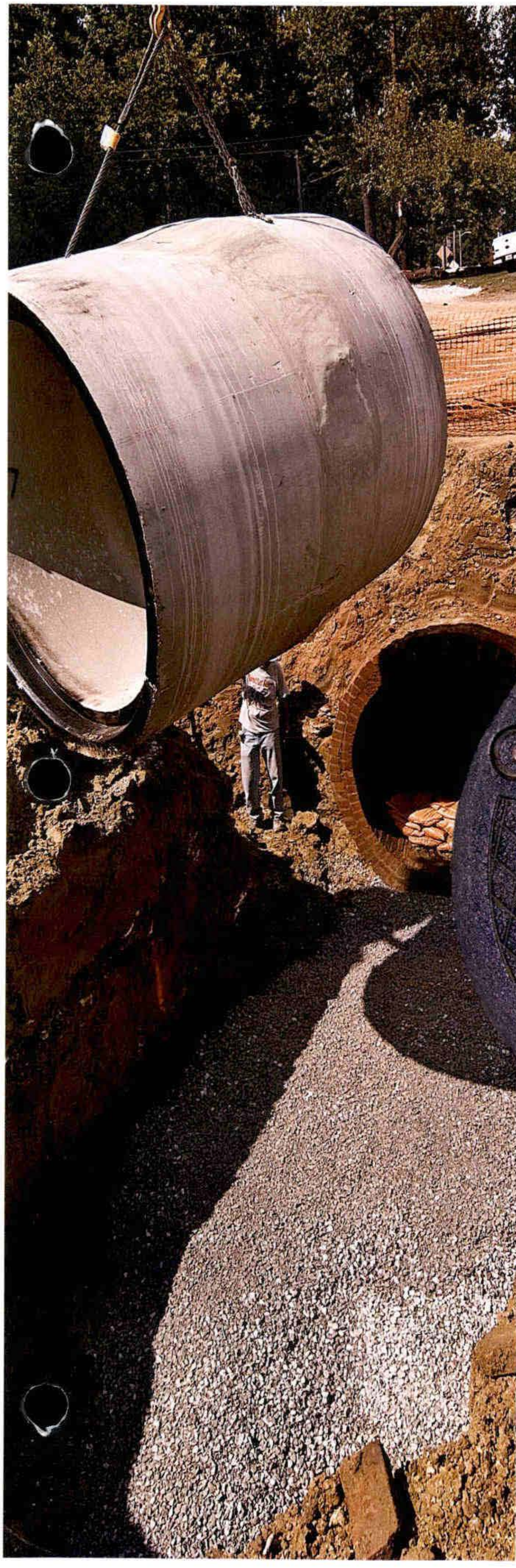


Final CSO Long-Term Control Plan

2012 MODIFICATION: MAY 2014
VOLUME 2 OF 3

MSD Metropolitan Sewer District

PROJECT WIN Waterway Improvements Now

Louisville and Jefferson County
Metropolitan Sewer District
700 West Liberty Street
Louisville, KY 40203

RESOLUTION OF
THE BOARD OF THE LOUISVILLE AND JEFFERSON COUNTY METROPOLITAN SEWER DISTRICT
AUTHORIZING THE EXECUTIVE DIRECTOR TO SUBMIT THE INTEGRATED OVERFLOW ABATEMENT PLAN FOR APPROVAL TO UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, THE KENTUCKY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND THE UNITED STATES DEPARTMENT OF JUSTICE

WHEREAS, the Board of the Louisville and Jefferson County Metropolitan Sewer District ("MSD") entered into a Consent Decree, as may be amended, with United States Environmental Protection Agency, the Kentucky Department of Environmental Protection and the United States Department of Justice on August 12, 2005; and

WHEREAS, the Consent Decree requires that MSD prepare and submit plans to control combined sewer overflows ("CSOs") and sanitary sewer overflows ("SSOs"); and

WHEREAS, MSD has prepared an Integrated Overflow Abatement Plan ("IOAP") to control both CSOs and SSOs as required by the Consent Decree, and state and federal law; and

WHEREAS, the IOAP was drafted by MSD's Wet Weather Team which includes a broad range of community stakeholders, MSD staff and consultants; and

WHEREAS, the staff of MSD presented the IOAP to the Board on October 27, 2008; and

WHEREAS, the staff of MSD presented the IOAP at several public meetings on November 10, 12, and 20, 2008; and

WHEREAS, the staff of MSD held a public hearing to receive both written and oral public comments on the IOAP on December 2, 2008; and

WHEREAS, the staff of MSD received written public comments during the period starting on October 1, 2008, and concluding on December 5, 2008; and

WHEREAS, the IOAP must be submitted to the USEPA and the Commonwealth by

December 31, 2008, as required by the Consent Decree;

THEREFORE BE IT HEREBY RESOLVED that the Executive Director is hereby authorized to submit to the USEPA and the Commonwealth by December 31, 2008, the IOAP as presented to the Board on October 27, 2008, as modified after the public hearing on December 2, 2008, and the conclusion of the public comment on December 5, 2008, and with the following scope:

The Louisville and Jefferson County Metropolitan Sewer District's Integrated Overflow Abatement Plan is a long-term plan to control combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in the community. The IOAP is expected to improve water quality in both Jefferson County streams and the Ohio River. The expected water quality benefits of the IOAP include: (a) reductions in the peak levels of bacteria in the Ohio River, the Beargrass Creek and other Jefferson County waterways; and (b) a reduction in the duration of wet weather impairment of local waterways (i.e., the number of days that bacteria levels exceed water quality standards during periods of wet weather). The IOAP—in coordination with other community water quality initiatives (further described below)—will also improve water quality under ambient conditions.

The specific benefits anticipated from the IOAP include the following:

- The suite of projects selected for the Long Term Control Plan (LTCP) for CSOs will result in approximately 96 percent capture and treatment of wet weather combined sewage during an average year. (As a point of reference, the "presumptive approach" in EPA's CSO Control Policy is based on a minimum of 85 percent wet weather capture.)
- Remaining CSO loads (after removing background) will no longer cause water quality standard violations in the Ohio River.

Peak fecal coliform counts are modeled to be reduced by 54 percent.

- At the mouth of Beargrass Creek, peak fecal coliform counts are modeled to be reduced by 18 percent. The control level associated with these reductions exceeds the EPA CSO Control Policy "presumptive approach" 85 percent wet weather capture threshold and reflects a point of significantly diminishing returns under the "knee of the curve" benefit-cost analysis.
- The suite of projects selected for the Sanitary Sewer Discharge Plan (SSDP) for SSOs will result in the elimination of capacity-related SSOs up to the site-specific level of protection (described below).
- The SSO projects are anticipated to eliminate an average of 145 SSO events per year, based on 2005–2007 data.
- In terms of water quality, SSO projects are estimated to eliminate an average of 290 million gallons of overflow volume per year (average of 2005–2007 normalized for rainfall), eliminating 100 tons of 5-day biochemical oxygen demand (BOD5) and almost 200 tons of solids annually.

Along with delivering water quality improvements from sewer overflow control, MSD participates in other community water quality improvement efforts. Sewer overflow control is essential to improving water quality, but overflow control alone is not enough to meet water quality standards. In light of this challenge, MSD will continue to leverage its role in supporting broader water quality improvement efforts in the community. The IOAP will be one of the key elements of MSD's participation in those water quality improvement efforts. In particular, the IOAP will be complementary to other wet weather and water quality programs managed by MSD and/or by other community partners. These complementary efforts include, but are not limited to, the Mayor's "Go Green Louisville" Initiative, the Partnership for a Green City, Metro Louisville's Municipal Separate Storm Sewer System (MS4) discharge permit, and initiatives of Jefferson County Public Schools (JCPS), private developers, and other entities.

The specific ways in which MSD is collaborating with other entities on community water quality improvement initiatives include the following:

- Partnership for a Green City: MSD is actively working with Louisville Metro Government, JCPS, and the University of Louisville to improve water quality through the Partnership for a Green City. The Partnership has established a Stormwater Committee that will be identifying opportunities to improve water quality associated with planned capital projects.

- Louisville Metro Government: MSD is an active participant in the Mayor's Go Green Louisville Initiative, which includes in its vision a commitment to focus on financially sustainable measures that improve air and water quality, land use, and energy efficiency. In coordination with this initiative, MSD is partnering with Louisville Metro Government on several green infrastructure demonstration projects in the IOAP.

- MS4 Program: MSD will coordinate IOAP implementation with the agencies that share implementation of the MS4 Program—including Metro Louisville government, small cities that handle their own drainage, and the Kentucky Department of Transportation. The MS4 program will draw upon the opportunities identified through the green infrastructure analysis conducted by MSD's IOAP technical team and the ideas suggested by WWT members during the development of the IOAP. MSD further anticipates implementing demonstration projects, such as rain gardens in the separate sewer area, under the MS4 as part of a coordinated effort with the IOAP to test and evaluate green infrastructure approaches to wet weather management.

The IOAP—as part of MSD's consent decree response—will be a federally enforceable action plan for sewer overflow abatement. Although many IOAP projects and programs will provide multiple benefits to the community, the scope of the IOAP is limited to commitments that directly relate to MSD programs and activities to address combined sewer overflow (CSO) and sanitary sewer overflow (SSO) issues. Other community water quality programs, which may be partly or completely out of MSD's control, can provide synergistic benefits with the IOAP, but they do not fall under the same federal enforcement. These programs may, however, have different mechanisms for ensuring accountability (e.g., the State of Kentucky oversees the MS4 stormwater permit that MSD and several other agencies hold). As noted above, MSD anticipates coordinating IOAP implementation with the water quality improvement initiatives of Louisville Metro Government and other public and private entities, even though these broader initiatives may not explicitly be part of the IOAP.

Adopted in open session this 15th day of December, 2008.

LOUISVILLE & JEFFERSON COUNTY
METROPOLITAN SEWER DISTRICT

Beverly G. Wheatley

Beverly Wheatley, Chairperson of the Board

Dana Price

Dana Price, Board Secretary

**RESOLUTION OF
THE BOARD OF THE LOUISVILLE AND JEFFERSON COUNTY
METROPOLITAN SEWER DISTRICT
AUTHORIZING THE EXECUTIVE DIRECTOR TO SUBMIT FOR APPROVAL
THE INTEGRATED OVERFLOW ABATEMENT PLAN 2012 MODIFICATION
TO UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, THE
KENTUCKY DEPARTMENT FOR ENVIRONMENTAL PROTECTION AND THE
UNITED STATES DEPARTMENT OF JUSTICE**

WHEREAS, the Board of the Louisville and Jefferson County Metropolitan Sewer District ("MSD") entered into a Consent Decree with United States Environmental Protection Agency, the Kentucky Department for Environmental Protection and the United States Department of Justice on August 12, 2005, and subsequently amended on April 15, 2009 ("Amended Consent Decree"); and

WHEREAS, the Amended Consent Decree requires that MSD prepare and submit plans to comply with KPDES permits and upgrade the separate sewer system, combined sewer system and water quality treatment centers (WQTCs) to adequately address sanitary sewer overflows ("SSOs") and unauthorized discharges, and discharges from combined sewer overflows ("CSOs") locations identified in the Morris Forman WQTC KPDES permit; and

WHEREAS, MSD previously prepared and submitted an Integrated Overflow Abatement Plan ("IOAP") to control SSOs, unauthorized discharges, and CSOs as required by the Amended Consent Decree, and state and federal law, which was subsequently approved by the United States Department of Justice on September 30, 2009; and

WHEREAS, MSD's Wet Weather Team which includes a broad range of community stakeholders, MSD staff and consultants has identified the need for modifications to the IOAP to incorporate through an adaptive management process additional information developed from continued flow monitoring, enhanced hydraulic modeling, and a detailed review of project types, size, location, and schedule; and

WHEREAS, the staff of MSD presented the proposed IOAP 2012 Modification to the Board on February 11, 2013; and

WHEREAS, the staff of MSD presented the proposed IOAP 2012 Modification at several public meetings Between September 27, 2011, and February 5, 2013; held a public hearing to receive both written and oral public comments on the IOAP 2012 Modification on March 26, 2013; received oral and written public comments during the period starting on March 13, 2013, and concluding on April 12, 2013;

THEREFORE BE IT HEREBY RESOLVED that the Executive Director is hereby authorized to submit to the United States Environmental Protection Agency, the Kentucky Department for Environmental Protection and the United States Department of Justice, the IOAP 2012 Modification as presented to the Board on May 13, 2013.

Adopted in open session this 13th day of May, 2013.

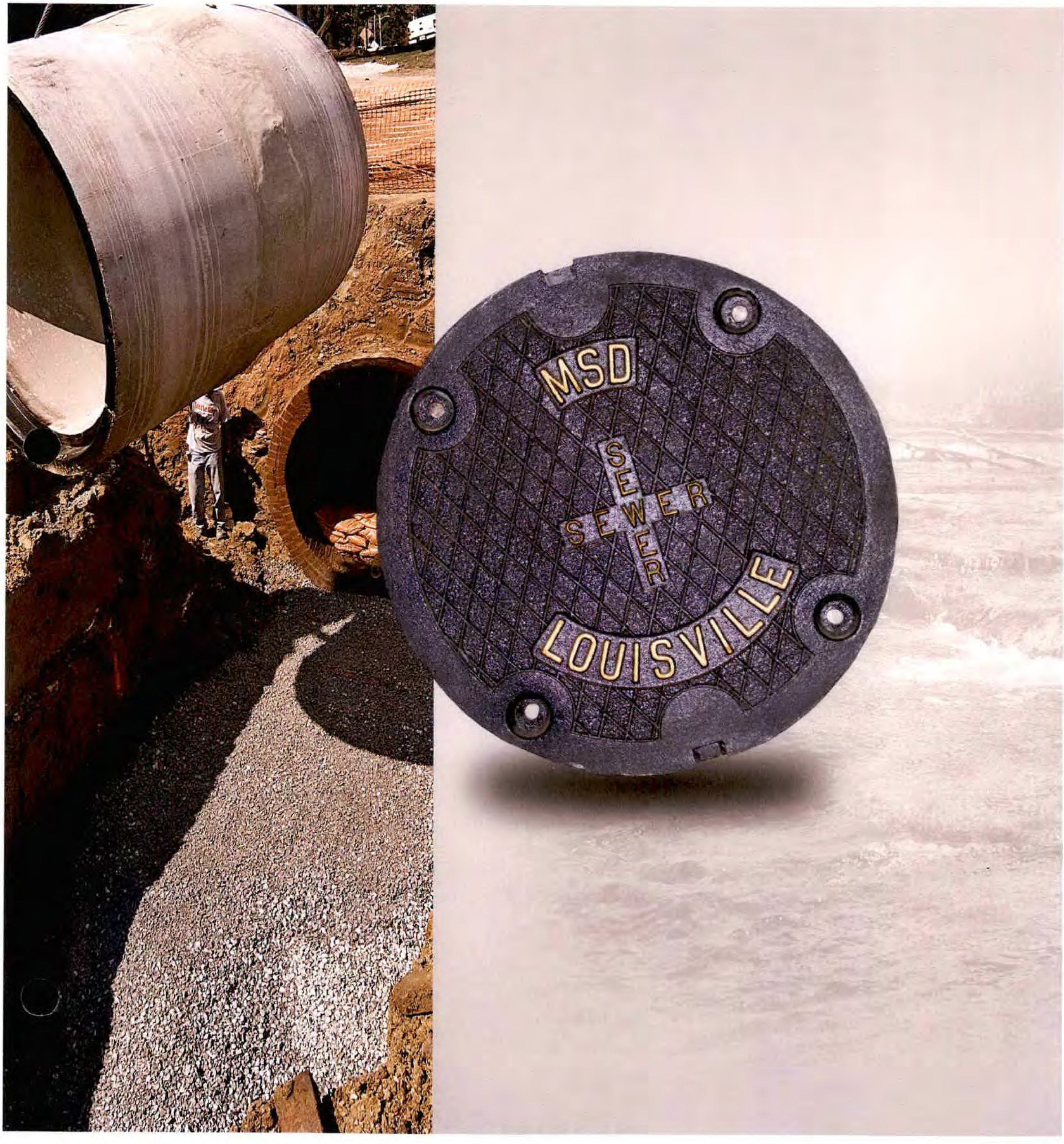
LOUISVILLE & JEFFERSON COUNTY
METROPOLITAN SEWER DISTRICT

James Craig, Chair

Attest:

Chad Collier, Secretary-Treasurer

Table of Contents



VOLUME 2: FINAL COMBINED SEWER OVERFLOW (CSO) LONG-TERM CONTROL PLAN (LTCP)

TABLE OF CONTENTS

CHAPTER 4: SELECTION OF FINAL CSO LONG-TERM CONTROL PLAN

CHAPTER 5: LONG-TERM CONTROL PLAN 2012 MODIFICATION

SUPPORTING INFORMATION

APPENDICES

Volume 2 Appendices are located on a DVD at the back of the binder.

Glossary

FINAL COMBINED SEWER OVERFLOW LONG-TERM CONTROL PLAN (LTCP) GLOSSARY

TABLE OF CONTENTS

DEFINITIONS

Amended Consent Decree (ACD) - Specific to this document, a federal judicial order expressing a voluntary agreement ordered on April 10, 2009 and filed on April 15, 2009 that incorporates all elements of the original Consent Decree (see Consent Decree definition) as well as imposing new requirements to cease activities alleged by the government to be illegal.

Average Annual Overflow Volume (AAOV) - The total volume of overflow predicted to occur from a specific location or consolidation of locations, calculated using a continuous simulation of precipitation that occurs in a "typical year." For the purpose of this Integrated Overflow Abatement Plan (IOAP), calendar year 2001 represents the typical year, based on an evaluation of precipitation patterns in that year compared to long-term meteorological averages.

Average Daily Flow (ADF) - The calculated or assumed average daily flow within the sewer system attributed to users without rainfall derived inflow and infiltration (I/I) within a 24-hour period.

Avoidable - A legal term of art meaning that a consequence could have been prevented with the exercise of reasonable engineering judgment in facilities planning and implementation, and/or adequate management, operations, and maintenance practices.

Baseline - The existing conditions. An initial set of observations or data used as a comparison or starting point from which the magnitudes of an alternative's effects are measured.

Benefit - Cost Analysis - A formal process used to help appraise, or assess, the cost effectiveness of different alternatives. The higher the Benefit-Cost Ratio, the more effective the alternative is.

Best Management Practices (BMPs) - Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to Waters of the United States. BMPs also include treatment requirements, operating procedures, and practice to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Biochemical Oxygen Demand (BOD) - A measurement of the amount of oxygen used by the decomposition of organic material over a specified time period (usually 5 days) in a wastewater sample. Used as a measurement of the readily decomposable organic content of water.

Bypass - The intentional diversion of waste streams from any portion of a treatment facility as set forth in 40 Code of Federal Regulations (CFR), § 122.41(m)(1) and 401 Kentucky Administrative Regulations (KAR) 5:002, Section 1(36). The practice of bypassing secondary treatment units and recombining the bypass flow with the secondary effluent prior to discharge, known commonly as blending, recombination, or diversion, constitutes a "Bypass." The term Bypass shall specifically exclude (1) practices at MSD's Morris Forman Wastewater Treatment Plant (WWTP) that are in accordance with the KPDES permit and the CSO Control Policy and (2) any flow that exceeds the design capacity of a tertiary process at any WWTP in accordance with a Kentucky Pollutant Discharge Elimination System (KDPES) permit.

Chemical Treatment - Any water or wastewater treatment process involving the addition of chemicals to obtain a desired result, such as precipitation, coagulation, flocculation, sludge conditioning, disinfection, or odor controls.

Combined Sewer Overflow (CSO) - an outfall identified as a combined sewer overflow or CSO in MSD's KPDES permit for the Morris Forman WWTP from which MSD is authorized to discharge during wet weather.

- **Dry Weather CSO** - An overflow from a permitted outfall identified as a combined sewer overflow or CSO in MSD's Morris Forman WWTP KPDES permit that is not the result of a wet weather event.
- **Wet Weather CSO** - An overflow from a permitted outfall identified as a combined sewer overflow or CSO in MSD's Morris Forman WWTP KPDES permit that is the result of a wet weather event.

Combined Sewer System (CSS) - the portion of MSD's Sewer System designed to convey municipal sewage (domestic, commercial, and industrial wastewaters) and stormwater runoff through a single-pipe system to MSD's Morris Forman WWTP or CSOs.

Consent Decree - A judicial decree expressing a voluntary agreement between parties to a suit, especially an agreement by a defendant to cease activities alleged by the government to be illegal in return for an end to the charges.

Controls - Processes and/or activities which contribute to removal of pollutants from wastewater or to containing and conveying wastewater for treatment and discharge.

Dissolved Oxygen (DO) - A measurement of the amount of oxygen dissolved in water.

Fats, Oils, and Grease (FOG) – A general category of lipid-based wastewater constituents that often are responsible for sewer blockages and resulting back-ups or overflows.

Feasible Alternatives - The legal term of art used in the "Bypass" regulation to identify alternative controls which are both technically achievable and affordable (40 CFR 122.42m).

Fecal Coliform - Bacteria present in the feces of warm blooded animals typically used as an indicator of fecal contamination and the potential presence of pathogens.

Flow Equalization - Transient storage of wastewater for release to a sewer system or treatment process at a controlled rate to provide a reasonably uniform flow.

Geographic Information System (GIS) - A computer based system that is capable of storing, managing, and analyzing geographic spatial data. This capability includes producing maps, displaying the results of data queries, and conducting spatial analysis.

Gray Infrastructure - Constructed structures such as treatment facilities, sewer systems, stormwater systems, or storage basins. The term "gray" refers to the fact that such structures are typically made of, or involve the use of concrete.

Green Infrastructure - An adaptable term used to describe an array of materials, technologies, and practices that use natural systems—or engineered systems that mimic natural processes—to enhance overall environmental quality and provide utility services. As a general principal, green infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff. Examples of green infrastructure include green roofs, porous pavement, rain gardens, and vegetated swales.

Infiltration - Groundwater that enters a wastewater system through such means as defects in pipes, pipe joints, connections, or manholes.

Inflow - Water other than wastewater that enters a wastewater system from sources such as stormwater, runoff, and drainage. Inflow is generally derived from surface water, as compared to infiltration that is generally derived from groundwater.

InfoWorks Collection Systems (CS) - Hydraulic modeling software developed by Wallingford Software used by MSD for collection system modeling.

Kentucky Department for Environmental Protection (KDEP) - Agency responsible for administering KPDES permits and receiving permit-related reports.

