fox Harbor #2 Lift Station (MSD1054-LS) wet weather capacity. The contributing area is single-family residential.

Hunting Creek South Branch 1 addresses one SSO: MSD1065-PS (Fairway View Pump Station). It is located next to the Hunting Creek golf course in a residential area. This SSO is most likely caused by upstream flows greater than the available Fairway View Pump Station wet weather capacity. The contributing areas is single-family residential.

Hunting Creek South Branch 2 addresses one SSO: MSD1063-PS (Deep Creek Pump Station). The SSO occurs at the Deep Creek Pump Station, and is located approximately 550 feet from Harrods Creek in a residential area. This SSO is most likely caused by upstream flows greater than the available Deep Creek Pump Station wet weather capacity. The contributing area is single-family residential.

Lake Forest Branch 1 addresses one SSO: MSD1169-LS (Lake Forest Lift Station). The SSO occurs at the Lake Forest Lift Station and is most likely caused by upstream flows greater than the available Lake Forest Lift Station wet weather capacity. The contributing area is single-family residential.

Chenoweth Hills Branch 1 addresses one SSO: 94187, which is caused by MSD1084-PS (St. Rene Road Pump Station). The SSO is likely caused by upstream flows greater than St. Rene Road Pump Station wet weather capacity. It is located in a residential area, approximately 550 feet from Chenoweth Run. The contributing area is single-family residential.

2.5.11.2 Validation for Small WQTCs

There is one validated SSO in the Berrytown WQTC modeled area (in addition to the SSO at the WQTC) located at the Lucas Lane Pump Station (MSD0199-LS). There is a modeled SSO during the 2.25-inch cloudburst storm at the Creel Lodge Pump Station (MSD1001-LS), which is upstream of the Lucas Lane Pump Station.

Excluding the SSO at the WQTC, there is one validated SSO in the Chenoweth Hills model: MSD1084-PS.

There are four validated SSOs in the North Hunting Creek model. There is a modeled SSO during the 1.52-inch cloudburst storm at manhole 66750, which is upstream of the Gunpowder Lift Station (MSD1055-LS).

Excluding the SSO at the WQTC, there are two validated SSOs in the Hunting Creek South model, and three modeled SSOs: Manhole 68563 (just upstream of Covered Cove Way Pump Station), MSD1064-PS (Westover Pump Station), both located upstream of SSO MSD1065-PS, and Manhole 66584, located upstream of SSO MSD1063-PS.

There is one validated SSO in the Lake Forest model: MSD1169-LS.

For procedures on the validation process, see Section 2.3.5.2.

2.5.11.3 RDI/I Reduction for Small WQTCs

RDI/I reduction was not applied to the Small WQTC models.

2.5.11.4 Build-out for Small WQTCs

There was no build-out applied to the Small WQTC models for future development flows.

2.5.11.5 Capital Improvement Projects for Small WQTCs

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There were no Capital Improvement Projects integrated into the Small WQTC hydraulic model.

2.5.12 Pond Creek Model Development

This section provides a summary of the Pond Creek watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.12.1 SSO Descriptions for Pond Creek

Pond Creek is divided into nine branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.14 for a map of the Pond Creek branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 3 addresses four SSOs: 25477, 25478, 25480, and MSD0130-PS (Cooper Chapel Pump Station). The SSOs occur at or directly upstream of the Cooper Chapel Pump Station in a residential area and are most likely caused by upstream flows greater than the available Cooper Chapel Pump Station wet weather capacity. The contributing area is single-family residential.

Branch 4 addresses three SSOs: 35309, 60679 and MSD1013-PS (Cinderella Pump Station). The SSOs 60679 and MSD1013-PS occur at the Cinderella Pump Station in a residential area and are most likely caused by upstream flows greater than the available Cinderella Pump Station wet weather capacity. Manhole 35309 is immediately downstream of the Cinderella PS force main discharge point. Given the drawdown peak flow capacity of the pump station, there is no hydraulic reason for the line to overflow. Model-simulated sedimentation was used immediately downstream to cause the SSO. The contributing area is single-family residential.