Kentucky Pollutant Discharge Elimination System (KPDES) Permit - Any National Pollutant Discharge Elimination System permit issued to MSD by the Cabinet pursuant to the authority of the Clean Water Act and Kentucky Revised Statues (KRS) Chapter 224 and the regulations promulgated thereunder.

Leadership in Energy and Environmental Design (LEED) - A rating system that is administered by the US Green Building Council (USGBC) and is currently the most accepted benchmark for the design, construction, and operation of high performance green buildings and neighborhood developments in the U.S. The five key areas include sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

Louisville and Jefferson County Metropolitan Sewer District (MSD) - The agency responsible for providing wastewater, stormwater, and flood protection services in Jefferson County. MSD is also responsible for response, mitigation, notification, and reporting of overflows, including unauthorized discharges.

Lower Gauge (LG) - A measure of the Ohio River's stage (elevation) below the McAlpine Lock and Dam. Gauge 0 is equal to an elevation of 373.2' above mean sea level. Normal pool elevation for the Ohio River is 384.5' or a lower gauge of 11.3.

National Pollutant Discharge Elimination System (NPDES) - A national program under the Clean Water Act that regulates discharges of pollutants from point sources to Waters of the United States. Discharges are illegal unless authorized by an NPDES permit.

Overflow - Any release of wastewater from MSD's sanitary or combined sewer system at locations not specified in any KPDES permit. This includes any Unauthorized Discharge and releases to public or private property that do not reach Waters of the United States, such as basement backups. However, wastewater backups into buildings caused by blockages, flow conditions, or malfunctions in a building lateral, other piping or conveyance system that is not owned or operationally controlled by MSD are not overflows for the purposes of the IOAP.

Pathogen - An organism capable of causing disease, including disease-causing bacteria, protozoa, and viruses.

Peak Flow - The maximum flow that occurs over a specific length of time (e.g., daily, hourly, instantaneous).

Peak Wet Weather Flow - The anticipated, calculated, or monitored maximum flow within the sewer system during an actual or synthetic rainfall event.

Primary Treatment - The practice of treatment by screening, sedimentation, and skimming adequate to remove at least 30 percent of both the biochemical oxygen demanding material and the suspended solids, as defined in 40 CFR Part 125.58(r). Primary treatment may also include disinfection, where appropriate or required.

Reasonable Engineering - As a legal term of art, this is the statutory and regulatory standard for judgment evaluating engineering practices.

Rim Elevation - The elevation of the top of a manhole cover. If the water surface elevation in a manhole is higher than the rim elevation, a sewer overflow will occur.

Risk Management - The process of identification, analysis and either acceptance or mitigation of risk. Essentially, risk management occurs anytime one analyzes the probability and consequences of an event happening, thereby quantifying the potential for losses and then takes the appropriate action (or inaction) given their objectives and risk tolerance.

Sanitary Sewer - A pipe or conduit (sewer) intended to carry wastewater or water-borne wastes from homes, businesses, and industries to the publicly owned treatment works.

Sanitary Sewer Overflow (SSO) - Any discharge of wastewater to waters of the United States from MSD’s Sewer System through a point source not authorized by a KPDES permit, as well as any release of wastewater from MSD’s Sewer System to public or private property that does not reach Waters of the United States, such as a release to a land surface or structure that does not reach Waters of the United States; provided, however, that releases or wastewater backups into buildings that are caused by blockages, flow conditions, or malfunctions in a building lateral, or in other piping or conveyance system that is not owned or operationally controlled by MSD are not SSOs.

Sanitary Sewer System (SSS) - The portion of MSD’s sewer system designed to convey only municipal sewage (domestic, commercial, and industrial wastewaters) to MSD’s WWTPs.

Secondary Treatment - A biological wastewater treatment technology required by the Clean Water Act for discharges from Publicly Owned Treatment Works, as that term is defined in 40 CFR Part 403.3(q). The minimum level of effluent quality attainable through the application of secondary treatment is established in 40 CFR Part 133.102 in terms of the parameters for 5-day biochemical oxygen demand (“BOD5”) concentration and percent removal, total suspended solids (“TSS”) concentration and percent removal, and pH.

Sensitive Areas - Areas of particular environmental significance or sensitivity as determined by the KPDES permitting authority in coordination with State and Federal agencies, that include Outstanding National Resources Waters, waters with threatened or endangered species and their habitats, waters with primary contract recreation, public drinking water intakes or their designated protection areas.

Sewer System - The wastewater collection, retention, and transmission system that MSD owns or operates, that are designed to collect, retain and convey municipal sewage (domestic, commercial and industrial wastewaters) to MSD's WWTPs or CSOs which is comprised of the CSS and the SSS.

Solids and Floatables (S&F) – Materials in sewage that are large enough to be visibly recognizable. Most solids and floatables in combined sewage are comprised of street litter and debris, but some plastic and paper products flushed down toilets stay in a visibly recognizable form, and are objectionable to some people.

Solution - A set of modifications to existing conditions in the hydraulic model developed to satisfy the overflow and surcharging requirements. Solutions are generally developed by trial and error modifications to the hydrological and hydraulic system at a given design storm. Modifications may include minimizing inflow and infiltration, modifications to conveyance (pipe diameter or pump capacity), added storage, system diversions or combinations thereof.

Surcharge - The condition within the sewer when the hydraulic grade line (water surface level) within the sewer system exceeds the crown of pipe elevation. The System Capacity Assurance Program (SCAP) defines a wet weather surcharge condition 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 an area of chronic backup complaints, then a surcharge condition is considered to be a water surface level within five feet of the manhole rim.

Upper Gauge (UG) - A measure of the Ohio River's stage (elevation) above the McAlpine Lock and Dam. Gauge 0 is equal to an elevation of 407.5' above mean sea level. Normal pool elevation for the Ohio River is 420.0' or an upper gauge of 12.5.

U.S. Environmental Protection Agency (EPA) - The federal agency responsible for enforcing the Clean Water Act, Safe Drinking Water Act and other federal environmental regulations.

Unauthorized Discharge - (a) any discharge of wastewater to waters of the United States from MSD's Sewer System or WWTPs through a point source not authorized by a KPDES permit and (b) any Bypass at MSD's WWTPs prohibited pursuant to the provisions of 40 CFR § 122.41(m)(2) and (4) or 401 KAR 5:065, Section 1(13)(a) and (c).

Water Quality Standards (WQS) - Standards that set the goals, pollution limits, and protection requirements for each waterbody. These standards are composed of designated (beneficial) uses, numeric and narrative criteria, and antidegradation policies and procedures.

Water Quality Treatment Center (WQTC) - The devices or systems used in the storage, treatment, recycling, and reclamation of municipal sewage that MSD owns or operates, and for which KPDES permits have been or will be issued to MSD. Treatment facilities may be referenced as Wastewater Treatment Plants (WWTPs) on enclosed maps or within the IOAP appendices due to MSD's transition to the WQTC terminology during IOAP development.

Waters of the United States - As defined in 40 CFR I22.2:

(a) All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(b) All interstate waters, including interstate "wetlands,"

(c) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters**:**

(1) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or

(2) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(3) Which are used or could be used for industrial purposes by industries in interstate commerce;

(d) All impoundments of waters otherwise defined as waters of the United States under this definition;

(e) Tributaries of waters identified in paragraphs (a) through (d) of this definition;

(f) The territorial sea; and

(g) "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through ('1) of this definition.

Note that the intent of the regulations cited above excludes waste treatment systems, manmade ponds, and prior converted cropland from the definition of "Waters of the US." With respect to prior converted cropland, EPA maintains jurisdiction for purposes of the Clean Water Act.

Watershed Approach - A flexible framework used for managing water resources within a specified drainage area, or watershed. This approach includes stakeholder involvement and management actions supported by sound science and appropriate technology.

Watershed - Land area that drains to a common waterway, such as a stream, lake, estuary, wetland, or ultimately the ocean.

Wet Weather Event - A discharge from a combined or sanitary sewer system that occurs in direct response to rainfall or snowmelt.

Wet Weather Team (WWT) - An advisement group for MSD composed of four subgroups: The Stakeholder Group, MSD employees, a Technical Team, and the Facilitation Team. A WWT is required by the Consent Decree.

ACRONYMS AND ABBREVIATIONS

AAOV	Average annual overflow volume
ACD	Amended Consent Decree
ADF	Average daily flow
BG	Billion gallons
BGCMI	Beargrass Creek Middle Fork
BGCMU	Beargrass Creek Muddy Fork
BGCSF	Beargrass Creek South Fork
BMP	Best management practice
BOD	Biochemical oxygen demand
CCTV	Closed-circuit television
CDS	Continuous Deflection Separator
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony forming unit
CMF	Central Maintenance Facility
CMOM	Capacity, Management, Operations, and Maintenance
COD	Chemical oxygen demand
CSO	Combined sewer overflow
CSS	Combined sewer system
CWA	Clean Water Act
DMR	Discharge monitoring report
DO	Dissolved oxygen
DWF	Dry weather flow
E. Coli	Escherichia Coli
EAP	Early Action Plan
ENR-CCI	Engineering News Record – Construction Cost Index
EPA	U.S. Environmental Protection Agency
FOG	Fats, oils, and grease
FY	Fiscal year
GIS	Geographic Information System
gpd	Gallons per day
GPS	Global Positioning Satellite
HEC RAS	hydraulic water flow modeling software
I&FP	Infrastructure and Flood Protection
I/I	inflow and infiltration

IOAP	Integrated Overflow Abatement Plan
IWD	Industrial Waste Department (also known as ICAM)
JCPS	Jefferson County Public Schools
JTown	Jeffersontown
KDEP	Kentucky Department of Environmental Protection
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	Kentucky Revised Statute
LEED	Leadership in Energy and Environmental Design
LF	Linear feet
LG	Lower gauge
LG&E	Louisville Gas & Electric
LOJIC	Louisville and Jefferson County Information Consortium
LS	Lift station
LTCP	Long-Term Control Plan
LTMN	Long Term Monitoring Network
LWC	Louisville Water Company
MHI	Median Household Income
MG	Million gallons
mgd	Million gallons per day
mg/l	Milligrams per liter
ml	Milliliter
MOP	Modeled overflow point
MS4	Municipal Separate Storm Sewer System
MSD	Louisville and Jefferson County Metropolitan Sewer District
NEXRAD	Next-Generation Radar
NMC	Nine Minimum Controls
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OR	Ohio River
ORFM	Ohio River Force Main
ORSANCO	Ohio River Sanitation Commission
OSHA	Occupational Safety and Health Administration
PE	Professional Engineer
PM	Preventive maintenance
POTW	Publicly owned treatment works
Project DRI	Project Drainage Response Initiative

Project WIN	Project Waterway Improvements Now
PS	Pump station
PIO	Public Information and Outreach
PVC	Polyvinyl chloride
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RBP	Stream Rapid Bioassessment Protocol
RDI/I	Rainfall-derived infiltration and inflow
ROW	Right-of-way
RTC	Real time control
S&F	solids and floatables
SAP$_{TM}$	Systems Analysis Program (MSD's financial management software)
SCADA	Supervisory Control and Data Acquisition
SCAP	Louisville Metro Sewer Capacity Assurance Plan
SED	Southeastern Diversion Structure
SIU	Significant Industrial User
SOP	Standard Operating Procedure
SORP	Sewer Overflow Response Protocol
SSDP	Sanitary Sewer Discharge Plan
SSES	Sanitary Sewer Evaluation Survey
SSO	Sanitary sewer overflow
SSOP	Sanitary Sewer Overflow Plan
SSS	Sanitary sewer system
SWMM	Stormwater and Wastewater Management Model
TMDL	Total maximum daily load
TSS	Total suspended solids
UAA	Use Attainability Analysis
UG	Upper Gauge
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WDR	Waste Discharge Regulations
WEF	Water Environment Federation
WERF	Water Environment Research Foundation
WQT	water quality tool
WQTC	Water Quality Treatment Center (formerly WWTP)
WWT	Wet Weather Team

MODELING AND FLOW MONITORING BASINS

BB	Buechel Branch	MC	Mill Creek
CC	Cedar Creek	MF	Middle Fork Beargrass Creek
FF	Floyds Fork	ND	Northern Ditch
HC	Hite Creek	ORFM	Ohio River Force Main
HP	Hikes Point	PC	Pond Creek
JT	Jeffersontown		

REGIONAL WATER QUALITY TREATMENT CENTERS

	KPDES No.	MSD No.
Cedar Creek	KY0098540	MSD0289
Floyds Fork	KY0102784	MSD0294
Hite Creek	KY0022420	MSD0202
Jeffersontown	KY0025194	MSD0255
Morris Forman	KY0022411	MSD0278
Derek R. Guthrie	KY0078956	MSD0277
(Formerly known as the West County Wastewater Treatment Plant)		

SMALL WATER QUALITY TREATMENT CENTERS

	KPDES No.	MSD No.
Bancroft	KY0039021	MSD0290
Berrytown	KY0036501	MSD0209
Chenoweth Hills	KY0029459	MSD0263
Glenview Bluff	KY0044261	MSD0207
Hunting Creek North	KY0029106	MSD0291
Hunting Creek South	KY0029114	MSD0292
Ken Carla	KY0022497	MSD0208
Lake Forest / Beckley Woods	KY0042226	MSD0403
Lake of the Woods	KY0044342	MSD0251
McNeely Lake	KY0029416	MSD0228
Shadow Wood	KY0031810	MSD0404
Silver Heights	KY0028801	MSD0258
Starview	KY0031712	MSD0247
Timberlake	KY0043087	MSD0293
Yorktown	KY0036323	MSD0271

Executive Summary

INTEGRATED OVERFLOW ABATEMENT PLAN

EXECUTIVE SUMMARY

SCOPE AND DESIRED OUTCOMES

On August 12, 2005, the Louisville and Jefferson County Metropolitan Sewer District (MSD) entered into a Consent Decree in Federal Court with the United States Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet. The Consent Decree was developed in response to an enforcement action taken by EPA and the Kentucky Department of Environmental Protection (KDEP) alleging violations of the Clean Water Act (CWA) primarily related to sewer overflows. The stated objective of the Consent Decree is to further the objectives of the CWA; eliminate unauthorized discharges from MSD's separate sewer system (SSS), combined sewer system (CSS), and water quality treatment centers (WQTCs); and to address discharges from MSD's combined sewer overflow (CSO) locations identified in the Kentucky Pollutant Discharge Elimination System (KPDES) permit for the Morris Forman WQTC. The Consent Decree outlines the compliance program and schedules for achieving specific objectives, including the development of discharge abatement plans.

On December 1, 2008, a draft Amended Consent Decree (ACD) was released for public comment. The draft ACD addressed alleged violations of the CWA primarily related to WQTC performance, record-keeping, and reporting. The public comment period closed on the draft ACD December 31, 2008. The ACD was entered into Federal Court on April 15, 2009.

The Consent Decree amendments were negotiated over several months, and the terms of the draft amendments were known to MSD during the final stages of development of this Integrated Overflow Abatement Plan (IOAP). For the purposes of the IOAP, except where specifically noted otherwise, the term "Consent Decree" will be understood to mean the ACD as it was entered into Federal Court April, 15, 2009.

This IOAP is a major part of MSD's response to the Consent Decree. The IOAP is a long-term plan to control CSOs and eliminate sanitary sewer overflows (SSOs) and other unauthorized discharges from MSD's sewerage system. The IOAP is expected to improve water quality in both Beargrass Creek and the Ohio River through and below Jefferson County. The expected water quality benefits of the IOAP include: (a) reductions in the peak levels of bacteria in the Ohio River and Beargrass Creek; and (b) a reduction in the amount of time that average bacteria levels to exceed water quality standards.

ADAPTIVE MANAGEMENT

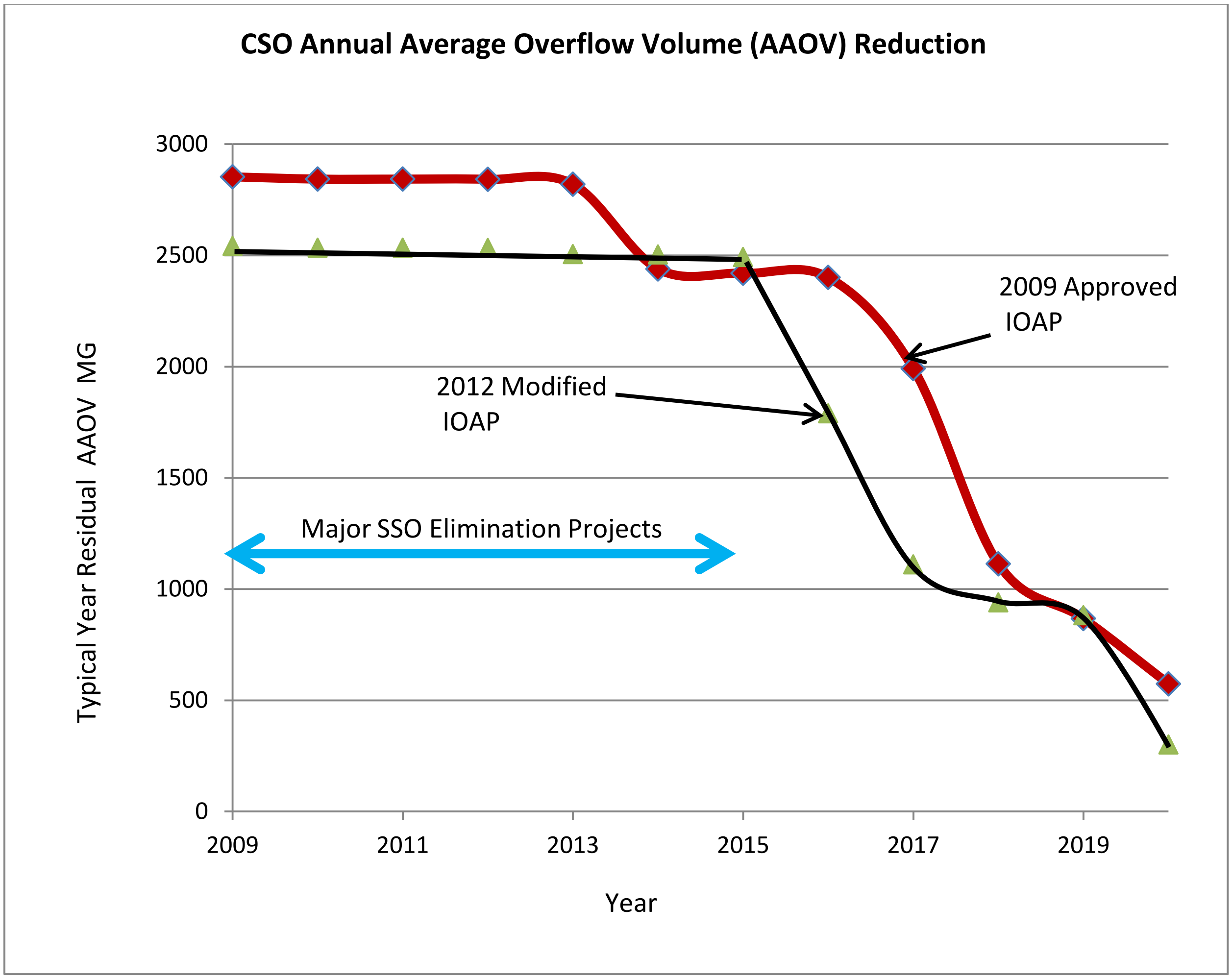
Recognizing the long-term nature of the IOAP, MSD committed to an approach of adaptive management, intending to make mid-course corrections as we learn more about the performance of our projects and the related response of our sewerage system. In 2011, MSD took advantage of four more years of flow monitoring data to perform a planned recalibration of the hydraulic models used to develop, evaluate, and design overflow abatement projects. As a result of this recalibration MSD found opportunities to revise the proposed suite of projects, providing increased levels of overflow abatement, faster, and for approximately the same cost. The 2012 IOAP Modification incorporated herein describes the project changes in technology, size, and schedule, and the resultant benefits of making those changes.

MSD developed a programmatic justification for this 2012 IOAP Modification utilizing the same benefit/cost methodology defined by the Wet Weather Team for the 2009 approved plan, as outlined in Volume 1 Chapter 2. This justification demonstrates the proposed modifications achieve a higher overall benefit to the community through earlier overflow reduction, increased use of green infrastructure and acknowledgement of pertinent public input.

A table showing the complete list of LTCP projects comparing the level of control, facility size, cost, and schedule for each of the projects in the 2009 approved IOAP and the 2012 IOAP Modification is included as Table ES.1 at the end of this Executive Summary. A similar table for the SSDP projects is included as Table ES.2 at the end of this Executive Summary. A schedule for all the projects in the LTCP and SSDP is also included at the end of this Executive Summary as Figure ES.1.

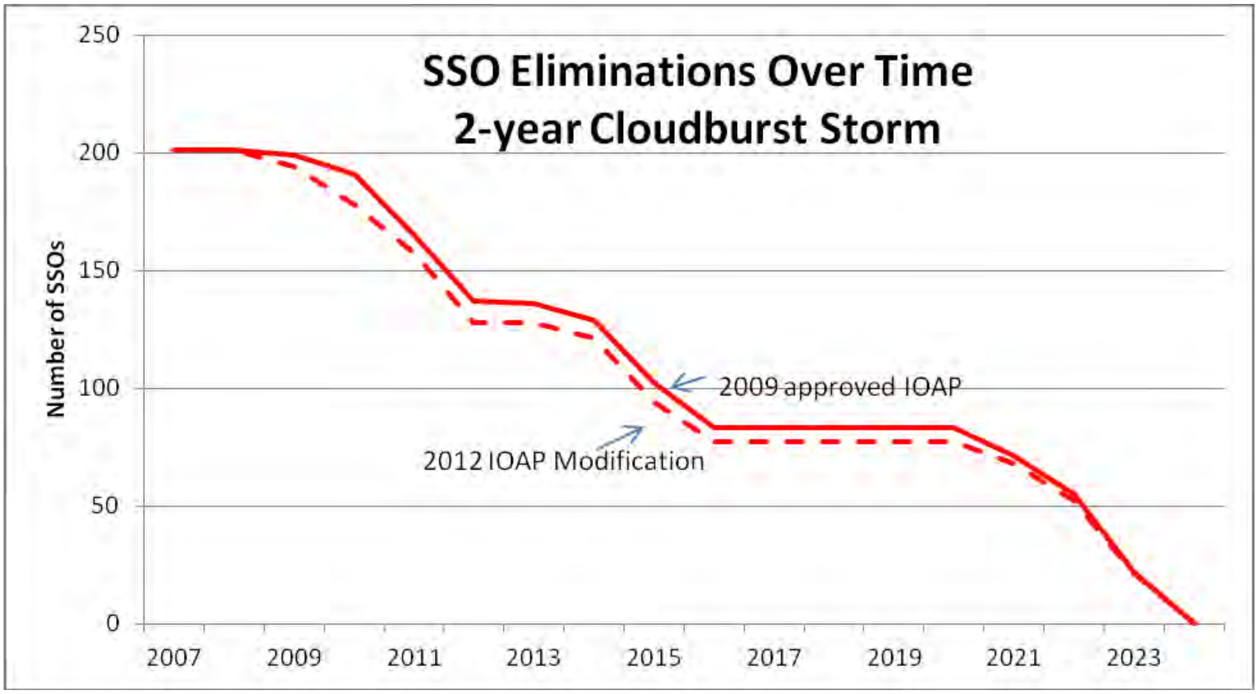
MSD has evaluated the impacts of the proposed modifications on the overflow reduction timing and overall overflow reduction performance as compared to the 2009 IOAP. Figure ES.2 below illustrates the effect of the proposed modifications on the timing of CSO elimination. The curve labeled “2009 Approved IOAP” shows the timing of average annual overflow volume (AAOV) reductions for the approved plan. The curve labeled “2012 Modified IOAP” shows that the proposed modifications achieve AAOV reductions earlier than was projected in the 2009 approved IOAP. In addition, residual AAOV is significantly lower in the 2012 Modified IOAP, reflecting a higher overall level of CSO control. Note that the apparent delay in achieving significant AAOV reductions is due to the need to focus initially on major SSO reductions required by the ACD and described in the Interim Sanitary Sewer Discharge Plan. Significant AAOV reductions were achieved prior to 2009 through the implementation of the first two phases of the Real Time Control (RTC) project, early action sewer separations, etc.

FIGURE ES.2 - CSO AAOV REDUCTION THRU 2020



MSD has similarly evaluated the impacts of the proposed modifications on the SSO overflow reduction timing and overall overflow reduction performance as compared to the 2009 IOAP. Figure ES.3 illustrates the effect of the proposed modifications on the timing of SSO elimination for the 1.82-inch cloudburst storm. Figure ES.3 shows that the number of SSO locations eliminated is the same, and the SSO eliminations occur quicker than originally proposed. In addition, more SSOs are eliminated to a higher level of control than proposed in 2009.

FIGURE ES.3 – SSO LOCATION REDUCTION THRU 2024



Figures ES.2 and ES.3 demonstrate that the proposed changes result in a more effective overflow abatement program with higher community benefit and more expeditious overflow reduction as a program.

CSO Benefits

The suite of projects selected for the Final CSO Long-Term Control Plan (LTCP) will result in approximately 98 percent capture and treatment of wet weather combined sewage during an average year. This benefit represents an 89 percent reduction in CSO volume compared to conditions in 2008. As a point of reference, the presumptive approach for compliance with water quality standards in EPA's CSO Control Policy is based on a minimum of 85 percent capture and treatment of wet weather combined sewage. Of the wet weather combined sewage captured and treated, approximately 70 percent receives secondary treatment at either the Morris Forman WQTC or the Derek R. Guthrie WQTC. The remainder of the wet weather flow receives primary treatment only.

Remaining CSO loads will no longer cause fecal coliform water quality standards violations in the Ohio River. Downstream from Morris Forman WQTC, peak fecal coliform counts are modeled to be reduced by 54 percent, from 100,000 colony-forming units (cfu) per 100 milliliter (cfu/100mL) to 46,000 cfu/100 mL. If CSOs were eliminated, background sources (e.g. upstream Ohio River, stormwater runoff, and other sources) would continue to cause standards to be exceeded 33 percent of the recreation contact season (May to October).

Remaining CSO loads (after removing background) will result in 100 percent compliance with fecal coliform water quality standards in Beargrass Creek. At the mouth of Beargrass Creek, peak fecal coliform counts are modeled to be reduced by 18 percent, from 44,300 cfu/100mL to 37,400 cfu/100 mL. Reducing fecal coliform loads from CSO sources by 85 percent (compared to 2008 levels) results in a reduction of total loads on Beargrass Creek of approximately 30 percent. This is reflective of the preponderance of loads from stormwater runoff and other sources unrelated to CSOs.

SSO Benefits

The suite of projects selected for the Final Sanitary Sewer Discharge Plan (SSDP) for SSO control will result in the elimination of capacity-related SSOs up to the site-specific level of protection. The SSO projects are anticipated to eliminate an average of 145 SSO events per year (290 million gallons {MG} of overflow volume), based on 2005–2007 data normalized for rainfall. In terms of water quality, SSO projects will eliminate 100 tons of five-day biochemical oxygen demand (BOD_5) and approximately 200 tons of suspended solids annually.

Along with delivering water quality improvements from sewer overflow control, MSD participates in other community water quality improvement efforts. Sewer overflow control is essential to improving water quality, but overflow control alone is not sufficient to meet water quality standards. In light of this challenge, MSD continues to leverage its role in supporting broader water quality improvement efforts in the community. The IOAP will be one of the key elements of MSD's participation in those water quality improvement efforts.

Integration with Other Water Quality Programs

The IOAP is a part of MSD's Consent Decree response and will be a federally enforceable action plan for sewer overflow abatement. Although many IOAP projects and programs will provide multiple benefits to the community, the scope of the IOAP is limited to commitments that directly relate to MSD programs and activities to address CSO and SSO issues. Other community water quality programs, which may be partly or completely out of MSD's control, can provide synergistic benefits with the IOAP, but they do not fall under the same federal enforcement. These programs may, however, have different enforcement mechanisms. As noted above, MSD anticipates coordinating IOAP implementation with the water quality improvement initiatives of Louisville Metro Government and other public and private entities, even though these broader initiatives may not explicitly be part of the IOAP.

The ancillary information provided by MSD that is not related to overflow abatement projects or the specific requirements of the Consent Decree is being provided and should be considered as supplemental, background information. It is not being submitted in response to any requirements, obligations or commitments to any specific actions or time frames that are required under the provisions of the Consent Decree. This supplemental information should not be considered as a commitment by MSD to any project not required by the Consent Decree.

Values-Based Performance Evaluation Framework

In accordance with the Consent Decree, MSD established a Wet Weather Team (WWT) comprised of a broad range of community stakeholders, MSD staff, and consultants. Through a series of 23 meetings over the course of more than two years, the WWT developed a values-based performance evaluation framework to use in evaluating, selecting, and prioritizing alternative approaches to overflow abatement. This analytic framework includes both a robust benefit-cost scoring methodology for evaluating and selecting project alternatives and a systematic process for evaluating the IOAP programmatically. The WWT identified and agreed upon the following eleven community values that underpin the analysis and selection of alternatives for the IOAP.

Project-Specific Values	Programmatic Value
• Asset protection • Eco-friendly solutions • Environmental enhancement • Public health enhancement • Regulatory performance	• Customer Satisfaction • Economic vitality • Education • Environmental justice and equity • Financial equity • Financial stewardship

Using the structured decision-making process as framed by the WWT, MSD developed and evaluated overflow abatement control options for the IOAP centered on managing risks to these community values. In particular, MSD's technical team analyzed each project alternative considered for the IOAP in terms of potential benefits and costs, where "benefits" are quantified using the anticipated reduction in risks to the community values, and "costs" reflect the total capital and operational costs of the alternative. The benefit-cost analysis influences the selection of site-specific abatement approaches or technologies, site-specific levels of protection (within the boundary conditions for CSOs and SSOs described below), and the relative priority of projects for implementation.

In developing the 2012 IOAP Modification, MSD continued to use the same benefit-cost analysis approach for alternative selection, level of control analysis, and project prioritization. The technical team maintained close contact with the WWT Stakeholder Group, and met with them during development of the modifications to ensure that the intent of the decision making process was adhered to.

Several of the WWT's community values relate to financial considerations, including the cost-effectiveness of individual solutions and the program as a whole (financial stewardship), the affordability of the program's total costs for the community (economic vitality), and how the costs are allocated among different segments of the population (financial equity). The WWT used the results of the values-based benefit-cost analysis of project alternatives to provide context to discussions about the appropriate level of investment in the IOAP.

The WWT's discussions about total program costs and the selection of projects for the IOAP have considered, as directed in EPA's CSO Control Policy, a "knee of the curve" analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs (59 Code of Federal Regulations {CFR} 18688). In addition to this analysis, the community's level of investment in the IOAP has been considered in the context of anticipated future requirements and other needs for MSD services, including stormwater compliance needs associated with Louisville Metro's MS4 stormwater permit and requirements to meet the forthcoming total maximum daily load (TMDL) allocations for Beargrass Creek. This consideration of other water quality investment needs is important since sewer overflow control alone will not be sufficient to meet water quality standards.

The technical team's analysis of the IOAP according to the WWT's programmatic values yielded the following conclusions.

Customer Service: The IOAP ensures service continuity by eliminating several small WQTCs and pump stations and by incorporating redundant equipment and standby generators in the proposed projects. Odor control guidelines have been consistently applied across all projects. Most storage basins proposed in the IOAP will be covered to minimize odors. Other storage basin and pump station improvement projects incorporate odor control equipment.

Economic Vitality: MSD's current rates are near the national average. The anticipated annual rate increases of 5 to 6.5 percent are consistent with initial estimates of program costs, and they include allowances for future MSD programs as well as IOAP implementation. Even with these rate increases, MSD's rates are anticipated to remain at or near the national average, assuming other communities face similar inflation and regulatory pressures. These estimates are based on current data; many unknown factors (such as, bond market, construction market conditions, etc.) will also affect future rates.

Education: Education is an integral and essential component of the IOAP. It supports a number of IOAP objectives, including promoting and sustaining participation in green infrastructure and source control efforts, and building a sense of personal responsibility and support for clean water initiatives.

Environmental Justice and Equity: The site selection process followed uniform criteria across the county, with most solutions placed near overflow points and with no homes or private businesses permanently displaced. Furthermore, the configuration of facilities was based on a uniform application of written design criteria and odor control criteria. Other nuisance conditions, such as noise, dust, and traffic disruptions will be minimized during the design and construction phases of projects.

Financial Equity: MSD's rate structure is based on a cost-of-service model tempered by consideration of customers' ability to pay. The rate increases proposed to fund the IOAP and other MSD programs will continue to be based on the cost of service, but the MSD Board supports the existing low income, senior citizen discount program, and has discussed the possibility that this discount program be expanded. The MSD Board also implemented subsidies and incentives for green infrastructure and inflow and infiltration (I/I) control based on their business value for overflow abatement.

Financial Stewardship: As described above, the IOAP is based upon a rigorous benefit-cost analysis that considered a broad range of technology alternatives and different levels of control that met or exceeded regulatory guidelines. The "knee of the curve" evaluations of IOAP projects demonstrated that the IOAP provides a high level of control, but does not exceed the point of diminishing returns.

As noted previously, the WWT included a diverse group of community stakeholders. This WWT Stakeholder Group included 20 community opinion leaders from local government, industry WWT environmental advocacy groups, education, public health and many other areas of interest. The Stakeholder Group played a key role in developing the framework for alternative evaluation, selection, and prioritization. Prior to final submittal of the IOAP, the WWT Stakeholder Group developed a memorandum expressing support for the IOAP. This WWT Support Memorandum is attached at the end of this Executive Summary (Attachment 1). The support from the WWT Stakeholder Group is based on their understanding of the plan as represented by an "IOAP Vision." The IOAP Vision is also attached at the end of the Executive Summary (Attachment 2). The WWT Stakeholder Group continues to meet and provide input relative to IOAP implementation. They also had the opportunity to review the 2012 IOAP Modifications, and developed a similar memorandum expressing support for this submittal. The updated WWT Support Memorandum was approved by the WWT Stakeholder Group on January 30, 2013. This Memorandum is included at the end of the Executive Summary as Attachment 3.

Control Levels for CSOs and SSOs

Under the CWA, CSOs are permitted discharges in wet weather, as long as they are managed to avoid degradation of water quality in the receiving streams. EPA's CSO Control Policy[1] has guidelines for establishing abatement targets for CSOs, one of which is the presumptive approach of establishing controls that provide for the elimination or capture and treatment of at least 85 percent of wet weather combined sewage. Under this approach, CSOs are presumed to be adequately controlled to comply with water quality standards. Regardless of the approach

[1] EPA's Combined Sewer Overflow Control Policy is available at http://cfpub1.epa.gov/npdes/cso/cpolicy.cfm.

that the community follows to establish abatement targets, implementation of the plans should provide that CSOs, in the absence of other loads, do not by themselves cause a violation of water quality standards.

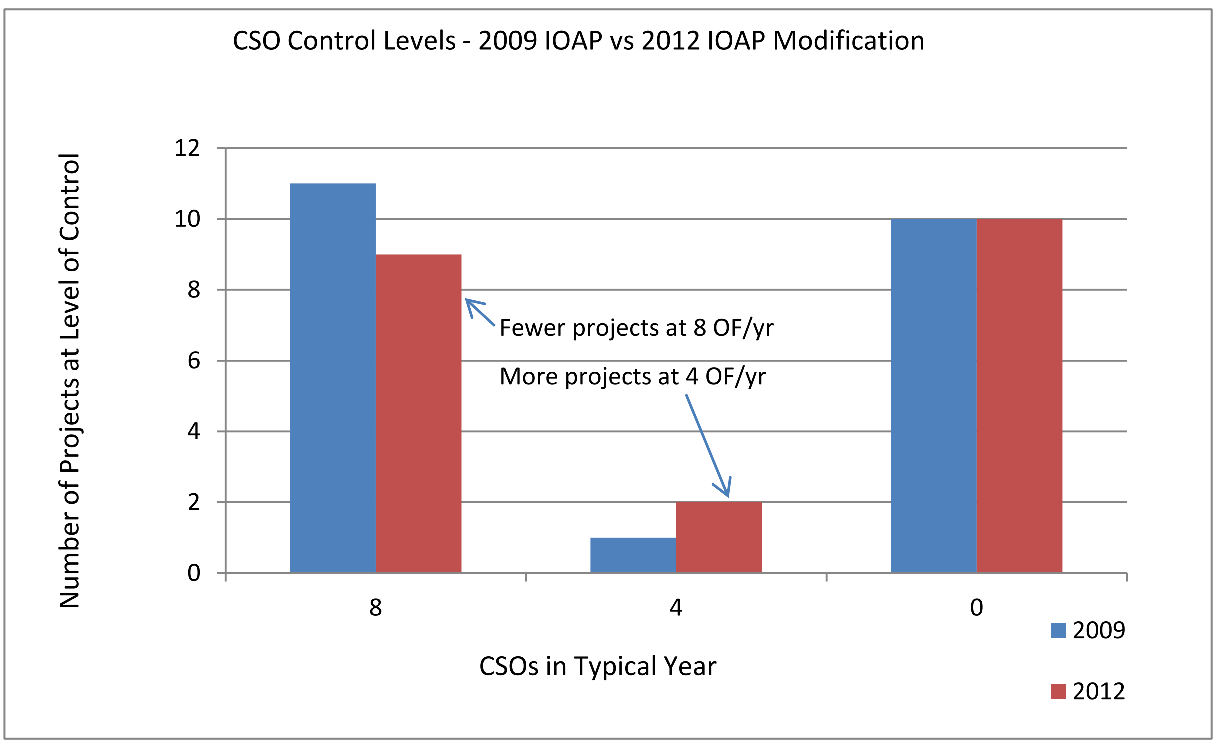
Using the values-based performance evaluation and risk management decision process described previously, MSD has elected to provide a level of CSO control that greatly exceeds EPA's presumptive approach of 85 percent capture of wet weather combined sewage. This level of overflow control represents a 96 percent capture of wet weather combined sewage, and an 85 percent reduction in overflow volumes as compared to 2008 levels.

CSO projects in the 2012 IOAP Modification have the following levels of control:

- Ten projects result in no overflows in a typical year; these locations would only overflow as a result of very large storms.
- Two projects would result in four overflows per year in a typical year.
- Nine projects result in eight overflows per year in a typical year.

Figure ES.4 below illustrates the improvement in level of protection offered by the projects of the 2012 IOAP Modification as compared to the 2009 approved IOAP.

FIGURE ES.4



MSD's strategy for SSO control reflects the fact that SSOs, unlike wet-weather CSOs, are considered to be unauthorized discharges that must be eliminated according to EPA. Given the variable impacts of rainfall on sewage flows, elimination of unauthorized discharges must be framed in the context of a "design storm" that will be community-specific.

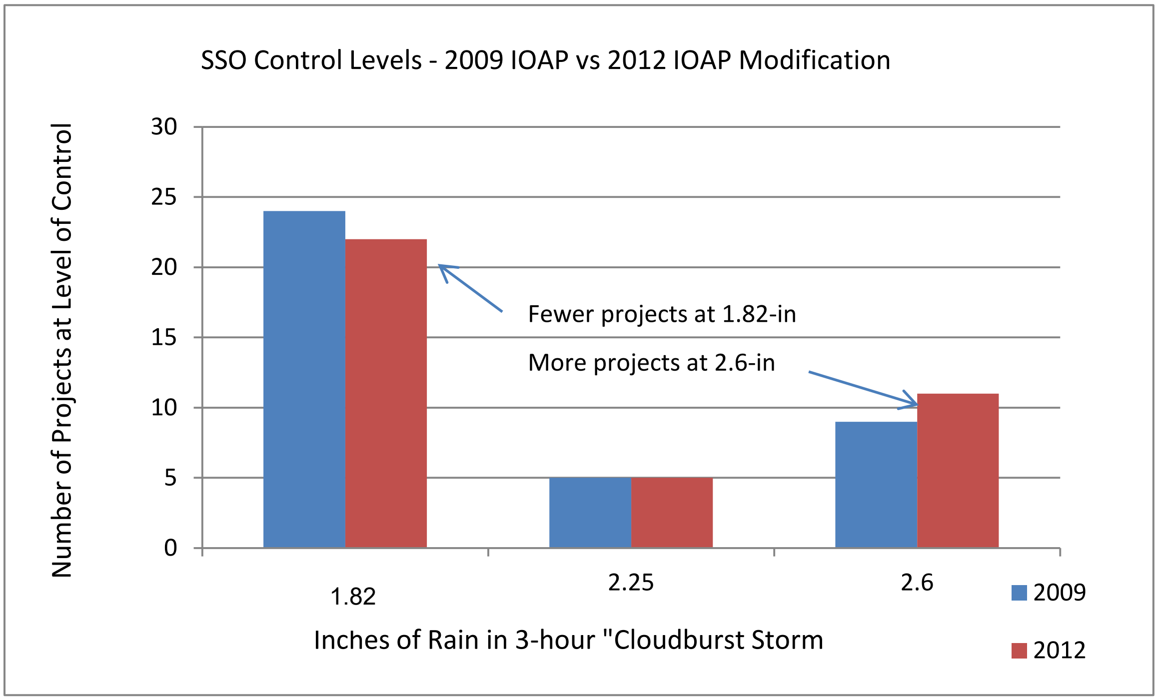
In the IOAP, the values evaluation framework has been used to evaluate a range of site-specific design storms to establish the appropriate level of control of SSOs. Consistent with an analysis of sixty years of historical weather patterns for Louisville Metro, the IOAP uses a three-hour "cloudburst" storm, with a statistically anticipated rainfall of 1.82-inches, as the minimum design storm considered. There is a 50 percent probability that a storm this large will occur in this area in any given year. The Cities of Atlanta, Cincinnati, and Knoxville used similar statistically probable design storms as the minimum protection level for SSO control. The approach of using the values evaluation framework to determine the SSO control level means that solutions to address certain SSOs have been designed to protect against larger storms (such as, a 2.25-inch cloudburst storm instead of a 1.82-inch cloudburst storm) because they yield a higher benefit-cost ratio in the analysis of project alternatives.

SSO projects in the 2012 IOAP Modification have the following levels of control:

- Twenty-two projects eliminate overflows up to a 1.82-inch cloudburst storm.
- Five projects eliminate overflows up to a 2.25-inch cloudburst storm.
- Eleven projects eliminate overflows up to a 2.60-inch cloudburst storm.

Figure ES.5 below illustrates the improvement in level of protection offered by the projects of the 2012 IOAP Modification as compared to the 2009 approved IOAP. Note that SSES projects are not included in this level of control analysis.

FIGURE ES.5



COMPONENTS OF MSD'S INTEGRATED OVERFLOW ABATEMENT PLAN

Control options in the IOAP, known as the IOAP toolkit, include source control such as green infrastructure and I/I reduction efforts, storage, conveyance/transport, treatment, and sewer separation. MSD's technical team used the benefit-cost tool to compare the project alternatives and program elements considered for inclusion in the IOAP. The specific mix of control options for individual CSO or SSO locations in the IOAP is driven by the benefit-cost analysis of how the project alternatives affect the WWT's community values and site-specific considerations. Project alternatives are built around MSD's existing infrastructure such as large diameter pipes and WQTCs and draw on synergistic benefits from other MSD projects (for instance the Interim SSDP projects). Furthermore, project budgets include an enhanced site restoration allowance to fund localized opportunities to reduce historical overflow impacts on aquatic and riparian environments near the sites of overflow abatement projects.

Green Infrastructure and Gray Solutions, Initiatives and Programs in the Final CSO LTCP

Driven by the values-based benefit-cost analysis, the IOAP reflects a balanced mix of green infrastructure and gray solutions to prevent and control sewer overflows. "Green infrastructure" solutions include options such as vegetated roofs, rain gardens, rain barrels, porous pavement, and bioretention, while "gray" solutions include options such as storage, treatment, conveyance/transport, and sewer separation. As a guiding principle, MSD's IOAP has been developed based on front-end consideration of source control and green infrastructure. This means that more traditional "gray" infrastructure in the IOAP has been sized after considering both (1) the anticipated flow-reduction benefits of programmatic and site-specific green infrastructure solutions and (2) the anticipated effectiveness of other source control approaches, including reduction of private sources of I/I.

Green solutions in the IOAP will be implemented as soon as possible, to allow data to be gathered on the flow reduction benefits that occur. Approximately 17 percent of the Final CSO LTCP budget is allocated to green infrastructure, and most of that is planned to support projects in the first six years of IOAP implementation. Prior to the final design of supporting gray solutions, the actual flow reduction performance will be documented and compared against the estimated targets. The final sizing of the gray solutions will then be based on actual documented performance of green infrastructure solutions, as well as any further green and source control investments justified by performance information. Green infrastructure investments are estimated to reduce the initial costs of CSO gray infrastructure projects by $40 million; potential future savings could double or triple this amount. A more detailed discussion of the green infrastructure program is presented in Volume 2.