Branch 5 addresses three SSOs: 25484, 93719, and MSD0101-PS (Lantana Drive Pump Station). The SSOs occur near the Lantana Dr. Pump Station in a residential area. They are most likely caused by upstream flows greater than the available Lantana Drive Pump Station wet weather capacity. The contributing area is single-family residential.

Branch 6 addresses one SSO: MSD0180-PS (Government Center Pump Station). The SSOs occur at the Government Center Pump Station near the parking lot of a Louisville Metro government building. They are most likely caused by upstream flows greater than the available Government Pump Station wet weather wet weather capacity. The contributing area is primarily single-family residential with some public landuse.

Branch 7 addresses one SSO: 21229-W, which occurs at the Avanti Pump Station in a residential area. It is most likely caused by upstream flows greater than the available Avanti Pump Station wet weather wet weather capacity. The contributing area is single-family residential.

Branch 8 addresses nine SSOs: 19360, 19369, 29933, 29943, 29948, 31083, 31084, 79076, and MSD1010-PS. The SSO MSD1010-PS occurs at the Lea Ann Way Pump Station in a residential area. MSD Operations have replaced the three existing pumps with higher peak flow capacity pumps in 2008, and a fourth pump has been installed by a contractor as a development agreement. The pump station is now rated at 22 mgd peak wet weather capacity, which eliminates the pump station wet weather capacity problems. The SSO 79076 occurs upstream of the Lea Ann Way Pump Station and is due to backwater conditions at the pump station; this SSO should be eliminated by the pump station upgrades. The other SSOs occur upstream of the Lea Ann Way Pump Station at gravity manholes in a residential area. These SSOs are caused by upstream flows greater than the available collector system wet weather capacity. The contributing area is single-family residential.

Branch 9 addresses four SSOs: 27116, 70212, 17724, and MSD0133-PS (Caven Ave. Pump Station). The SSOs 70212 and 17724 occur upstream of a hydraulic constriction at I-65 and the Outer Loop and is due to backwater conditions caused by the constriction in addition to insufficient collector system wet weather capacity. SSOs 27116 and MSD0133-PS are caused by upstream flows greater than the available Caven Avenue. Pump Station wet weather wet weather capacity. The contributing area is single-family residential.

Branch 10 addresses two SSOs: 36419 and MSD1019-PS (Leven Pump Station). The SSOs occur at the Leven Pump Station in a residential area. They are most likely caused by upstream flows greater than the available Leven Pump Station wet weather capacity. The contributing area is single-family residential.

Branch 11 addresses two SSOs: 92098 and MSD1048-PS (Edsel Pump Station). The SSOs occur at the Edsel Pump Station in a residential area. The SSOs are suspected to be caused by maintenance-related issues or excessive I/I during wet weather. They are targeted for investigation by MSD I&FP to determine if a downstream blockage has occurred.

2.5.12.2 Validation for Pond Creek

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There were 32 validated SSOs in the Pond Creek modeled area. There were two unvalidated SSOs at manhole 35309 and Edsel Pump Station (MSD1048-Pump Station) and are believed to be maintenance-related issues or I/I induced.

The SSO 35309 is immediately downstream of the Cinderella Pump Station force main. Given the drawdown peak flow capacity of the pump station, there is no hydraulic reason for the line to overflow. Model-simulated sedimentation was used immediately downstream to cause the SSO.

The Valley Village SSOs (32682 and 32688) were not validated as they are due to backwater conditions from Derek R. Guthrie WQTC and will be eliminated as part of the Interim SSDP Derek R. Guthrie WQTC improvements.

2.5.12.3 Sedimentation for Pond Creek

Based on validation results and a review of the interceptor condition assessment, sedimentation was needed in the model for the Pond Creek SSO validation. Sediment amounts, which are listed in Table 2.5.16, were added in the pipes downstream of the listed manhole ID in the hydraulic model.