Table ES.3 shows the 22 gray infrastructure projects to control CSOs defined in the IOAP.

TABLE ES.3
GRAY INFRASTRUCTURE PROJECTS TO CONTROL CSOS (2012 MODIFICATION)

Number of Projects	Project Type
3	Sewer separation projects
14	Storage basin projects includes in-line and off-line storage. Most in-line storage projects have a RTC component
1	Replacement and expansion of the Nightingale Sanitary Pump Station
2	Conveyance expansion projects
1	"Green infrastructure only" project (with one other under consideration)
1	One high-rate wet weather treatment (screening, settling, and disinfection) with in-line and off-line storage.

In addition to these 22 CSO control projects, MSD will implement five projects at flood pump stations. These projects will eliminate a major cause of dry weather overflows related to operation of the flood pump stations in compliance with the U.S. Army Corps of Engineers (USACE) Flood Protection System Pumping Operations Manual.

Green Infrastructure Program

The IOAP includes both an annual Green Infrastructure Program and an initial set of green infrastructure demonstration projects. The Green Infrastructure Program is front-end loaded to maximize benefits on downsizing future gray infrastructure. For example, the IOAP project schedule calls for a $40 million investment in green infrastructure programs and projects during the first six years.

Programmatic green infrastructure components in the IOAP include a downspout disconnect program, green roof construction subsidies or incentives, green roads and alleys partnership incentives, and pervious pavement sidewalks and parking. MSD has based the proposed incentives and subsidies on a “business case” analysis of the financial benefit of green infrastructure in terms of costs per gallon of flow removed from the CSS. Through the anticipated green infrastructure partnership, incentive, and education programs, MSD's initial $40 million investment in green infrastructure has the potential to leverage $60 million more from other private and public funding sources, thereby yielding up to $100 million in green infrastructure projects.

MSD plans to construct a series of new green infrastructure demonstration projects across Louisville Metro. The proposed green infrastructure projects in the CSS area will be part of MSD’s IOAP, while the proposed green infrastructure projects outside the CSS area will be a part of the community’s MS4 stormwater program and not a part of this IOAP. These demonstration projects are designed to achieve three main objectives: (1) improve water quality and reduce sewer overflows, (2) provide data on green infrastructure effectiveness, and (3) educate the community about the value and benefits of green infrastructure.

All proposed green infrastructure demonstration projects will incorporate a monitoring component, so that the effectiveness of the pilot projects can be regularly tracked. Project reports will document lessons learned and successes and be the mechanism for reporting to regulators and the public. MSD will use these monitoring results to guide future IOAP implementation, under the IOAP’s adaptive management plan (further described below).

This IOAP vision currently reflects a minimum commitment to 19 green infrastructure demonstration projects. A complete list of demonstration projects completed and other green infrastructure projects completed and underway as of October 2012 can be found in Volume 2, Chapter 5. Source Control and Gray Solutions, Initiatives and Programs in the Final SSDP.

Similar to the integrating of green infrastructure with gray infrastructure in the Final CSO LTCP, MSD will implement an annually-funded I/I reduction program to reduce clear water intrusion into the sewers. I/I is one of the main causes of SSOs, so eliminating the source can be an effective way of reducing SSOs. To be effective, an I/I elimination program must deal with collection system defects in both the public and the privately owned portions of the sewer system. MSD's program includes an active private side I/I reduction approach currently implemented through voluntary, subsidized programs.

Prior to the final design of supporting gray solutions, the actual flow reduction performance from source control programs will be documented and compared against the estimated targets. The final sizing of the gray solutions will then be based on actual documented performance of source control solutions. Approximately 15 percent of the Final SSDP budget is allocated to I/I reduction and other source control programs. In addition, the Final SSDP includes eight specific I/I reduction projects targeting overflows that appear to be controllable through source control alone.

Table ES.4 shows the technology components of the 47 gray infrastructure projects to control SSOs defined in the Final SSDP. Note that some projects have multiple components, so those projects will be counted in more than one category.

TABLE ES.4
GRAY INFRASTRUCTURE PROJECT COMPONENTS TO CONTROL SSOS (2012 MODIFICATION)

Number of Projects Including Component	Project Type
19	Conveyance capacity upgrades and interceptor relief projects
9	Storage projects (in-line and off-line storage, many with pipe upgrades also)
13	Pump station upgrades or replacements.
12	Pump Station eliminations
7	Small WQTC eliminations including 5 in the Prospect Area

Note: Final SSDP projects also include the potential elimination of the Jeffersontown WQTC. Interim SSDP projects include the replacement of the SSS in the Beechwood Village area, the decommissioning of the Highgate Springs Pump Station, construction of an interceptor to eliminate pumped overflows in the Hikes Point area, construction of a relief sewer and a diversion interceptor to route wet weather flows to the Derek R. Guthrie WQTC (formerly known as the West County Wastewater Treatment Plant), and an expansion of the wet weather capacity of the Derek R. Guthrie WQTC.

Control of Private Sources of I/I

MSD's technical team analyzed methods to control private sources of I/I into the SSS and proposed several potential options. This analysis indicates that private-side I/I control must be an essential part of the IOAP implementation, because it will reduce the overall anticipated costs of overflow abatement.

Private source options include mitigating building laterals, downspouts, sump pumps, and foundation drains. The technical team also analyzed options requiring inspections of private properties. The required inspection options include: during the property transfer process, when building permits are issued, when contractors install roof and gutter systems, when plumbers connect sump pumps, and/or at other times. MSD would seek some form of cost share as well as conduct an aggressive education campaign. The MSD Board approved changes to the Wastewater and Stormwater Discharge Regulations that allow MSD to take specific action in this regard. MSD will develop specific policies to guide implementation of these measures.

Public Information, Education, and Involvement Program

Education and public involvement are critical to the long-term implementation success of the IOAP. MSD uses the term "Project WIN" (Waterway Improvements Now) to describe its Consent Decree response activities to the public.

The ongoing public information, education, and involvement program for Project WIN is designed to accomplish the following objectives:

- Generate a sense of personal ownership and responsibility for clean water;
- Promote and sustain participation in critical voluntary programs in the IOAP, including private-side I/I control and green infrastructure;
- Promote public acceptance and support for the financial investments required to achieve consent decree and CWA compliance; and
- Encourage support for other agency programs or legislation that supports overflow abatement efforts.

To achieve these objectives, the Project WIN education and public involvement program uses a wide range of communication media. These public involvement efforts are focused on several key audiences; including property owners, schools and children, and target groups such as, project neighborhoods, builders, and restaurants. Focusing education efforts on children is important to ensure the long-term sustainability of voluntary programs in the IOAP. MSD uses five key messages to promote Project WIN:

1. Value clean water.
2. Your investment is paying dividends, and our water is getting cleaner.
3. Protecting public health is critically important.
4. MSD and many community partners are working hard to improve water quality.
5. <u>You</u> can make a difference in improving water quality.

Post-Construction Compliance Monitoring

MSD's IOAP will use an adaptive management implementation approach based on monitoring and evaluation efforts. MSD's post-construction compliance monitoring and evaluation plan for the IOAP includes: (a) water quality monitoring, (b) sewer flow monitoring, (c) overflow events analysis, (d) gray and green infrastructure project performance monitoring, and (e) measurement of the effectiveness of source control and behavior-change efforts. A part of the post-construction compliance monitoring program will be a periodic recalibrating of sewer system models that will support project performance evaluation and resultant project re-sizing based on monitoring results.

In 2011, MSD took advantage of four more years of flow monitoring data to perform a planned recalibration of the hydraulic models used to develop, evaluate, and design overflow abatement projects. As a result of this recalibration MSD found opportunities to revise the proposed suite of projects, providing increased levels of overflow abatement, faster, and for approximately the same cost. The 2012 IOAP Modification incorporated herein describes the project changes in technology, size, and schedule, and the resultant benefits of making those changes.

MSD will continue to adapt the CSO management and SSO elimination approaches based on the monitoring and evaluation results. Adjustments may include recalibrating models, "right-sizing" gray solutions, reevaluating the effectiveness of green solutions, and adjusting the types and characteristics of projects planned for later phases of implementation, supplementing existing control projects with additional storage or conveyance, and including additional investments in green infrastructure or source control beyond those proposed in the initial program. At this time, there is recognition that historical weather trends may not be as reliable as in the past due to potential changes in the climate. The IOAP's adaptive management approach will allow MSD to continue to monitor rain events and weather pattern developments and adjust its plans as more technical data become available.

Future Development Considerations

Solutions in the IOAP consider future development based on the community's long-term landuse plan, Cornerstone 2020.[2] IOAP solutions are designed to accommodate the anticipated impacts of population growth and landuse development. The solutions consider the effects of growth on connections to existing infrastructure that is upstream from existing overflow points. However, the IOAP is not intended to provide capacity for all future growth that is predicted by Cornerstone 2020. Cases where the growth outlined in Cornerstone 2020 would logically be provided by new infrastructure and is not hydraulically dependent on or connected

[2] For more information about the Cornerstone 2020 plan, see www.louisvilleky.gov/PlanningDesign/Cornerstone+2020.htm.

to the IOAP solution, have not been considered part of the IOAP. Moreover, the IOAP solutions are designed and sized to account for the impacts of anticipated growth on existing infrastructure, but the IOAP itself is not intended to build the capacity needed for growth.

IOAP Funding Plan

To meet the requirements of the Consent Decree, the funding plan is designed to cover the IOAP capital projects that will be constructed to improve MSD's sewer infrastructure. The IOAP funding plan is based on the following four principles:

1. Rates and fees for the IOAP must pay MSD's operating costs and debt service.
2. MSD's current bond rating (AA) should, at a minimum, be maintained.
3. Rates and fees should allow for continued economic development in the community and a strong local economy.
4. Rates must be affordable for MSD's customers.

For IOAP implementation, these funding plan principles affect the amount of money MSD may borrow at one time and the level of increases in rates and fees needed to fund capital and operating expenses.

MSD will fund the IOAP primarily through a combination of annual rate increases and bond issues or other loans. MSD also plans to pursue grants, line-item appropriations, and public/private partnerships (e.g., recapture agreements) to help pay for capital construction costs, as appropriate; however, the funding plan is not built around these funding sources since they are less certain. By estimates, the Consent Decree will cost $843 million in capital expenditures; as a result, average sewer bills for residential customers are expected to increase from 5.5 to 6.5 percent annually through 2025. Due to the Consent Decree capital construction expenses, this means that the average monthly residential sewer and Consent Decree surcharge bill would increase from $29.58 in 2008 to approximately $77.42 by 2025. Along with these rate increases, MSD expects to borrow approximately $938 million between 2009 and 2025 based on the estimates of capital costs; this would increase MSD's debt service payments from $94 million annually to $127 million annually by 2025, assuming interest rates at four percent for new issues. A mixture of fixed and variable rate borrowings is anticipated. These rate increases and loans would be used to address both IOAP construction costs and other MSD capital needs for infrastructure renewal, replacement, and expansion.

Estimates of IOAP costs appear to be within the community's ability to pay, as indicated by affordability analysis completed using EPA guidelines. MSD recognizes, however, the rate increases could nevertheless be difficult for some segments of the population to afford, especially in the context of other living expenses. For this reason, the WWT considered potential discount options to customers that face financial hardship. The MSD Board adopted a discount program for low-income senior citizens that provided over $600,000 of rate assistance in FY 2012. The MSD Board has also considered other discount programs for other impacted groups, but has not implemented them at the time of this 2012 IOAP Modification preparation.

As noted above, MSD will construct the capital projects to meet the regulatory requirements of the Consent Decree and achieve compliance with the CWA. Many of the elements of the IOAP—including the Project WIN education program, operations and maintenance of IOAP projects, and monitoring and evaluation programs—will also continue past the construction phase of the IOAP. MSD is committed to making sure that the IOAP programs and projects provide for long-term improvements in water quality in Louisville Metro.

An Approvable IOAP

MSD has developed the IOAP in conformance with the Consent Decree, the CSO Control Policy, and other applicable regulations. The following presents the "road map" of compliance factors for both the Final CSO LTCP and the Final SSDP.

An Approvable Final CSO LTCP

The MSD Final CSO LTCP as submitted on June 19, 2009, is fully compliant with the Consent Decree and the requirements of the CSO Policy. This 2012 IOAP Modification provides a higher level of CSO control and a lower final residual AAOV, confirming that it is also fully compliant with the Consent Decree and the CSO Control Policy. MSD's water quality compliance approach is based on EPA's Demonstration Approach in that water quality modeling demonstrates that both Beargrass Creek and the Ohio River would be in full compliance with existing water quality standards if all background loads were removed. The IOAP projects, when fully implemented, are projected to capture 96 percent of the wet weather combined sewage generated in the service area. This flow will be treated with at least the equivalent of primary clarification, control of solids and floatables, and disinfection. The innovative and site-specific approach includes implementation of green infrastructure and public education. The Final CSO LTCP is also fully compliant with the three goals required in the Consent Decree [paragraph 25. (b) (2) A (i); (ii) and (iii)].

Both the Consent Decree and the CSO Policy require specific elements of the Final CSO LTCP as noted in the Table ES.5; MSD has fully complied with both the Consent Decree and the CSO Policy through the full inclusion of each of these elements in the Final CSO LTCP.

TABLE ES.5
FINAL CSO LTCP ELEMENTS AS REQUIRED BY THE CONSENT DECREE

Requirement Per Consent Decree Paragraph 25 (b) (2)	IOAP and Final CSO LTCP Chapters and Sections	Compliance with CSO Policy and Consent Decree
(i) Results of characterization, monitoring, modeling activities and design parameters as the basis for selection and design of effective CSO controls (including controls to address those discharges resulting from MSD's compliance with the requirements of the USACE Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988).	Volume 2 - Final CSO LTCP: Chapter 2 for an evaluation of the controls to address flood pumping issues, Chapter 3 for the alternative analysis Chapter 4 and 5 for the selection of effective CSO Controls including modifications to the flood pumping system, where required, to implement revised operating procedures at the flood pump stations.	**Yes** – the proposed plan is based on an extensive process in which every alternative accounted for data and was reviewed by WWT.
(ii) Results of an evaluation of WQTC peak flow treatment capacity for any WQTC other than the Morris Forman WQTC that will receive additional flow based on any LTCP project. Such evaluation shall be consistent with the EPA publications "Improving POTW Performance Using the Composite Correction Approach and "Retrofitting POTWs"	No existing treatment plants other than the Morris Forman WQTC will receive any additional flow as a result of the Final CSO LTCP. Volume 2, Chapter 3.3 Evaluation of CSO Control Alternatives; Table 3.1.1 shows treatment alternatives; Chapter 3.2.7.5 Utilization of Morris Forman WQTC; Chapter 3.2.7.5 Satellite treatment alternatives; Table 3.3.1.	**Yes** – peak flow treatment capacity will be available with use of storage, real time control (RTC), and treatment.
(iii) Report on the Public Participation Process	Volume 1 - IOAP, Chapter 3	**Yes** – the WWT and the general public were actively involved in the decision making to select the long-term CSO controls.
(iv) Identification of how the LTCP addresses sensitive areas as the highest priority for controlling overflows	Volume 2, Chapter 1.6.6.7; Chapter 2.8; and Chapter 3.2.7.6.	**Yes** – while all receiving waters considered in the Final CSO LTCP are categorized sensitive under CSO Policy criteria, MSD performed further prioritization of stream reaches based on ecological characteristics.
(v) Report on the cost analyses of the alternatives considered	Volume 1, Chapter 2 Volume 1, Chapter 6 presents rate and affordability impacts Volume 2, Chapter 3.3.2, and Chapter 4 and 5.	**Yes** – application of cost to community value framework for a cost-benefit and a knee of the curve analysis were part of the development of project alternatives and choices. Affordability and phases were also accounted in the development of the schedule.

TABLE ES.5
FINAL CSO LTCP ELEMENTS AS REQUIRED BY THE CONSENT DECREE

Requirement Per Consent Decree Paragraph 25 (b) (2)	IOAP and Final CSO LTCP Chapters and Sections	Compliance with CSO Policy and Consent Decree
(vi) Operational plan revisions to include agreed upon long term controls	Volume 1, Chapter 6	**Yes** – operational plan budgets adequate resources to operate and maintain the Final CSO LTCP projects.
(vii) maximization of treatment and evaluation of treatment capacity at Morris Forman WQTC	Volume 2, Chapter 3.2.7.5 Utilization of Morris Forman WQTC Chapter 3.3 Evaluation of CSO Control Alternatives Appendix 3.2.20 Morris Forman WQTC Wet Weather SOP Procedures Appendix 3.2.21 Morris Forman WQTC Expansion Tech Memo;	**Yes** – Wet Weather flow capacity has been maximized and verified through extensive testing. Additional peak flow treatment capacity will be available with use of storage, RTC and a new retention treatment basin.
(viii) Identification of an implementation schedule for the selected CSO control	Volume 2, Chapter 4 and 5, Final CSO LTCP and selected Project Final Recommended Project List	**Yes** – All projects completed by Consent Decree deadline of December 31, 2020.
(ix) A post-construction compliance monitoring program adequate to verify compliance with water quality-based CWA requirement and ascertain the effectiveness of CSO controls	Volume 1 Chapter 6.5.	**Yes** – a full suite of monitoring will be implemented in order to determine efficacy and adapt plan as appropriate.

An Approvable Final SSDP

The MSD Final SSDP as submitted on June 19, 2009, is fully compliant with all the requirements of the Consent Decree under paragraph 25 (a) (3) A. and B, as shown in Table ES.6. The 2012 IOAP Modifications provide a higher level of control (as indicated by the design events used for project sizing) and is therefore also fully compliant with the Consent Decree. The combined, sustained and phased implementation includes both a gray infrastructure plan and a source control program including a private sewer program intended to reduce I/I. This SSDP, in conjunction with the Sewer Overflow Response Protocol (SORP) and public education aimed at individual responsibility and behavior modification (as it relates to fats, oil and grease {FOG}, private sewer maintenance and rehabilitation and illicit cross connections and drainage) will eliminate unauthorized discharges from the SSS, CSS and WQTCs by December 31, 2024.

In addition, the Consent Decree requires that the results of an evaluation of the WQTC peak flow treatment capacity for any WQTC that will receive additional flow based on any Interim SSDP or Final SSDP project. These analyses were fully developed and can be found in Volume 1, Chapter 4.

TABLE ES.6
FINAL SSDP ELEMENTS AS REQUIRED BY THE CONSENT DECREE

Requirement Per Consent Decree Paragraph 25(a)(3)	IOAP and Final SSDP Chapters and Sections	Compliance With Consent Decree
(3) The long-term SSDP projects, including schedules, milestones, and deadlines	Volume 1 – IOAP, Chapter 4.3, Chapter 6.3; Volume 3 – Final SSDP, Chapter 4 1 and Chapter 5.	**Yes –** The Final SSDP describes 41gray infrastructure projects, I/I reductions studies, and a source control program to eliminate 214 documented, suspected, and modeled SSOs. The project schedule shows milestones and completion dates for each of these projects.
(3) Results of an evaluation of WQTC peak flow treatment capacity for any WQTC that will receive additional flow based on any Interim or Final SSDP project. Such evaluation shall be consistent with the EPA publications "Improving POTW Performance Using the Composite Correction Approach and "Retrofitting POTWs"	Volume 1, Chapter 4.4	**Yes -** All the plants that could receive additional flow as a result of SSO elimination have been evaluated.
(A) A map that shows the location of all known Unauthorized Discharges. The map shall include the areas and sewer lines that serve as a tributary to each Unauthorized Discharge. Smaller maps of individual tributary areas also may be included to show the lines involved in more detail.	Volume 3 – Final SSDP, Chapter 2.5, Figures 2.5.3 through 2.5.15.	**Yes –** The network branch maps show all 214 SSOs, with sufficient detail to see tributary sewers.
(B.i) A description of each Unauthorized Discharge location that includes the frequency of the Unauthorized Discharge	Volume 3 – Final SSDP, Appendix 4.5.1 - SSO Fact Sheets as well as in the Project Fact Sheets.	**Yes –** Discharge location as well as frequency is listed for each individual documented SSO in Appendix 4.5.1. Additionally, discharge location is located in the Project Fact Sheets.
(B.ii) The annual volume released from the Unauthorized Discharge	Volume 3 Final SSDP, Appendix 4.5.1 - SSO Fact Sheets.	**Yes –** Total annual volume is listed for each individual documented SSO in Appendix 4.5.1.
(B.iii) A description of the type of Unauthorized Discharge location	Volume 3 Final SSDP, Chapter 2.4, Table 2.4.2 as well as in the Project Fact Sheets.	**Yes –** Table 2.4.2 contains this information and in the Project Fact Sheets.
(B.iv) The receiving stream	Volume 3 Final SSDP, Chapter 2.4, Table 2.4.2 as well as in the Project Fact Sheets.	**Yes –** Table 2.4.2 contains this information and in the Project Fact Sheets.
(B.v.) The immediate and downstream land use, including the potential for public health concerns	Volume 3 – Final SSDP, Chapter 2.2.1, Appendix 4.5.1 - SSO Fact Sheets	**Yes –** Descriptions of the WQTC service areas describe landuse and the history of sewer system development in the area. Downstream landuse acreage is listed for each individual documented SSO in Appendix 4.5.1

TABLE ES.6
FINAL SSDP ELEMENTS AS REQUIRED BY THE CONSENT DECREE

Requirement Per Consent Decree Paragraph 25(a)(3)	IOAP and Final SSDP Chapters and Sections	Compliance With Consent Decree
(B.vi) A description of any previous (within the last 5 years) current, or proposed studies to investigate the Unauthorized Discharge	IOAP Volume 3 – Final SSDP, Chapter 1.3.	**Yes –** Chapter 1 summarizes MSD's previous and current SSO elimination efforts.
(B.vii) A description of any previous (within the last 5 years) current or proposed rehabilitation or construction work to remediate or eliminate the Unauthorized Discharge	Volume 3 – Final SSDP, Chapter 1.3. Chapter 2.2 and 2.3.	**Yes –** Chapter 1 summarizes MSD's previous rehabilitation efforts. In Chapter 2, The descriptions of the WQTC service areas include summary descriptions of previous construction work, and the descriptions of the model development describes those on-going or currently planned projects that contribute to SSO elimination.
(C) A prioritization of Unauthorized Discharge locations based on the frequency, volume, and impact on the receiving stream and upon public health, in coordination with CMOM programs	Volume 1, Chapter 6.3, Volume 3 – SSDP Chapter 4.2.1.	**Yes –** The referenced chapters describe the schedule prioritization process, based in part on the benefit-cost ratio that includes the required parameters in the benefit calculation.
(C) Schedules for design and construction, phased based on sound engineering judgment, and in no case extending beyond December 31, 2024	Volume 1, Chapter 6.3, Volume 3 Final SSDP, Chapter 4.2 and Chapter 5.	**Yes** – Schedules are included that show the required phases, and this schedule shows completion by December 31, 2024.
(D) A plan to involve stakeholders in the planning, prioritization and selection of projects.	Volume 1, Chapter 3.2, Volume 3 – Final SSDP, Chapter 4.3	**Yes** – The IOAP included a robust stakeholder involvement process that included participation in decisions on selection and prioritization of projects.

"NO SURPRISES" FOR APPROVING AGENCIES

Throughout the development of the IOAP, meetings were scheduled with those regulatory agencies having jurisdiction over the program to facilitate open communication between MSD and the regulators regarding progress and compliance with Consent Decree requirements. Electronic reporting updates requested by KDEP and EPA have been developed and implemented to provide current information. Additionally, reports are prepared for each of the four quarters of the calendar year and are submitted to EPA and KDEP within 30 days of the end of the new quarter and are posted on MSD's Project WIN website in Library section for public review. These reports include specific information about activities consistent with the requirements of the Consent Decree and the progress toward the development of the Final CSO LTCP.

In addition to these reports, MSD initiated periodic face-to-face meetings with technical team members from the KDEP and EPA to discuss the progress of the Project WIN Overflow Abatement Program. The intent of these meetings was to ensure that there are no surprises when the IOAP was submitted, and that the IOAP met all the parameters to allow approval.

SUPPORTING INFORMATION

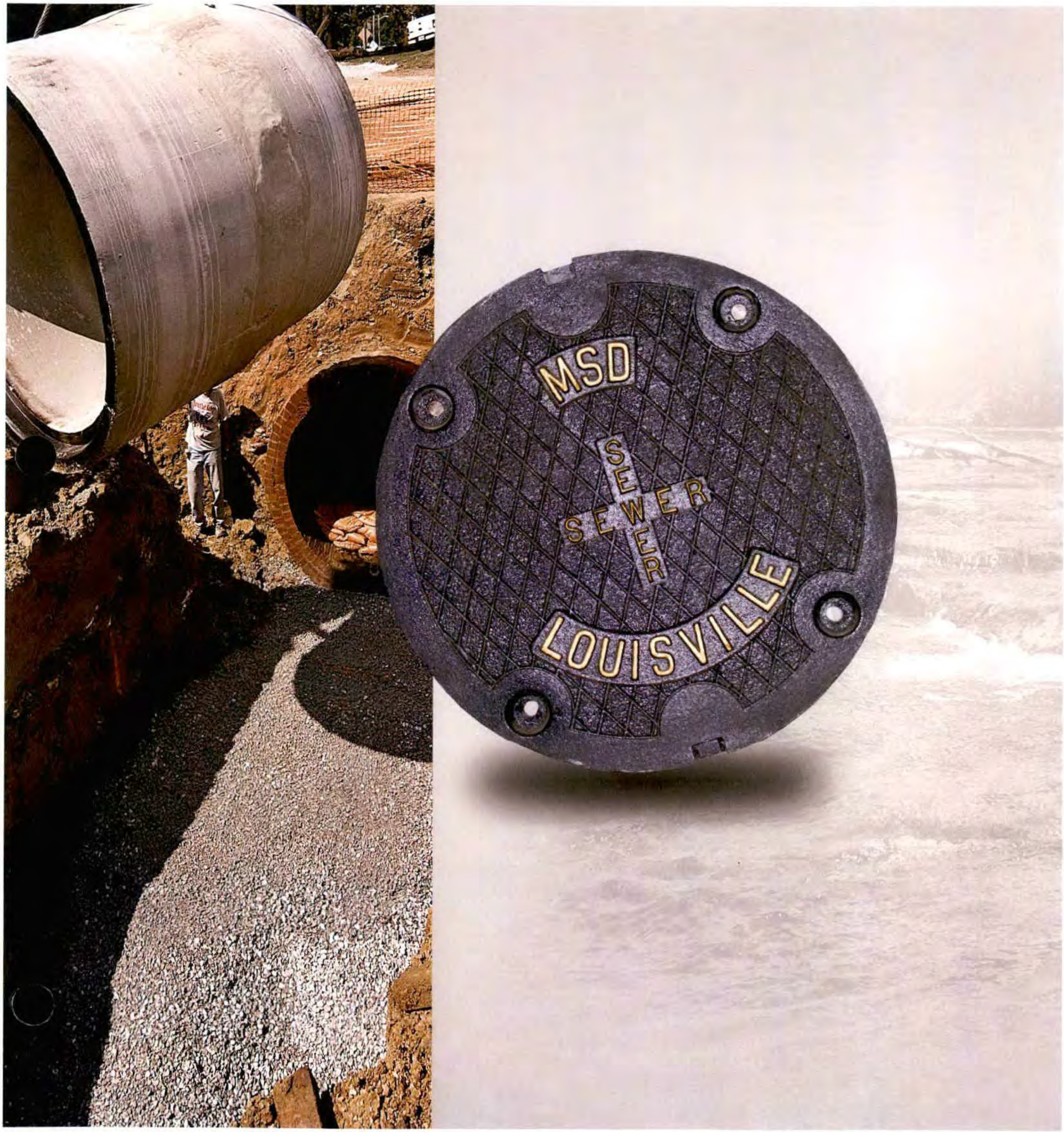
Attachment 1 WWT Support Memorandum

Attachment 2 IOAP Stakeholder Group Vision

Attachment 3 Updated WWT Support Memorandum January 30, 2013

Tables

ES.1 and ES.2



ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_172_S_09B_B_A_0	**Adams Street Sewer Separation**	Ohio River	CSO172	0	0.12	$983,000	CSO172	0	Sewer Separation	$20,000	12/31/2012	12/31/2012	Project modification request to revise this project to a sewer separation has been previously submitted and accepted. Upon inspection of the sewer system, all but two catch basins were found to have been separated already during recent redevelopment. Project Completed - Monitoring Ongoing
L_OR_MF_058_S_08_A_A_0	**CSO058 In-line Storage and Green Infrastructure**	Ohio River	CSO058	0	Sewer Separation	$1,361,000	N/A	8	Weir Modifications As Part of 13th & Rowan Solution	N/A	12/31/2014	12/31/2014 (Weir Modification) 12/21/2020 (w/ 13th & Rowan Solution)	The overflow from this CSO will be addressed in the 13th & Rowan storage basin. Modeling indicates that the overflow is caused by interceptor surcharging. Separation of the small drainage area upstream of the CSO would be ineffectual. Weir modifications for CSO058 will be performed in 2014. Costs associated with modifications and CSO058 are included in the 13th & Rowan solution.
L_SO_MF_093_S_08_A_A_0	**CSO093 Structural Modifications & Green Infrastructure**	South Fork	CSO093	0	Sewer Separation	$952,000	CSO093	0	Structural Modifications & Green Infrastructure	$488,000	12/31/2015	12/31/2015	The project modification involves the re-construction of the CSO structure to replace the existing leaping weir with a more conventional overflow weir.
L_MI_MF_140_S_08_A_A_0	**CSO140 In-Line Storage & Green Infrastructure Controls**	Middle Fork	CSO140	0	Sewer Separation	$3,150,000	CSO140	0	Pipe upgrade & Green Infrastructure	$574,000	12/31/2015	12/31/2015	The project modification involves the re-construction of the CSO structure to increase the low flow line to a 42-inch diameter opening which will increase the conveyance capacity.
L_OR_MF_160_S_08_A_A_0	**CSO160 In-Line Storage & Green Infrastructure**	Ohio River	CSO160	0	Sewer Separation	$237,000	CSO160	0	Inline Storage & Weir Modifications	$231,000	12/31/2015	12/31/2015	The project modification involves the creation of in-line storage provided by a combination of raising the existing overflow weir and installing 88 feet of 72-inch diameter pipe.
L_MI_MF_127_M_09B_B_A_8	**I-64 and Grinstead Drive Storage Basin****	Middle Fork	CSO125, CSO126, CSO127, CSO166	8	2.74	$12, 950,000	CSO125, CSO126, CSO127, CSO166	4	8.5 plus stormwater diversions	$38,590,000	12/31/2014	12/31/2020	Public comments received requested serious consideration for green infrastructure utilization in the basin drainage area along with intensive public involvement. Due to the size of the drainage area and the increased size and cost of the basin, additional time is needed to evaluate green infrastructure opportunities and right-size this project appropriately.
L_OR_MF_015_M_13_B_B_8	**Bells Lane Wet Weather Treatment Facility (formerly known as Paddy's Run)**	Ohio River	CSO015, CSO191	8	50 MGD	$24,940,000	CSO015, CSO191	8	50 MGD/ 25 MG Storage	$68,472,000	12/31/2014	12/31/2016	Optimization of flow through Morris Forman's Main Diversion Structure and MSD's Real Time Control strategy added storage volume requirements. Additional time for construction is being requested due to size increase, moving the site, offline storage and integration of Southwestern Pump Station.
L_OR_MF_020_S_09B_B_A_8	**Story Avenue and Main Street Storage Basin**	Ohio River	CSO020	8	0.13	$1,580,000	CSO020	8	5.42	$12,576,000	12/31/2013	12/31/2020	Story and Main & 13th and Rowan basins are linked together functionally. Story & Main grew substantially in size due to more conservative operational assumptions for Starkey PS. MSD proposes to split out and accelerate the schedule of CRD/CSO 22/CSO 23/CSO054 projects using green infrastructure and localized storage. Additional time is requested to right size the Story/Main and 13th/Rowan basins once the impacts of green infrastructure and upstream storage are realized and monitored.
L_SO_MF_130_S_09B_B_A_8	**Story Avenue and Spring Street Storage Basin**	South Fork	CSO130	8	0.01	$1,077,000	CSO130	8	Green Infrastructure	$896,000	12/31/2016	12/31/2016	A project modification request to use a suite of green infrastructure projects in lieu of the storage basin is anticipated in early 2012. No schedule change for overflow reduction is anticipated.
L_OR_MF_155_M_09B_B_B_4	**13th Street and Rowan Street Storage Basin**	Ohio River	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO155 and Central Relief Drain CSO's (11 total w/ AAOV)	4	14.44	$49,680,000	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO058, CSO150, CSO155	8	4.36	$27,863,000	12/31/2020	12/31/2020	MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule. CSO 58 will also be included with this project and weir modifications for CSO 58 are included with the revised cost.
L_OR_MF_211_M_13_B_A_8	**Southern Outfall In-line Storage (SOR1) at 43rd Street**	Ohio River	N/A	N/A	NA	NA	CSO016/210	8	11.4	$3,544,000	12/31/2018	12/31/2018	New stand-alone project. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.

TABLE ES.1 2012 FINAL LTCP PROJECT SUITE

ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_211_M_13_B_A_8	**Southern Outfall In-line Storage (SOR2) at 12th Street and Wilson**	Ohio River	N/A	N/A	NA	NA	CSO211	8	4.7	$3,544,000	12/31/2018	12/31/2018	New stand-alone project. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.
L_OR_MF_211_M_13_B_A_8	**Algonquin Parkway Storage Basin/In-line Storage**	Ohio River	CSO016, CSO210, CSO211	8	4.84	$17,300,000	N/A	N/A	N/A	N/A	12/31/2018	Eliminated	Offline storage eliminated. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes to eliminate the Algonquin storage basin portion of the project.
L_SO_MF_097_M_13_A_A_8	**Beargrass Creek Parallel Interceptor**	N/A	N/A	N/A	N/A	$12,994,000	N/A	N/A	N/A	N/A	12/31/2017	Eliminated	Consolidation of Calvary/Creekside Basin with Logan Street Basin makes the parallel interceptor unnecessary.
L_SO_MF_097_M_09B_B_D_8	**Calvary Creekside Storage Basin**	South Fork	CSO097, CSO106, CSO110, CSO111, CSO137, CSO148, CSO151	8	3.46	$13,720,000	N/A	N/A	N/A	N/A	12/31/2017	Eliminated	Basin volume now addressed through Logan Street. Project is proposed to be eliminated.
L_OR_MF_155_M_09B_B_B_4	**Central Relief Drain (CRD) CSO In-Line Storage, Green Infrastructure & Distributed Storage**	Ohio River	N/A	N/A	N/A	N/A	Central Relief Drain CSOs (13 total with an AAOV: CSO028, CSO029, CSO034, CSO036, CSO178, CSO181, CSO193, CSO195, CSO196, CSO197, CSO199, CSO200, CSO202)	8	Diversion, Weir Modifications & Green Infrastructure	$2,184,000	N/A	12/31/2018	New project. MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule.
L_MU_MF_154_M_09B_B_A_8	**Clifton Heights Storage Basin**	Muddy Fork	CSO132, CSO154, CSO167	8	6.55	$13,870,000	CSO088, CSO131, CSO132, CSO154, CSO167	4	7	$19,575,000	12/31/2018	12/31/2018	No changes are proposed for this project schedule.
L_SO_MF_083_M_09B_B_A_8	**Lexington Road and Payne Street Storage Basin**	South Fork	CSO082, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	8	7.31	$25,200,000	CSO082, CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	0	8.18	$25,904,000	12/31/2020	12/31/2020	No changes are proposed for this project schedule.
L_SO_MF_092_M_09B_B_D_8	**Logan and Breckinridge Street Storage Basin**	South Fork	CSO091, CSO113, CSO117, CSO146, CSO149, CSO152	8	11.83	$30,320,000	CSO091, CSO097, CSO106, CSO110, CSO111, CSO113, CSO117, CSO137, CSO146, CSO148, CSO149, CSO151, CSO152	8	16.6	$48,243,000	12/31/2017	12/31/2017	A review of project approach and benefit/cost results eliminated the Calvary Creekside basin, consolidating storage to the Logan Street basin location. No changes to schedule are proposed.
L_SO_MF_018_S_03_A_A	**Nightingale Pump Station Replacement & Storage**	South Fork	CSO018	0	60 MGD/0 MG	$15,710,000	CSO018	0	33 MGD/7.7 MG	$22,123,000	12/31/2016	12/31/2016	Pump Station size was reduced as a result of adding storage.
L_OR_MF_190_S_09B_B_A_8	**18th and Northwestern Pky. Storage Basin**	Ohio River	CSO190	8	1.31 MG	$4,514,000	CSO190	8	1.24	$4,486,000	12/31/2017	12/31/2017	Project slightly smaller
L_OR_MF_105_M_13_B_A_0	**Southwestern Parkway Storage Basin**	Ohio River	CSO104, CSO105, CSO189	0	5.08	$17,620,000	CSO104, CSO105, CSO189	0	11.07	$30,937,000	12/31/2018	12/31/2018	No changes are proposed for this project schedule.
	NO CHANGE												
L_SO_MF_108_S_09A_B_A_4	**CSO108 Dam Modification**	South Fork	CSO108	N/A	N/A	$150,000	CSO108	N/A	N/A	$150,000	12/31/2010	12/31/2010	Project Completed - Monitoring Ongoing
L_MI_MF_123_S_08_A_A_0	**CSO123 Downspout Disconnection**	Middle Fork	CSO123	N/A	N/A	$315,000	CSO123	N/A	N/A	$315,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_MI_MF_206_S_08_A_A_0	**CSO206 Sewer Separation**	Middle Fork	CSO206	N/A	N/A	$3,842,000	CSO206	N/A	N/A	$3,842,000	12/31/2013	12/31/2013	Project Completed - Monitoring Ongoing
L_OR_MF_019_S_13_B_A_8	**Portland Wharf Storage Basin**	Ohio River	CSO019	8	6.37 MG	$20,000,000	CSO019	8	6.37	$20,000,000	12/31/2019	12/31/2019	

TABLE ES.1 2012 FINAL LTCP PROJECT SUITE

ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_019_S_03_A_B	**34th Street Flood Pump Station**	Ohio River	CSO019	N/A	N/A	$541,000	CSO019	N/A	N/A	$541,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_OR_MF_022_M_03_A_A	**4th Street Flood Pump Station**	Ohio River	CSO022, CSO023	N/A	N/A	$944,000	CSO022, CSO023	N/A	N/A	$944,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_OR_MF_019_S_03_A_A	**27th Street Flood Pump Station**	Ohio River	CSO019	N/A	N/A	$476,000	CSO019	N/A	N/A	$476,000	6/30/2013	6/30/2013	Project Completed - Monitoring Ongoing
L_OR_MF_189_M_03_A_A	**Shawnee Flood Pump Station**	Ohio River	CSO104, CSO105, CSO189	N/A	N/A	$411,000	CSO104, CSO105, CSO189	N/A	N/A	$411,000	6/30/2013	6/30/2013	Project Completed - Monitoring Ongoing
L_OR_MF_190_S_03_A_A	**17th Street Flood Pump Station**	Ohio River	CSO190	N/A	N/A	$625,000	CSO190	N/A	N/A	$625,000	12/31/2014	12/31/2014	

Table ES.2 2012 SSDP Final Project Suite

ACD Project Number	Project Name	Receiving Stream	Overflows Controlled	2009 Level of Control Depth (in)	2009 Level of Control Storm	2009 Size (MG)	2009 Cost	2012 Level of Control Depth (in)	2012 Level of Control Storm	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
CEDAR CREEK AREA														
S_CC_CC_70158_M_09A_C	**Idlewood Inline Storage**	CEDAR CREEK	28998, 28984, 63094, 63095, 70158	1.82	2-Year, 3-Hour	N/A	$2,317,000	1.82	2-Year, 3-Hour	N/A	$2,317,000	12/31/2023	12/31/2023	
S_FF_CC_81316_M_03_C_A	**Fairmount Road Pump Station Off-Line Storage**	BIG RUN	Fairmount Road PS (81316 & 97362)	N/A	N/A (New Project)	N/A	N/A	1.82	2-Year, 3-Hour	3.4 MG	$13,439,000	N/A	12/31/2015	Project needed to accommodate flows from eliminated Jeffersontown WQTC and acknowledge capacity at Cedar Creek WQTC.
S_CC_CC_67997_M_01_C	**Little Cedar Creek Interceptor Improvements**	LITTLE CEDAR CREEK	67997, 67999, 86423, 86424, 89195, 89196, 89197	1.82	2-Year, 3-Hour	Pipe Upgrades	$1,875,000	1.82	2-Year, 3-Hour	N/A	$1,875,000	12/31/2024	12/31/2024	
S_CC_CC_MSD1025_S_03_B	**Bardstown Rd. PS Improvements**	BIG RUN	88545	2.25	5-Year, 3-Hour	N/A	$281,000	2.25	5-Year, 3-Hour	N/A	$281,000	12/31/2021	12/31/2021	
S_CC_CC_MSD1080_S_01_C	**Running Fox PS Elimination**	LITTLE CEDAR CREEK	MSD1080-LS	1.82	2-Year, 3-Hour	N/A	$96,000	1.82	2-Year, 3-Hour	N/A	$77,000	12/31/2010	12/31/2010	Project Completed
HITE CREEK AREA														
S_HC_HC_MSD1082_S_09A_C	**Meadow Stream Pump Station & Force Main Upgrade**	FLOYDS FORK, SOUTH FORK HARRODS CREEK	Meadow Steam PS (91087, MSD1082-PS)	1.82	2-Year, 3-Hour	0.5	$974,000	2.60	10-Year, 3-Hour	3.89 MGD PS & New 18" Force Main	$974,000	12/31/2016	12/31/2012	Project changed from a small storage basin to a pump station upgrade and new force main due to the capacity needs of Crestwood. The City paid the additional costs beyond MSD's overflow control commitment. Project Completed - Monitoring Ongoing
S_HC_HC_MSD1086_M_07_C_A	**Floydsburg Rd. SSES, Rehabilitation and Pump Station Upgrade**	FLOYDS FORK	Floydsburg Road (MSD1086-PS, 90776, 108956, 108957, 108958)	1.82	2-Year, 3-Hour	N/A	$57,000	1.82	2-Year, 3-Hour	N/A	$57,000	12/31/2010	12/31/2010	Project Completed - Monitoring Ongoing
S_HC_HC_MSD1085_S_03_A	**Kavanaugh Rd. PS Improvements**	HITE CREEK	Kavanaugh Rd (MSD1085-PS)	2.60	10-Year, 3-Hour	N/A	$1,110,000	2.60	10-Year, 3-Hour	N/A	$1,110,000	12/31/2024	12/31/2024	
FLOYDS FORK AREA														
S_FF_FF_NB01_S_01_C_A	**Woodland Hills PS Diversion**	POPE LICK	33003, 65531	1.82	2-Year, 3-Hour	N/A	$20,000	1.82	2-Year, 3-Hour	N/A	$20,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing
S_FF_FF_NB02_S_13_C	**Eden Care PS SSO Investigation**	FLOYDS FORK	Eden Care PS (MSD1105-PS)	N/A	N/A (Monitor)	N/A	N/A	N/A	N/A	N/A	$0	N/A	Eliminated	Only one overflow had been documented at this location. MSD cleaned the sewers in the vicinity and has not documented an overflow in over 3 years. No further action is deemed necessary.
S_FF_FF_NB03_M_01_C_A	**Ashburton PS Improvements & Diversion**	FLOYDS FORK	Olde Copper Court PS (MSD0165-PS), Ashburton PS (MSD0166-PS)	1.82	2-Year, 3-Hour	N/A	$118,000	1.82	2-Year, 3-Hour	N/A	$118,000	12/312021	12/312021	Project Completed
JEFFERSONTOWN AREA														
S_JT_JT_NB01_M_01_C_A	**Jeffersontown WQTC Elimination**	CHENOWETH RUN	28390, 28391, 28392, 28395, 28551, 31733, Jeffersontown WQTC (28173 & 64505 & MSD0255 & IS028-SI)	1.82	2-Year, 3-Hour	N/A	$23,737,000	1.82	2-Year, 3-Hour	N/A	$23,737,000	12/31/2015	12/31/2015	
S_JT_JT_NB01A_M_03_C	**Chenoweth Hills WQTC Elimination & PS Improvements**	CHENOWETH RUN	Chenoweth Run PS (MSD0196-PS & 86052 & 64096), Chippewa PS (92061), Chenoweth Hills WQTC PS (MSD0263A-PS), Chenoweth Hills WQTC (MSD0263)	1.82	2-Year, 3-Hour	N/A	$3,140,000	1.82	2-Year, 3-Hour	N/A	$3,140,000	12/31/2015	12/31/2015	
S_JT_JT_NB02_M_01_C	**Dell Rd & Charlane Project Pkwy Interceptor**	BEATTY BROOK	Charlane Pkwy (28250, 28249, 28340, 28336, 104289), Dell Rd. (28413, 28414, 28415, 28416, 28417)	1.82	2-Year, 3-Hour	Pipe Upgrades	$917,000	1.82	2-Year, 3-Hour	N/A	$917,000	12/31/2022	12/31/2022	
S_JT_JT_NB03_M_01_C	**Raintree & Marian Ct PS Eliminations and Pipe Upgrades (2 Phases)**	BEATTY BROOK	28719, 28711, Marian Court PS (28729), Raintree PS (MSD0149-PS)	1.82	2-Year, 3-Hour	N/A	$1,005,000	1.82	2-Year, 3-Hour	N/A	$1,005,000	12/31/2021	12/31/2021	
S_JT_JT_NB04_M_01_A	**Monticello PS Elimination**	FERN CREEK	Monticello Place PS (MSD0151-PS & 27969)	2.60	10-Year, 3-Hour	N/A	$207,000	2.60	10-Year, 3-Hour	N/A	$207,000	12/31/2022	12/31/2022	