TABLE 2.5.16

POND CREEK SEDIMENTATION

Sedimentation for SSO Validation	
Site (Manhole ID)	**Sediment Depth**
35308	6 inches
35309	6 inches
Average Sediment Depth	**6 inches**

2.5.12.4 RDI/I Reduction for Pond Creek

The RDI/I reduction process for Pond Creek follows the procedures described in Section 2.3.5.7. Table 2.5.17 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Pond Creek. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.17

POND CREEK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
58046	2.4	0%
41789	2.7	1%
22349	3.5	4%
84926-42	3.7	5%
22324	3.8	6%
22340	3.8	6%
61725-21	3.8	6%
85330	4.0	7%
22304	4.4	8%
61725-36	4.4	8%
64052	4.5	8%
60325	4.8	10%
82316	5.8	14%
84926-21	7.1	19%
32685	11.6	25%
Average Projected RDI/I Reduction		**8.4%**

2.5.12.5 Build-out for Pond Creek

In preparing solutions, potential future development (build-out) was considered. Build-out was only applied as additional flow upstream of known or suspected SSOs. The build-out process for Pond Creek follows the procedures described in Section 2.3.5.10 and the result is listed in Table 2.5.18. There are four general locations where additional flow was added to the model to represent future development and corresponding flows.

TABLE 2.5.18

POND CREEK PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
Branch 1	32682	211,789
Branch 4	102339	3,492
Branch 4	35308	3,903
Branch 6	31300	30,904
Total Future Projected Additional Flows		**250,088**

2.5.12.6 Capital Improvement Projects for Pond Creek

MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There were three Capital Improvement Projects integrated into the Pond Creek hydraulic model. In addition, there was a capital project completed in March 2008 that eliminated the Valley Village Pump Station SSO; a pump was repaired and placed back into service.

<u>MSD Project C94103: Charleswood Subdivision Interceptor</u>. The project includes 3,150 LF of sewer and a system of collector sewers along Cooper Chapel Road between Charleswood Road and Price Lane. All the improvements are planned to be constructed in conjunction with the widening of Cooper Chapel Road. The Cooper Chapel Pump Station will be eliminated and sanitary sewer service will be provided to an area currently using on-site disposal systems (58 properties). This project is scheduled to be completed in 2010.

<u>MSD Project C06295: Zabel Way Pump Station Elimination</u>. The project included 2,000 LF of new 10-inch sewer to eliminate the Zabel Way Pump Station. This project was completed in September 2008.

<u>Lea Ann Way Pump Station Upgrades</u>. MSD Operations have replaced the three existing pumps with higher peak flow capacity pumps in 2008. A fourth pump has been installed by a contractor as a development agreement. The pump station is now rated at 22 mgd peak flow capacity.

2.5.13 Mill Creek Model Development

This section provides a summary of the Mill Creek watershed model development including SSO descriptions, validation process, RDI/I reduction, build-out potential, and existing or proposed capital improvement projects relevant to the watershed. The full calibration/validation report is available for review in Appendix 2.3.2.

2.5.13.1 SSO Descriptions for Mill Creek

Mill Creek is divided into two branches (see Section 2.3.5.6 for details on branching) based on SSO locations and system deficiencies. Refer to Figure 2.5.15 for a map of the Mill Creek branching and SSO locations at the end of this chapter. Brief descriptions of the SSOs in each branch are below.