ACD Project Number	Project Name	Receiving Stream	Overflows Controlled	2009 Level of Control Depth (in)	2009 Level of Control Storm	2009 Size (MG)	2009 Cost	2012 Level of Control Depth (in)	2012 Level of Control Storm	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
MIDDLE FORK AREA														
S_MISF_MF_NB01_M_01_C_A1	**Middle Fork Relief Interceptor, Wet Weather Storage, and Upper Middle Fork LS Diversion (2 Phases)**	MIDDLE FORK BEARGRASS CREEK	02932, 02933, 02935, 08537, 23211, 23212, 27005, 51180, 51221, 51160, 51161, 45835, 47583, 47593, 47596, 47603, 47604, 90700, IS021A-SI, Middle Fork at Breckenridge (08935-SM)	1.82	2-Year, 3-Hour	1.6	$26,333,500	1.82	N/A	N/A	$26,333,500	12/31/2013, 12/31/2023	12/31/2013, 12/31/2023	
S_MI_MF_NB04_M_03_B	**Goose Creek PS Improvements & Wet Weather Storage (2 Phases)**	GOOSE CREEK	Devondale PS (21628-W), Goose Creek PS (46891, 62418, 62420, 91629, 91630, 105936), Saurel PS (43472)	2.25	5-Year, 3-Hour	0.5	$7,558,000	2.25	5-Year, 3-Hour	N/A	$7,558,000	12/31/2024	12/31/2024	
S_MI_MF_NB06_M_01_A_A - 1, S_MI_MF_NB06_M_01_A_A - 2	**Anchor Estates PS Eliminations (2 Phases)**	MIDDLE FORK BEARGRASS CREEK	Vannah PS (01106), Anchor Estates #1 PS (00746 & 00056-W), Anchor Estates #2 PS (MSD0057-LS)	2.60	10-Year, 3-Hour	N/A	$1,909,000	2.6	10-Year, 3-Hour	N/A	$1,909,000	12/31/2013, 12/31/2016	12/31/2013, 12/31/2016	Phase 1 Completed - Vannah PS Eliminated
S_MI_MF_NB07_S_07_C	**Hurstbourne I/I Investigation & Rehabilitation**	HURSTBOURNE CREEK	01793	1.82	2-Year, 3-Hour	N/A	$536,000	1.82	2-Year, 3-Hour	N/A	$536,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing
SOUTHEAST DIVERSION AREA														
S_SD_MF_NB03_S_07_C	**Parkview Estates I/I Investigation & Rehabilitation**	SOUTH FORK BEARGRASS CREEK	47250	1.82	2-Year, 3-Hour	N/A	$285,000	1.82	2-Year, 3-Hour	N/A	$285,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing
S_SD_MF_NB04_S_01_B_A	**Klondike Interceptor**	SOUTH FORK BEARGRASS CREEK	25676 (Alcona), 26650, 26651	2.25	5-Year, 3-Hour	Pipe Upgrades	$558,000	2.25	5-Year, 3-Hour	N/A	$558,000	12/31/2015	12/31/2015	
S_SD_MF_NB05_M_01_A	**Sutherland Interceptor**	SOUTH FORK BEARGRASS CREEK	Sutherland (16649)	2.60	10-Year, 3-Hour	Pipe Upgrades	$412,000	2.60	10-Year, 3-Hour	N/A	$412,000	12/31/2023	12/31/2023	
S_SD_MF_NB06_S_13_C	**Beargrass Interceptor Rehab Ph. 2**	SOUTH FORK BEARGRASS CREEK	51594	1.82	2-Year, 3-Hour	N/A	$57,000	1.82	2-Year, 3-Hour	N/A	$57,000	12/31/2010	12/31/2010	Monitoring Ongoing
POND CREEK AREA														
S_PO_WC_PC03_M_01_C	**Charleswood Interceptor Extension**	FISHPOOL CREEK	25477, 25478, Cooper Chapel PS (25480 & MSD0130-PS)	1.82	2-Year, 3-Hour	Pipe Upgrades	$603,000	1.82	2-Year, 3-Hour	N/A	$1,600,000	12/31/2022	12/31/2022	
S_PO_WC_PC04_M_01_C	**Cinderella PS Elimination**	FISHPOOL CREEK	Cinderella PS (60679 & MSD1013-PS), 35309	1.82	2-Year, 3-Hour	N/A	$2,205,000	1.82	2-Year, 3-Hour	N/A	$2,205,000	12/31/2023	12/31/2023	
S_PO_WC_PC05_M_07_C	**Lantana PS I/I Investigation & Rehabilitation**	PENNSYLVANIA RUN	Lantana Drive #1 PS (25484 & 93719 & MSD0101-PS)	1.82	2-Year, 3-Hour	N/A	$20,000	N/A (SSES/Rehab)	N/A (SSES/Rehab)	N/A	$20,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing
S_PO_WC_PC06_M_01_C	**Government Center PS Elimination**	PENNSYLVANIA RUN	Government Center PS (MSD0180-PS)	1.82	2-Year, 3-Hour	N/A	$1,225,000	1.82	2-Year, 3-Hour	N/A	$1,225,000	12/31/2024	12/31/2024	Project Completed - Monitoring Ongoing
S_PO_WC_PC07_M_01_A	**Avanti PS Elimination**	LITTLE CEDAR CREEK	Avanti PS (21229-W)	2.60	10-Year, 3-Hour	N/A	$31,000	2.6	10-Year, 3-Hour	N/A	$31,000	12/31/2010	12/31/2010	Project Completed - Monitoring Ongoing
S_PO_WC_PC08_M_01_C	**Lea Ann Way System Improvements**	FERN CREEK	19360, 19369, 29933, 29948, 29943, 31083, 31084, 79076, Lea Ann Way PS (MSD1010-PS)	1.82	2-Year, 3-Hour	Pipe Upgrades	$827,000	1.82	2-Year, 3-Hour	Additional Pipe Upgrades	$827,000	12/31/2015	12/31/2015	Additional overflows have been occurring in recent years. Therefore, additional sewer inspection and rehabilitation are underway. Contingency plans have been developed and are dependent upon the efficacy of rehabilitation of wet weather flows.
S_PO_WC_PC09_M_09B_C	**Outer Loop Wet Weather Storage**	FISHPOOL CREEK	70212, 17724	1.82	2-Year, 3-Hour	1.42	$4,280,000	2.60	10-Year, 3-Hour		$0	12/31/2024	Eliminated	Due to improvements in the Pond Creek hydraulic model calibration, this storage basin is no longer necessary.
S_PO_WC_PC09_M_09B_C	**Caven Ave Pump Station Elimination**	FISHPOOL CREEK	27116, Caven Ave PS (MSD0133-PS)	1.82	2-Year, 3-Hour	0.21	$731,000	2.60	10-Year, 3-Hour	PS Elimination	$1,800,000	12/31/2024	12/31/2016	Recent new pipeline constructed to eliminate a nearby package treatment plant makes the elimination of the pump station the most cost effective overflow solution.
S_PO_WC_PC10_M_01_C	**Leven PS Elimination**	PENNSYLVANIA RUN	Leven PS (36419 & MSD1019-PS)	1.82	2-Year, 3-Hour	N/A	$376,000	1.82	2-Year, 3-Hour	N/A	$376,000	12/31/2022	12/31/2022	
S_PO_WC_PC11_M_07_C	**Edsel PS I/I Investigation & Rehabilitation**	FERN CREEK	Edsel PS (92098 & MSD1048-PS)	1.82	2-Year, 3-Hour	N/A	$367,000	1.82	2-Year, 3-Hour	N/A	$367,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing

Table ES.2 2012 SSDP Final Project Suite

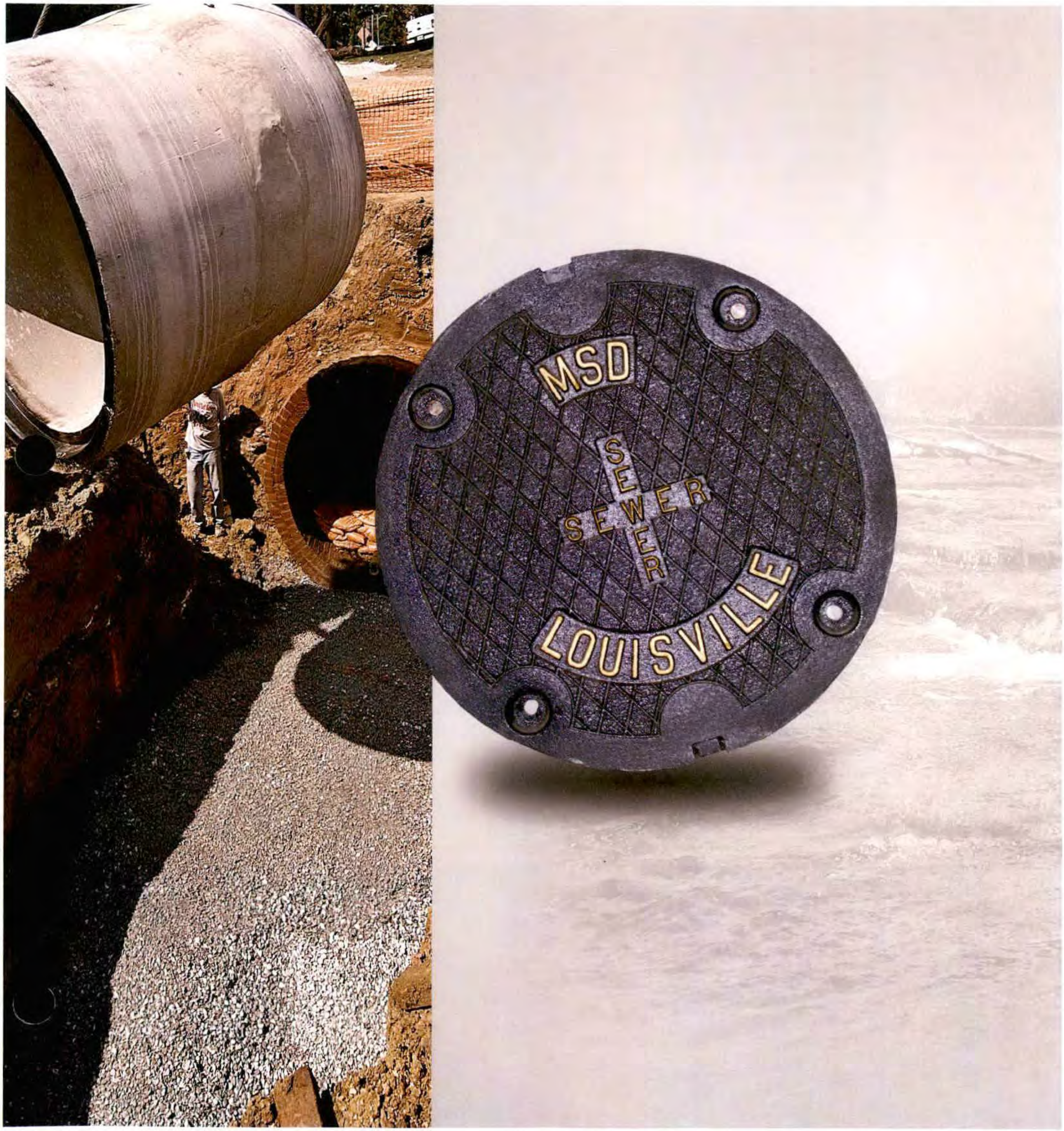
ACD Project Number	Project Name	Receiving Stream	Overflows Controlled	2009 Level of Control Depth (in)	2009 Level of Control Storm	2009 Size (MG)	2009 Cost	2012 Level of Control Depth (in)	2012 Level of Control Storm	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
ORFM AREA														
S_OR_MF_NB01_M_01_B	**Mellwood PS and Forcemain Improvements, System Improvements & PS Eliminations (2 Phases)**	MUDDY FORK BEARGRASS CREEK	26752, 41374, 41416, Mockingbird Valley PS (MSD0007-PS), Winton PS (MSD0010-PS), Mellwood Avenue PS (24472 & MSD0023-PS), Canoe Lane PS (24152-W & MSD0024-PS)	2.25	5-Year, 3-Hour	N/A	$3,055,000	2.25	5-Year, 3-Hour	N/A	$3,055,000	12/31/2012, 12/31/2024	12/31/2012, 12/31/2024	Phase 1 Project Completed - Monitoring Ongoing
S_OR_MF_NB02_S_13_C	**Leland Road SSO Investigation**	CHERRYWOOD CREEK	96020	N/A	N/A	N/A	N/A	N/A (Rehab & Monitoring)	N/A (Rehab & Monitoring)	N/A	$0	N/A	Eliminated	Only one overflow had been documented at this location. MSD cleaned the sewers in the vicinity and has not documented an overflow in over 3 years. No further action is deemed necessary.
S_OR_MF_NB03_S_07_C	**Derington Ct. PS I/I Investigation & Rehabilitation**	GOOSE CREEK	Derington Court PS (MSD0095-PS)	1.82	2-Year, 3-Hour	N/A	$265,000	1.82	2-Year, 3-Hour	N/A	$265,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
S_OR_MF_NB04_M_03_B_B	**Prospect WQTC Eliminations, Harrods Creek PS, and ORFM System Improvements (3 Phases)**	LITTLE GOOSE CREEK	40870, 40871, 40872, 89646, Barbour Lane PS (42680, 65633, 65635, MSD0192-PS), West Goose Creek PS (22436 & MSD0123-PS), Phoenix Hill PS (MSD1044-PS), Glenview Hills PS (MSD0183-PS), New Market PS (MSD0193-PS), Deep Creek PS (MSD1063-PS), Hunting Creek South WQTC (MSD0292)	2.25	5-Year, 3-Hour	N/A	$31,368,000	2.25	5-Year, 3-Hour	N/A	$31,368,000	12/31/2015, 12/31/2016	12/31/2015, 12/31/2016	
MILL CREEK AREA														
S_MC_WC_NB01_M_01_A	**Shively Interceptor**	LYNNVIEW DITCH	04498, 04542, Pioneer PS (81814-W), Fern Lea PS (MSD0047-PS), Garr's Lane PS (MSD0050-PS)	2.60	10-Year, 3-Hour	Pipe Upgrades	$16,419,000	2.6	10-Year, 3-Hour	N/A	$16,419,000	12/31/2014	12/31/2014	Project Completed - Monitoring Ongoing
S_MC_WC_NB02_S_03_C	**East Rockford PS Relocation**	MILL CREEK	East Rockford PS (04699-W)	1.82	2-Year, 3-Hour	N/A	$1,044,000	1.82	2-Year, 3-Hour	N/A	$1,044,000	12/31/2021	12/31/2021	Project Completed
SMALL WQTC AREA														
S_FF_BT_NB01_S_09A_C_A	**Lucas Ln. PS Inline Storage**	GOOSE CREEK	Lucas Lane PS (MSD0199-LS)	1.82	2-Year, 3-Hour	N/A	$183,000	1.82	2-Year, 3-Hour	N/A	$183,000	12/31/2021	12/31/2021	
S_HC_HN_NB01_S_03_C_A	**Riding Ridge PS Improvements**	HARRODS CREEK	Riding Ridge PS (MSD1060-LS)	1.82	2-Year, 3-Hour	N/A	$27,000	1.82	2-Year, 3-Hour	N/A	$27,000	12/31/2014	12/31/2014	
S_HC_HN_NB02_S_09A_C_B	**Gunpowder PS Inline Storage**	HARRODS CREEK	Gunpowder PS (MSD1055-LS)	1.82	2-Year, 3-Hour	N/A	$176,000	1.82	2-Year, 3-Hour	N/A	$176,000	12/31/2021	12/31/2021	
S_HC_HN_NB03_S_09A_A_A	**Fox Harbor Inline Storage**	HARRODS CREEK	Fox Harbor #1 and #2 PS (62769)	2.60	10-Year, 3-Hour	N/A	$328,000	2.60	10-Year, 3-Hour	N/A	$328,000	12/31/2021	12/31/2021	
S_HC_HS_NB01_S_03_C_A	**Fairway View PS Improvements**	HARRODS CREEK	Fairway View PS (MSD1065-PS)	1.82	2-Year, 3-Hour	N/A	$87,000	1.82	2-Year, 3-Hour	N/A	$167,000	12/31/2014	12/31/2014	
S_FF_LF_NB01_S_13_C_A	**Lake Forest PS SSO Investigation**	CHENOWETH RUN	Lake Forest PS (MSD1169-LS)	N/A	N/A	N/A	N/A	N/A (Monitoring)	N/A (Monitoring)	N/A	$77,000	12/31/2012	12/31/2012	Monitoring Ongoing
S_FF_CH_NB01_S_09A_C_A	**St. Rene Rd. PS Inline Storage**	CHENOWETH RUN	94187	1.82	2-Year, 3-Hour	N/A	$30,000	1.82	2-Year, 3-Hour	N/A	$30,000	12/31/2021	12/31/2021	
CSS AREA														
S_OR_MF_42007_S_07_C	**Sonne PS I/I Investigation**	PADDY RUN	Sonne Avenue PS (MSD0042-PS)	1.82	2-Year, 3-Hour	N/A	$265,000	1.82	2-Year, 3-Hour	N/A	$265,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing
S_SF_MF_30917_M_09_A	**Camp Taylor System Improvements (Four Phases)**	MUDDY FORK BEARGRASS CREEK	08717, 13931, 13943, 36763, 44396, 44397, 66349, 104223, 104231	2.60	10-Year, 3-Hour	Pipe Upgrades	$28,279,000	2.60	10-Year, 3-Hour	Pipe Upgrades	$28,279,000	Dec 31, 2012, 2013, 2017 & 2024	Multiple (Same as 2009)	Project approach is similar to 2009, but the project area targeted for inspection and rehabilitation is larger.
S_MC_MF_55665_S_07_C	**Hazelwood PS I/I Investigation & Rehabilitation**	MANSLICK BRANCH	Hazelwood PS (55665)	1.82	2-Year, 3-Hour	N/A	$173,000	1.82	2-Year, 3-Hour	N/A	$173,000	12/31/2011	12/31/2011	Project Completed - Monitoring Ongoing

Table ES.2 2012 SSDP Final Project Suite

ACD Project Number	Project Name	Receiving Stream	Overflows Controlled	2009 Level of Control Depth (in)	2009 Level of Control Storm	2009 Size (MG)	2009 Cost	2012 Level of Control Depth (in)	2012 Level of Control Storm	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
INTERIM SSDP														
HIKES LANE INTERCEPTOR /HIGHGATE SPRINGS PS	**Hikes Lane Interceptor and Highgate Springs**	SOUTH FORK BEARGRASS CREEK AND WEDGEWOOD DITCH	18134, 18298, 18302, 18434, 18471, 18483, 18505, 18595, 49224, 49236, 49672, 49673, MSD0012-PS								$21,216,000		11/27/2012	This project includes improvements to the Hikes Point Sewer System and eliminates the Highgate Springs Pump Station. In the general Hikes Point area includes improvements of 3,500 LF of new or replacement sewers, and decommissioning the Highgate Springs Pump Station. The new Hikes Lane Interceptor consists of 10,000 LF of 72-inch sewer that connects to Southeastern Interceptor. Project Completed - Monitoring Ongoing
SOUTHEASTERN DIVERSION STRUCTURE & INTERCEPTOR	**Southeastern Diversion Structure and Interceptor**	SOUTH FORK BEARGRASS CREEK	08426, 08427, 08430, 08431, 30680, 30681, 49647								$1,744,000		5/12/2012	This project includes improvements to the Southeast Diversion Structure for increased flows due to the Hikes Lane Interceptor and other Final SSDP projects. The project consists of a new parallel Southeastern Interceptor relief sewer, two flow control junction boxes, and modifications to the existing Southeastern Diversion Structure (including removing control weirs and reprogramming Real Time Control gates). Project Completed - Monitoring Ongoing
NORTHERN DITCH DIVERSION INTERCEPTOR	**Northern Ditch Diversion Interceptor**	NORTHERN DITCH	MSD0271 (Yorktown)								$20,397,000		7/31/2011	This project includes construction of a new Northern Ditch Diversion Interceptor which will allow flow from upstream projects to reach the Derek R. Guthrie WQTC. The project consists of 13,000 LF of 84-inch pipe constructed long Greasy Ditch. Project Completed - Monitoring Ongoing
SINKING FORK RELIEF SEWER	**Sinking Fork Relief Sewer**	MIDDLE FORK BEARGRASS CREEEK AND UPPER SINKING FORK	21103, 25012, 63319								$1,690,000		12/23/2009	This project includes conveying flow from some of the new Beechwood Village sewers and providing additional wet weather capacity downstream of the Beechwood Village East area to accommodate upstream SSDP projects. The project includes installing 2,800 LF of 24-inch relief sewer. Project Completed
BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT	**Beechwood Village Sanitary Sewer Replacement**	UPPER SINKING FORK	21061, 21089, 21101, 21153, 21156								$11,800,000		4/27/2011	This project includes replacing or rehabilitating the entire local system, including 23,700 LF of sewer pipe and 580 homeowner's service connections. The project will be completed in two phases, East and West. Project Completed
DEREK R GUTHRIE WATER QUALITY TREATMENT CENTER	**Derek R. Guthrie WQTC**	OHIO RIVER, BLACK POND CREEK, ALVEY DITCH, MENDORA BRANCH, MILL CREEK	Wet Weather SSOs	4.50	10-Year, 24-Hour	100 MGD HRT	$102,700,000	4.50	10-Year, 24-Hour	100 MGD HRT	$102,700,000	12/31/2011	11/27/2012	Full high rate treatment capacity not yet available for flows to be seen by 2024 due to extreme wet weather in 2011, but current flows and overflow eliminations can be accommodated with current treatment capacity. Project Completed - Monitoring Ongoing

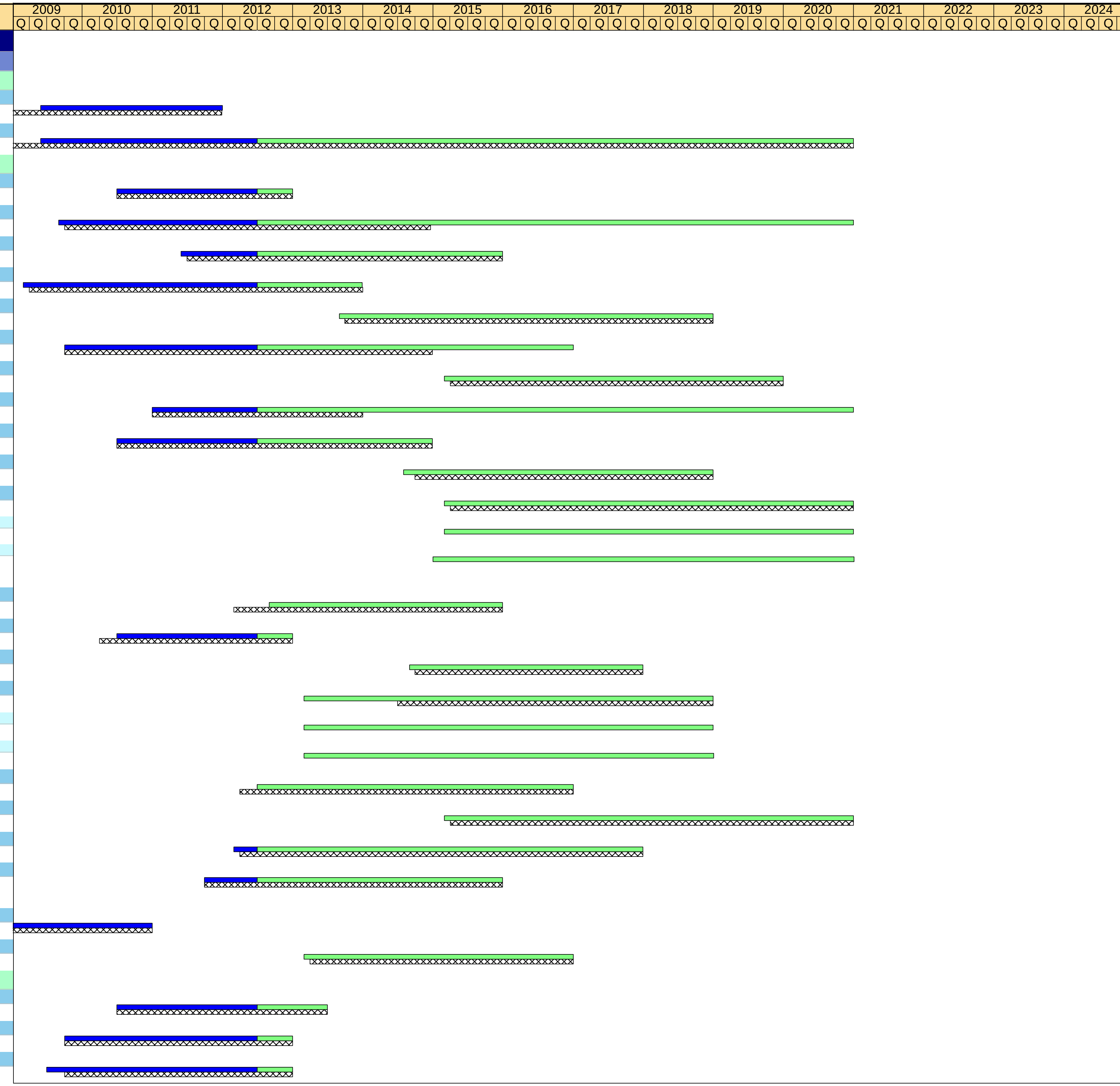
Figure

ES.1



MSD Integrated Overflow Abatement Plan Implementation Schedule (01 Jan 2009- 31 Dec 2024)

Activity Name	Scheduled Finish	2009 IOAP Completion	2012 IOAP Modification
MSD IOAP ANNUAL SCHEDULE	31-Dec-24	31-Dec-24	31-Dec-24
LONG TERM CONTROL PLAN	01-Jan-21	31-Dec-20	31-Dec-20
GREEN DEMONSTRATION PROJECTS	31-Dec-20	31-Dec-20	31-Dec-20
GREEN INFRASTRUCTURE DEMONSTRATION PROJECTS	31-Dec-11 A	31-Dec-11	31-Dec-11
GREEN INFRASTRUCTURE DEMONSTRATION PROJECTS	31-Dec-11 A	31-Dec-11	31-Dec-11
GREEN INFRASTRUCTURE PROGRAM	31-Dec-20	31-Dec-20	31-Dec-20
GREEN INFRASTRUCTURE PROGRAM	31-Dec-20	31-Dec-20	31-Dec-20
GRAY INFRASTRUCTURE PROJECTS	01-Jan-21	31-Dec-20	31-Dec-20
CSO 123 DOWNSPOUT DISCONNECTION	31-Dec-12	31-Dec-12	31-Dec-12
CSO 123 DOWNSPOUT DISCONNECTION	31-Dec-12	31-Dec-12	31-Dec-12
I-64 AND GRINSTEAD DRIVE STORAGE BASIN	31-Dec-20	21-Dec-14	31-Dec-20
I-64 AND GRINSTEAD DRIVE STORAGE BASIN	31-Dec-20	21-Dec-14	31-Dec-20
CSO 140 INCREASE PIPE CONVEYANCE	31-Dec-15	31-Dec-15	31-Dec-15
CSO 140 INCREASE PIPE CONVEYANCE	31-Dec-15	31-Dec-15	31-Dec-15
CSO 206 SEWER SEPARATION	30-Dec-13	31-Dec-13	30-Dec-13
CSO 206 SEWER SEPARATION	30-Dec-13	31-Dec-13	30-Dec-13
CLIFTON HEIGHTS STORAGE BASIN	31-Dec-18	31-Dec-18	31-Dec-18
CLIFTON HEIGHTS STORAGE BASIN	31-Dec-18	31-Dec-18	31-Dec-18
BELL'S LANE WET WEATHER TREATMENT FACILITY AND IN LINE STORAGE	31-Dec-16	31-Dec-14	31-Dec-16
BELL'S LANE WET WEATHER TREATMENT FACILITY AND IN LINE STORAGE	31-Dec-16	31-Dec-14	31-Dec-16
PORTLAND WHARF STORAGE BASIN	31-Dec-19	31-Dec-19	31-Dec-19
PORTLAND WHARF STORAGE BASIN	31-Dec-19	31-Dec-19	31-Dec-19
STORY AVENUE AND MAIN STREET STORAGE BASIN	31-Dec-20	31-Dec-13	31-Dec-20
STORY AVENUE AND MAIN STREET STORAGE BASIN	31-Dec-20	31-Dec-13	31-Dec-20
CSO 058 IN-LINE STORAGE AND GREEN INFRASTRUCTURE CONTROLS	31-Dec-14	31-Dec-14	31-Dec-14
CSO 058 IN-LINE STORAGE AND GREEN INFRASTRUCTURE CONTROLS	31-Dec-14	31-Dec-14	31-Dec-14
SOUTHWESTERN PARKWAY STORAGE BASIN	31-Dec-18	31-Dec-18	31-Dec-18
SOUTHWESTERN PARKWAY STORAGE BASIN	31-Dec-18	31-Dec-18	31-Dec-18
13TH STREET AND ROWAN STREET STORAGE BASIN	01-Jan-21	31-Dec-20	31-Dec-20
13TH STREET AND ROWAN STREET STORAGE BASIN	31-Dec-20	31-Dec-20	
13TH STREET AND ROWAN STREET STORAGE BASIN	31-Dec-20		31-Dec-20
13TH STREET AND ROWAN STREET STORAGE BASIN	31-Dec-20		31-Dec-20
CENTRAL RELIEF DRAIN IN-LINE STORAGE, GREEN INFRASTRUCTURE AND DISTRIBUTED STORAGE	01-Jan-21		31-Dec-18
CENTRAL RELIEF DRAIN IN-LINE STORAGE, GREEN INFRASTRUCTURE AND DISTRIBUTED STORAGE	01-Jan-21		31-Dec-18
CSO 160 IN-LINE STORAGE AND GREEN INFRASTRUCTURE CONTROLS	31-Dec-15	31-Dec-15	31-Dec-15
CSO 160 IN-LINE STORAGE AND GREEN INFRASTRUCTURE CONTROLS	31-Dec-15	31-Dec-15	31-Dec-15
ADAMS STREET SEWER SEPARATION AND STORAGE BASIN	31-Dec-12	31-Dec-12	31-Dec-12
ADAMS STREET SEWER SEPARATION AND STORAGE BASIN	31-Dec-12	31-Dec-12	31-Dec-12
18TH AND NORTHWESTERN PKY STORAGE BASIN	31-Dec-17	31-Dec-17	31-Dec-17
18TH AND NORTHWESTERN PKY STORAGE BASIN	31-Dec-17	31-Dec-17	31-Dec-17
ALGONQUIN PARKWAY STORAGE BASIN	01-Jan-19	31-Dec-18	31-Dec-18
ALGONQUIN PARKWAY STORAGE BASIN	31-Dec-18	31-Dec-18	
SOUTHERN OUTFALL IN-LINE STORAGE (SOR 1)	31-Dec-18		31-Dec-18
SOUTHERN OUTFALL IN-LINE STORAGE AT 43RD ST. (SOR 1)	31-Dec-18		31-Dec-18
SOUTHERN OUTFALL IN-LINE RETENTION (SOR 2)	01-Jan-19		31-Dec-18
SOUTHERN OUTFALL IN-LINE RETENTION AT 13TH AND WILSON AVE. (SOR	01-Jan-19		31-Dec-18
NIGHTINGALE PUMP STATION AND STORAGE BASIN	31-Dec-16	31-Dec-16	31-Dec-16
NIGHTINGALE PUMP STATION AND STORAGE BASIN	31-Dec-16	31-Dec-16	31-Dec-16
LEXINGTON ROAD AND PAYNE STREET STORAGE BASIN	31-Dec-20	31-Dec-20	31-Dec-20
LEXINGTON ROAD AND PAYNE STREET STORAGE BASIN	31-Dec-20	31-Dec-20	31-Dec-20
LOGAN STREET AND BRECKENRIDGE ST STORAGE BASIN	31-Dec-17	31-Dec-17	31-Dec-17
LOGAN STREET AND BRECKENRIDGE ST STORAGE BASIN	31-Dec-17	31-Dec-17	31-Dec-17
CSO 093 STRUCTURAL MODIFICATIONS AND GREEN INFRASTRUCTURE	31-Dec-15	31-Dec-15	31-Dec-15
CSO 093 STRUCTURAL MODIFICATIONS AND GREEN INFRASTRUCTURE CONTROLS	31-Dec-15	31-Dec-15	31-Dec-15
CSO 108 DAM MODIFICATIONS	31-Dec-10 A	31-Dec-10	31-Dec-10
CSO 108 DAM MODIFICATIONS	31-Dec-10 A	31-Dec-10	31-Dec-10
STORY AVENUE AND SPRING STREET GREEN INFRASTRUCTURE CONTROLS	31-Dec-16	31-Dec-16	31-Dec-16
STORY AVENUE AND SPRING STREET GREEN INFRASTRUCTURE CONTROLS	31-Dec-16	31-Dec-16	31-Dec-16
FLOOD PUMP STATION PROJECTS	31-Dec-14	31-Dec-14	31-Dec-14
27TH STREET FLOOD PUMP STATION	30-Jun-13	30-Jun-13	30-Jun-13
27TH STREET FLOOD PUMP STATION	30-Jun-13	30-Jun-13	30-Jun-13
34TH STREET FLOOD PUMP STATION	31-Dec-12	31-Dec-12	31-Dec-12
34TH STREET FLOOD PUMP STATION	31-Dec-12	31-Dec-12	31-Dec-12
4TH STREET FLOOD PUMP STATION	31-Dec-12	31-Dec-12	31-Dec-12
4TH STREET FLOOD PUMP STATION	31-Dec-12	31-Dec-12	31-Dec-12

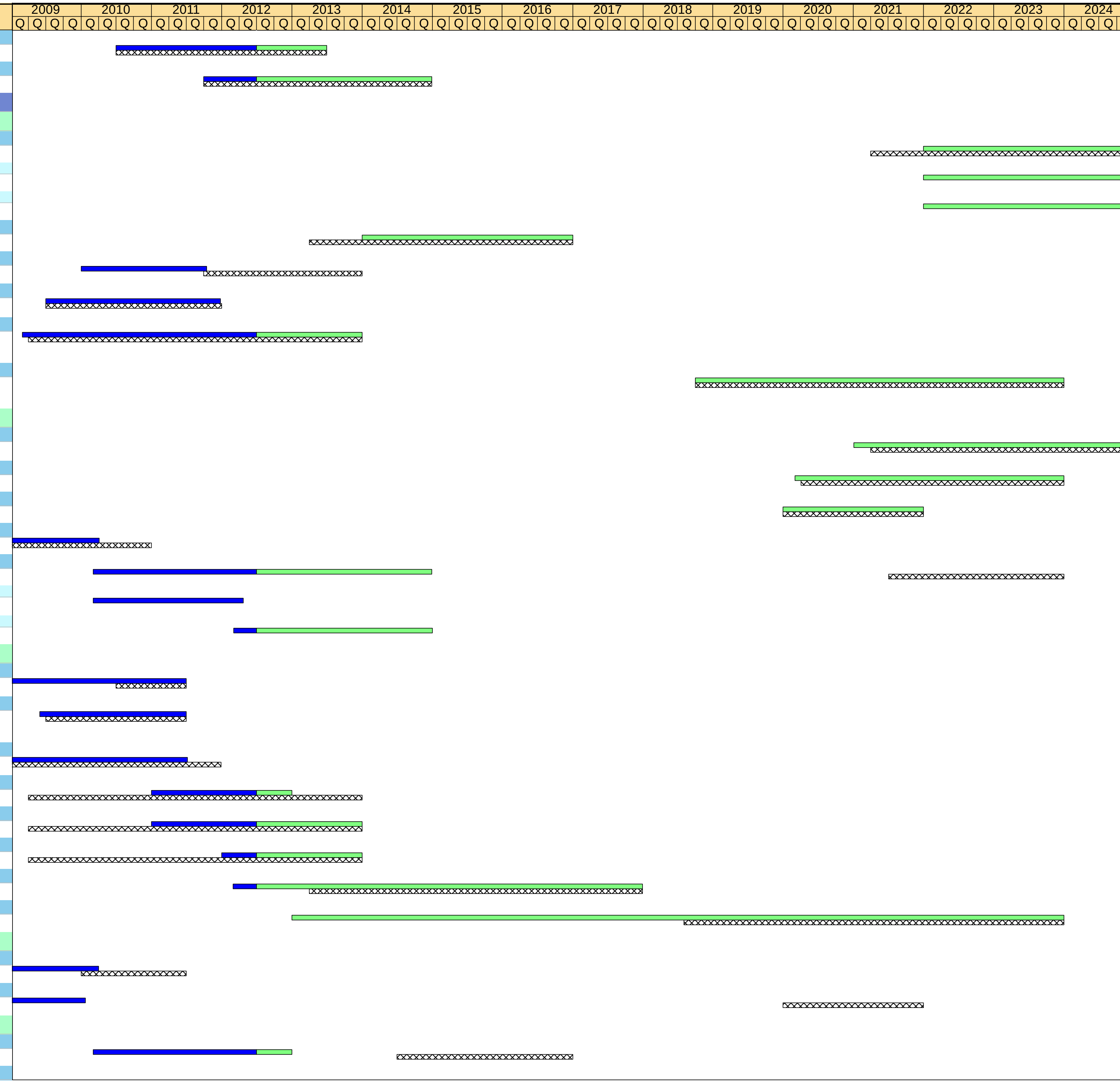


Approved 2009 IOAP | Remaining Work | Completed Work

Date Date: 01-Jul-12

MSD Integrated Overflow Abatement Plan Implementation Schedule (01 Jan 2009- 31 Dec 2024)

Activity Name	Scheduled Finish	2009 IOAP Completion	2012 IOAP Modification
SHAWNEE FLOOD PUMP STATION	30-Jun-13	30-Jun-13	30-Jun-13
SHAWNEE FLOOD PUMP STATION	30-Jun-13	30-Jun-13	30-Jun-13
17TH STREET FLOOD PUMP STATION	31-Dec-14	31-Dec-14	31-Dec-14
17TH STREET FLOOD PUMP STATION	31-Dec-14	31-Dec-14	31-Dec-14
SANITARY SEWER DISCHARGE PLAN	31-Dec-24	31-Dec-24	31-Dec-24
BEARGRASS CREEK MIDDLE FORK AREA	31-Dec-24	31-Dec-24	31-Dec-24
GOOSE CREEK PUMP STATION	31-Dec-24	31-Dec-24	31-Dec-24
GOOSE CREEK PUMP STATION	31-Dec-24	31-Dec-24	
GOOSE CREEK PS PH1 - DEVONDALE PS WW STORAGE	31-Dec-24		31-Dec-24
GOOSE CREEK PS PH1 - DEVONDALE PS WW STORAGE	31-Dec-24		31-Dec-24
GOOSE CRK PS PH2 - PS & WET WEATHER STORAGE	31-Dec-24		31-Dec-24
GOOSE CRK PS PH2 - PS & WET WEATHER STORAGE	31-Dec-24		31-Dec-24
ANCHOR ESTATES- ANCHOR ESTS PS 1 & 2 PS ELIMINATIONS	31-Dec-16	31-Dec-16	31-Dec-16
ANCHOR ESTATES- ANCHOR ESTS PS 1 & 2 PS ELIMINATIONS	31-Dec-16	31-Dec-16	31-Dec-16
ANCHOR ESTATES- VANNAH PS ELIMINATION	15-Oct-11 A	31-Dec-13	31-Dec-13
ANCHOR ESTATES- VANNAH PS ELIMINATION	15-Oct-11 A	31-Dec-13	31-Dec-13
HURSTBOURNE I&I INVESTIGATION & REHABILITATION	27-Dec-11 A	31-Dec-11	31-Dec-11
HURSTBOURNE I&I INVESTIGATION & REHABILITATION	27-Dec-11 A	31-Dec-11	31-Dec-11
MIDDLE FORK RELIEF INTERCEPTOR, WET WEATHER STORAGE, AND UMFLS DIVERSION 1 -	31-Dec-13	31-Dec-13	31-Dec-13
MIDDLE FORK RELIEF INTERCEPTOR, WET WEATHER STORAGE, AND UMFLS DIVERSION 1 - BUECHEL BASIN	31-Dec-13	31-Dec-13	31-Dec-13
MIDDLE FORK RELIEF INTERCEPTOR, WET WEATHER STORAGE, AND UMFLS DIVERSION 2 I	31-Dec-23	31-Dec-23	31-Dec-23
MIDDLE FORK RELIEF INTERCEPTOR, WET WEATHER STORAGE, AND UMFLS DIVERSION 2 PS & WET WEATHER STORAGE	31-Dec-23	31-Dec-23	31-Dec-23
CEDAR CREEK AREA	31-Dec-24	31-Dec-24	31-Dec-24
LITTLE CEDAR CREEK INTRECEPTOR IMPROVEMENTS	31-Dec-24	31-Dec-24	31-Dec-24
LITTLE CEDAR CREEK INTRECEPTOR IMPROVEMENTS	31-Dec-24	31-Dec-24	31-Dec-24
IDLEWOOD INLINE STORAGE	31-Dec-23	31-Dec-23	31-Dec-23
IDLEWOOD INLINE STORAGE	31-Dec-23	31-Dec-23	31-Dec-23
BARDSTOWN RD PS IMPROVEMENTS	31-Dec-21	31-Dec-21	31-Dec-21
BARDSTOWN RD PS IMPROVEMENTS	31-Dec-21	31-Dec-21	31-Dec-21
RUNNING FOX PS ELIMINATION	05-Apr-10 A	31-Dec-10	31-Dec-10
RUNNING FOX PS ELIMINATION	05-Apr-10 A	31-Dec-10	31-Dec-10
FAIRMOUNT RD PS IMPROVMENTS	01-Jan-15	31-Dec-23	31-Dec-23
FAIRMOUNT RD PS IMPROVMENTS	31-Dec-14	31-Dec-23	
FAIRMOUNT RD PS IMPROVEMENTS	24-Apr-12 A		31-Dec-23
FAIRMOUNT RD PS IMPROVEMENTS	24-Apr-12 A		31-Dec-23
FAIRMOUNT RD PS IMPROVEMENT PH 2	01-Jan-15		31-Dec-15
FAIRMOUNT STORAGE BASIN	01-Jan-15		31-Dec-15
COMBINED SEWER SYSTEM AREA	31-Dec-23	31-Dec-23	31-Dec-23
HAZELWOOD PS I&I INVESTIGATION & REHABILITATION	30-Jun-11 A	30-Jun-11	30-Jun-11
HAZELWOOD PS I&I INVESTIGATION & REHABILITATION	30-Jun-11 A	30-Jun-11	30-Jun-11
SONNE PUMP STATION I&I INVESTIGATION & REHABILITATION	30-Jun-11 A	30-Jun-11	30-Jun-11
SONNE PUMP STATION I&I INVESTIGATION & REHABILITATION	30-Jun-11 A	30-Jun-11	30-Jun-11
CAMP TAYLOR SSES	08-Jul-11 A	31-Dec-11	31-Dec-13
CAMP TAYLOR SSES	08-Jul-11 A	31-Dec-11	31-Dec-13
CAMP TAYLOR SANITARY SEWER #1A	31-Dec-12	31-Dec-13	31-Dec-13
CAMP TAYLOR SANITARY SEWER #1A	31-Dec-12	31-Dec-13	31-Dec-13
CAMP TAYLOR SANITARY SEWER #1B	31-Dec-13	31-Dec-13	31-Dec-13
CAMP TAYLOR SANITARY SEWER #1B	31-Dec-13	31-Dec-13	31-Dec-13
CAMP TAYLOR SANITARY SEWER #2	31-Dec-13	31-Dec-13	31-Dec-13
CAMP TAYLOR SANITARY SEWER #2	31-Dec-13	31-Dec-13	31-Dec-13
CAMP TAYLOR #3- SEWER REHABILITATION	31-Dec-17	31-Dec-17	31-Dec-17
CAMP TAYLOR #3- SEWER REHABILITATION	31-Dec-17	31-Dec-17	31-Dec-17
CAMP TAYLOR #4-SEWER REHABILITATION & REPLACEMENT	31-Dec-23	31-Dec-23	31-Dec-23
CAMP TAYLOR #4-SEWER REHABILITATION & REPLACEMENT	31-Dec-23	31-Dec-23	31-Dec-23
FLOYDS FORK AREA	01-Apr-10 A	31-Dec-21	01-Apr-10
WOODLAND HILL PS DIVERSION	01-Apr-10 A	30-Jun-11	01-Apr-10
WOODLAND HILL PS DIVERSION	01-Apr-10 A	30-Jun-11	01-Apr-10
ASHBURTON PS IMPROVEMENTS AND DIVERSION	22-Jan-10 A	31-Dec-21	22-Jan-10
ASHBURTON PS IMPROVEMENTS AND DIVERSION	22-Jan-10 A	31-Dec-21	22-Jan-10
HITE CREEK AREA	31-Dec-24	31-Dec-24	31-Dec-24
MEADOW STREAM PS AND FORCE MAIN	31-Dec-12	31-Dec-16	31-Dec-16
MEADOW STREAM PS AND FORCE MAIN	31-Dec-12	31-Dec-16	31-Dec-16
KAVANAUGH RD PS IMPROVEMENTS	31-Dec-24	31-Dec-24	31-Dec-24