Branch 1 addresses five SSOs: 04498, 04542, 81814-W (Pioneer Rd. Pump Station), MSD0047-PS (Fern Lea Pump Station), and MSD0050-PS (Garrs Lane Pump Station). The SSO 81814-W occurs at the Pioneer Road Pump Station in a residential area; the SSO is most likely caused by upstream flows greater than the available Pioneer Road Pump Station wet weather capacity. The SSOs at 04542 and MSD0047-PS occur at the Fern Lea Pump Station in a residential area; the SSOs are most likely caused by upstream flows greater than the available Fern Lea Pump Station wet weather capacity. The SSO MSD0050-PS occurs at the Garrs Lane Pump Station in a residential area; the SSO is most likely caused by upstream flows greater than the available Garrs Lane Pump Station wet weather capacity. SSO 04498 occurs along the 10” sewer line between Pioneer Road. Pump Station and Fern Lea Pump Station and most likely occurs due to backwater conditions from the Fern Lea Pump Station.

Branch 2 addresses one SSO: 04699-W. The SSO occurs at the East Rockford Pump Station in a residential area. This pump station is built in an area prone to surface flooding, which most likely inundates the pump station and causes the SSO.

2.5.13.2 Validation for Mill Creek

There is a modeled SSO near each known SSO at the appropriate threshold rain event (explained in Section 2.3.5.2). There are four validated SSOs in the Mill Creek modeled area.

The Derek R. Guthrie SSOs (22385, 22370, 59169, and MSD0277) were not validated as they are due to backwater conditions from Derek R. Guthrie WQTC and will be eliminated as part of the Interim SSDP Derek R. Guthrie WQTC improvements.

2.5.13.3 RDI/I Reduction for Mill Creek

The RDI/I reduction process for Mill Creek follows the procedures described in Section 2.3.5.7. Table 2.5.19 summarizes the average peaking factor and projected RDI/I reduction for sub-catchments of Mill Creek. Peaking factor is the peak flow (the monitored maximum flow within the sewer system during a rainfall event) at the flow monitor compared to average DWF at the flow monitor. The average peaking factor is computed from three major storms that occurred in the flow-monitoring period. The projected RDI/I reduction represents the percent of contributing area which was reduced for models used in MSD SSO evaluation modeling (see Appendix 2.3.4 for explanation of peaking factors, RDI/I reduction, and model refinements).

TABLE 2.5.19

MILL CREEK PROJECTED RDI/I REDUCTION

Rainfall Dependent Inflow and Infiltration Reduction		
Flow Monitoring Location (Manhole ID)	**Average Peaking Factor**	**Projected RDI/I Reduction**
100763	2.7	1%
33000	3.1	3%
26716-NE	3.3	4%
22382	3.4	4%
08689	3.5	4%
26716-NW	3.6	5%
81919	3.8	6%
96658	4.1	7%
59250	4.3	8%
56968	5.9	14%
Average Projected RDI/I Reduction		**5.6%**

2.5.13.4 Build-out for Mill Creek

In preparing solutions, potential future development (build-out) was considered. Build-out was only applied as additional flow upstream of known or suspected SSOs. The build-out process for Mill Creek follows the procedures described in Section 2.3.5.10 and listed in Table 2.5.20. There are five general locations where additional flow was applied to the model to represent future development and corresponding flows.

TABLE 2.5.20

MILL CREEK PROJECTED BUILD-OUT

Build-out Areas		
Branch	**Build-out Input Location (Manhole/node ID)**	**Future development additional DWF (gpd)**
NB01	22370	23,500
NB01	22385	3,600
NB01	59169	17,100
NB01	MSD0047	9,600
Total Future Projected Additional Flows		**53,800**

2.5.13.5 Capital Improvement Projects for Mill Creek

All MSD projects within the current five-year capital plan were considered in branch solutions. In considering these projects, modelers were given the latitude to modify design parameters (such as pipe diameter or pump capacity) to the extent of the preliminary project design. There was one Capital Improvement Project integrated into the Mill Creek hydraulic model.

MSD Project Budget ID B06208 Shively Interceptor. This project will eliminate five pump stations (Jacks Lane, Pioneer Road, Fern Lea, Garrs Lane, and City Park Pump Stations) to provide gravity service and eliminate SSOs due to Mechanical and/or Power failures.