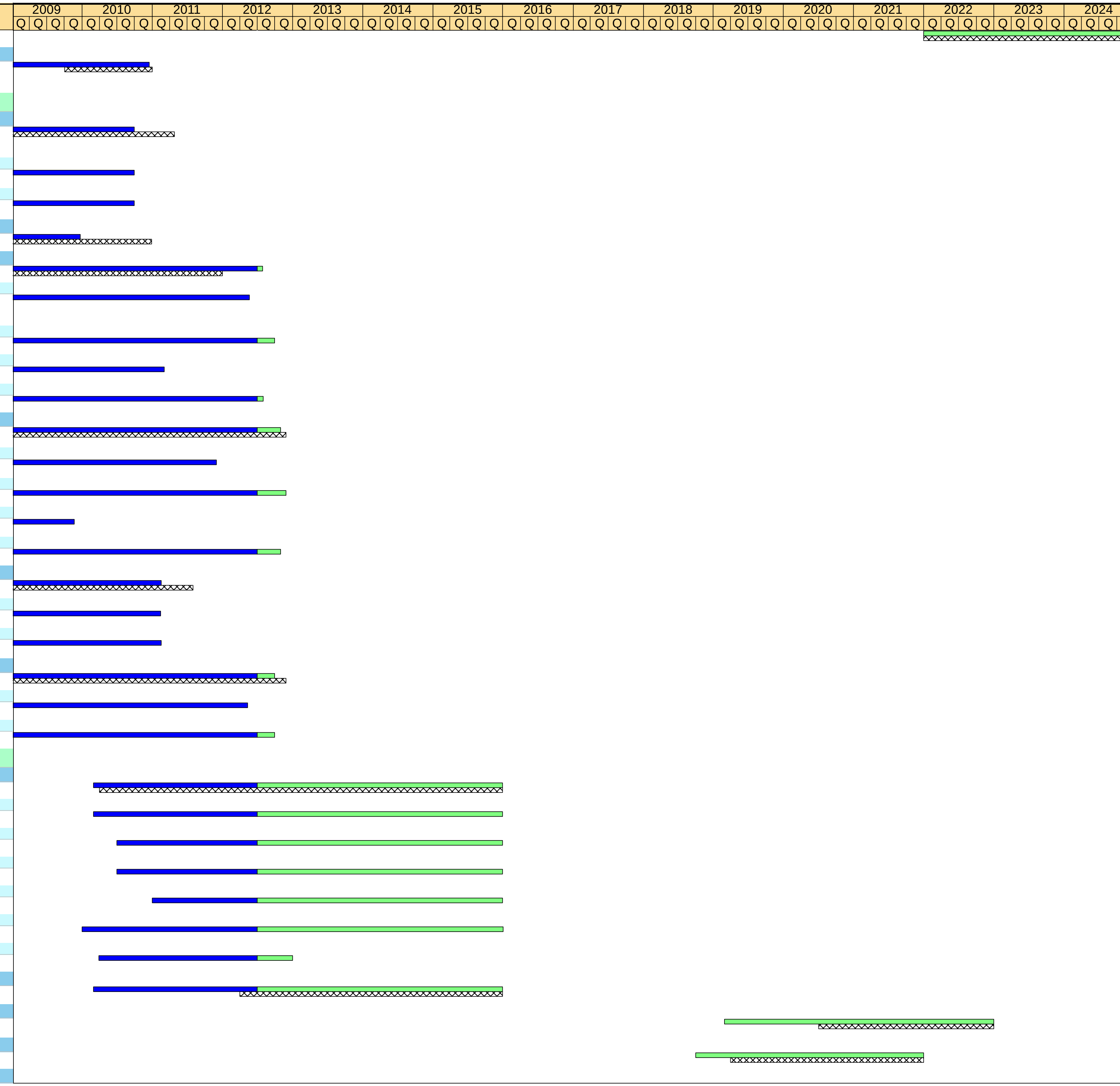


Approved 2009 IOAP   Remaining Work
Completed Work

Date Date: 01-Jul-12

MSD Integrated Overflow Abatement Plan Implementation Schedule (01 Jan 2009- 31 Dec 2024)

Activity Name	Scheduled Finish	2009 IOAP Completion	2012 IOAP Modification
KAVANAUGH RD PS IMPROVEMENTS	31-Dec-24	31-Dec-24	31-Dec-24
FLOYDSBURG RD SSES, REHAB AND PUMP STATION UPGRADE	17-Dec-10 A	31-Dec-10	31-Dec-10
FLOYDSBURG RD SSES, REHAB AND PUMP STATION UPGRADE	17-Dec-10 A	31-Dec-10	31-Dec-10
INTERIM SSDP PROJECTS	27-Nov-12	27-Nov-12	27-Nov-12
ISSDP BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT	29-Sep-10 A	27-Apr-11	27-Apr-11
ISSDP BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT	29-Sep-10 A	27-Apr-11	
BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT (WEST)	29-Sep-10 A		27-Apr-11
BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT	29-Sep-10 A		27-Apr-11
BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT (EAST)	29-Sep-10 A		27-Apr-11
BEECHWOOD VILLAGE SANITARY SEWER REPLACEMENT	29-Sep-10 A		27-Apr-11
SINKING FORK RELIEF SEWER	23-Dec-09 A	30-Dec-10	23-Dec-09
SINKING FORK RELIEF SEWER	23-Dec-09 A	30-Dec-10	23-Dec-09
ISSDP DEREK R GUTHRIE WATER QUALITY TREATMENT CENTER	30-Sep-12	31-Dec-11	27-Nov-12
ISSDP DEREK R GUTHRIE WATER QUALITY TREATMENT CENTER	30-Jul-12	31-Dec-11	
DEREK R GUTHRIE WQTC WET WEATHER TREATMENT FACILITY	20-May-12 A		27-Nov-12
DEREK R GUTHRIE WQTC WET WEATHER TREATMENT FACILITY	20-May-12 A		27-Nov-12
WCWTP: WW FLOW EQU & TMT	30-Sep-12		27-Nov-12
WCWTP: WW FLOW EQU & TMT	30-Sep-12		27-Nov-12
DRGWQTC: BLOWER PACKAGE	03-Mar-11 A		27-Nov-12
DRGWQTC: BLOWER PACKAGE	03-Mar-11 A		27-Nov-12
DRGWQTC: WET WEATHER EQUALIZATION BASIN	31-Jul-12		27-Nov-12
DRGWQTC: WET WEATHER EQUALIZATION BASIN	31-Jul-12		27-Nov-12
ISSDP HIKES LANE INTERCEPTOR /HIGHGATE SPRINGS PS	27-Nov-12	27-Nov-12	27-Nov-12
ISSDP HIKES LANE INTERCEPTOR /HIGHGATE SPRINGS PS	30-Oct-12	27-Nov-12	
HIKES POINT INTERCEPTOR	30-Nov-11 A		27-Nov-12
HIKES POINT INTERCEPTOR	30-Nov-11 A		27-Nov-12
HIKES POINT INTERCEPTOR PHASE 2	27-Nov-12		27-Nov-12
HIKES POINT INTERCEPTOR PHASE 2	27-Nov-12		27-Nov-12
CARSON & RIBBLE RELIEF	20-Nov-09 A		27-Nov-12
CARSON & RIBBLE RELIEF	20-Nov-09 A		27-Nov-12
HIKES POINT RELIEF EFFORT	31-Oct-12		27-Nov-12
HIKES POINT RELIEF EFFORT	31-Oct-12		27-Nov-12
ISSDP NORTHERN DITCH DIVERSION INTERCEPTOR	16-Feb-11 A	31-Jul-11	31-Jul-11
ISSDP NORTHERN DITCH DIVERSION INTERCEPTOR	16-Feb-11 A	31-Jul-11	
NORTHERN DITCH DIVERSION INTERCEPTOR	16-Feb-11 A		31-Jul-11
NORTHERN DITCH DIVERSION INTERCEPTOR	16-Feb-11 A		31-Jul-11
NORTHERN DITCH DIVERSION INTERCEPTOR PH 2	16-Feb-11 A		31-Jul-11
NORTHERN DITCH DIVERSION INTERCEPTOR PH 2	16-Feb-11 A		31-Jul-11
ISSDP SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR	30-Sep-12	27-Nov-12	30-Sep-12
ISSDP SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR	28-Sep-12	27-Nov-12	
SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR	12-May-12 A		12-May-12
SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR	12-May-12 A		12-May-12
SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR Phase 2	30-Sep-12		30-Sep-12
SOUTHEAST DIVERSION STRUCTURE & INTERCEPTOR Phase 2	30-Sep-12		30-Sep-12
JEFFERSONTOWN AREA	31-Dec-22	31-Dec-22	31-Dec-22
JEFFERSONTOWN WQTC ELIMINATION	01-Jan-16	31-Dec-15	31-Dec-15
JEFFERSONTOWN WQTC ELIMINATION	31-Dec-15	31-Dec-15	
JEFFERSONTOWN WQTC ELIMINATION	31-Dec-15		31-Dec-15
JEFFERSONTOWN WQTC ELIMINATION	31-Dec-15		31-Dec-15
JEFFERSONTOWN FORCE MAIN	31-Dec-15		31-Dec-15
JEFFERSONTOWN FORCE MAIN	31-Dec-15		31-Dec-15
GRAND AVENUE PUMP STATION	31-Dec-15		31-Dec-15
GRAND AVENUE PUMP STATION	31-Dec-15		31-Dec-15
UPPER BILLTOWN RD INTERCEPTOR	31-Dec-15		31-Dec-15
UPPER BILLTOWN RD INTERCEPTOR	31-Dec-15		31-Dec-15
BILLTOWN RD INTERCEPTOR SS	01-Jan-16		31-Dec-15
BILLTOWN RD INTERCEPTOR SS	01-Jan-16		31-Dec-15
BILLTOWN RD PS, FM & INT	31-Dec-12		31-Dec-12
BILLTOWN RD PS, FM & INT	31-Dec-12		31-Dec-12
CHENOWETH HILLS WQTC ELIMINATION & PS IMPROVEMENTS	31-Dec-15	31-Dec-15	31-Dec-15
CHENOWETH HILLS WQTC ELIMINATION & PS ELIMINATION	31-Dec-15	31-Dec-15	31-Dec-15
DELL RD & CHARLANE PKWY INTERCEPTOR IMPROVEMENTS	31-Dec-22	31-Dec-22	31-Dec-22
DELL RD & CHARLANE PKWY INTERCEPTOR IMPROVEMENTS	31-Dec-22	31-Dec-22	31-Dec-22
RAINTREE & MARIAN CT PH1 - PS ELIMINATION	31-Dec-21	31-Dec-21	31-Dec-21
RAINTREE & MARIAN CT PH1 - PS ELIMINATION	31-Dec-21	31-Dec-21	31-Dec-21
RAINTREE & MARIAN CT PS ELIMINATION	31-Dec-21	31-Dec-21	31-Dec-21

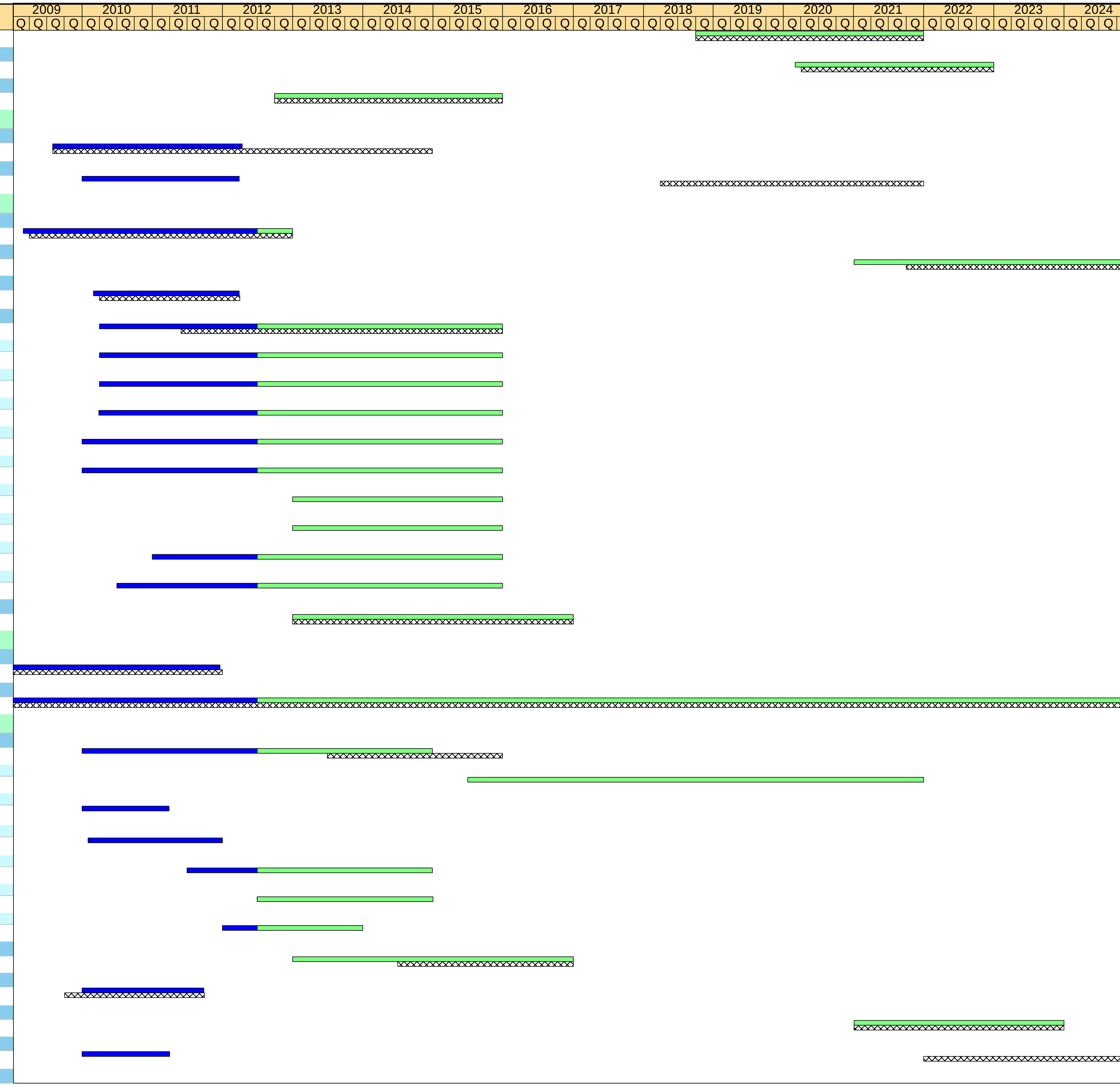


Approved 2009 IOAP — Remaining Work — Completed Work

Date Date: 01-Jul-12

MSD Integrated Overflow Abatement Plan Implementation Schedule (01 Jan 2009- 31 Dec 2024)

Activity Name	Scheduled Finish	2009 IOAP Completion	2012 IOAP Modification
RAINTREE & MARIAN CT PS ELIMINATION	31-Dec-21	31-Dec-21	31-Dec-21
MONTICELLO PS ELIMINATION	31-Dec-22	31-Dec-22	31-Dec-22
MONTICELLO PS ELIMINATION	31-Dec-22	31-Dec-22	31-Dec-22
KLONDIKE INTERCEPTOR	31-Dec-15	31-Dec-15	31-Dec-15
KLONDIKE INTERCEPTOR	31-Dec-15	31-Dec-15	31-Dec-15
MILL CREEK AREA	13-Apr-12 A	31-Dec-21	31-Dec-21
SHIVELY INTERCEPTOR	13-Apr-12 A	31-Dec-14	31-Dec-14
SHIVELY INTERCEPTOR	13-Apr-12 A	31-Dec-14	31-Dec-14
EAST ROCKFORD LANE PS RELOCATION	30-Mar-12 A	31-Dec-21	31-Dec-21
EAST ROCKFORD LANE PS RELOCATION	30-Mar-12 A	31-Dec-21	31-Dec-21
OHIO RIVER FORCE MAIN AREA	31-Dec-24	31-Dec-24	31-Dec-24
MELLWOOD SYS 1 - MELLWOOD PS & FORCE MAIN	31-Dec-12	31-Dec-12	31-Dec-12
MELLWOOD SYS 1 - MELLWOOD PS & FORCE MAIN	31-Dec-12	31-Dec-12	31-Dec-12
MELLWOOD SYS 2 - WINTON & MOCKINGBIRD PS ELIM & PIPE UPGRADES	31-Dec-24	31-Dec-24	31-Dec-24
MELLWOOD SYS 2 - WINTON & MOCKINGBIRD PS ELIM & PIPE UPGRADES	31-Dec-24	31-Dec-24	31-Dec-24
DERINGTON CT PS I/I INVESTIGATION & REHABILITATION	30-Mar-12 A	31-Mar-12	31-Mar-12
DERINGTON CT PS I/I INVESTIGATION & REHABILITATION	30-Mar-12 A	31-Mar-12	31-Mar-12
PROSPECT WQTC ELIMINATIONS	31-Dec-15	31-Dec-15	31-Dec-15
PROSPECT WQTC ELIMINATIONS	31-Dec-15	31-Dec-15	
HARROD'S CREEK PS & FM	31-Dec-15		31-Dec-15
HARRODS CREEK PS & FM	31-Dec-15		31-Dec-15
HARRODS CREEK INT	31-Dec-15		31-Dec-15
HARRODS CREEK INT	31-Dec-15		31-Dec-15
HARRODS CREEK INT PH 2	31-Dec-15		31-Dec-15
HARRODS CREEK INT PH 2	31-Dec-15		31-Dec-15
RIVER ROAD INT	31-Dec-15		31-Dec-15
RIVER ROAD INT	31-Dec-15		31-Dec-15
TIMBERLAKE & HUNTING CREEK S WQTC ELIM	31-Dec-15		31-Dec-15
TIMBERLAKE & HUNTING CREEK S WQTC ELIM	31-Dec-15		31-Dec-15
KEN CARLA WQTC ELIM	31-Dec-15		31-Dec-15
KEN CARLA WQTC ELIM	31-Dec-15		31-Dec-15
HARRODS CREEK FORCE MAIN PH 3	31-Dec-15		31-Dec-15
HARRODS CREEK FORCE MAIN PH 3	31-Dec-15		31-Dec-15
SHADOW WOOD WWTP ELIM	31-Dec-15		31-Dec-15
SHADOW WOOD WWTP ELIM	31-Dec-15		31-Dec-15
N HUNTING CREEK PS & FM	31-Dec-15		31-Dec-15
N HUNTING CREEK PS & FM	31-Dec-15		31-Dec-15
PROSPECT #3- ORFM SYSTEM IMPROVEMENTS	31-Dec-16	31-Dec-16	31-Dec-16
PROSPECT #3 - ORFM SYSTEM IMPROVEMENTS	31-Dec-16	31-Dec-16	31-Dec-16
OTHER PROJECTS	30-Dec-24	31-Dec-24	30-Dec-24
CPE/CCP MODIFICATIONS TO WQTC	19-Dec-11 A	31-Dec-11	31-Dec-11
CPE/CCP MODIFICATIONS TO WQTC	19-Dec-11 A	31-Dec-11	31-Dec-11
I/I REDUCTION PROGRAM	30-Dec-24	31-Dec-24	30-Dec-24
I/I REDUCTION PROGRAM	30-Dec-24	31-Dec-24	30-Dec-24
POND CREEK AREA	31-Dec-23	31-Dec-24	31-Dec-24
LEE ANN WAY PUMP STATION IMPROVEMENTS	31-Dec-21	31-Dec-15	31-Dec-15
LEE ANN WAY PUMP STATION IMPROVEMENTS	31-Dec-14	31-Dec-15	
LEA ANN WAY SANITARY SEWER I/I REHAB	31-Dec-21		31-Dec-15
LEA ANN WAY SANITARY SEWER I/I REHAB	31-Dec-21		31-Dec-15
LEE ANN WAY PS SYSTEM SSES	30-Mar-11 A		31-Dec-15
LEE ANN WAY PS SYSTEM SSES	30-Mar-11 A		31-Dec-15
LEE ANN WAY PH 2 ICA	31-Dec-11 A		31-Dec-15
LEE ANN WAY PH 2 ICA	31-Dec-11 A		31-Dec-15
LEE ANN WAY SSR PH 1	31-Dec-14		31-Dec-15
LEE ANN WAY SSR PH 1	31-Dec-14		31-Dec-15
LEE ANN WAY SSR PH 2	01-Jan-15		31-Dec-15
LEE ANN WAY SSR PH 2	01-Jan-15		31-Dec-15
LEE ANN WAY INTERCEPTOR I/I REHAB	31-Dec-13		31-Dec-15
LEE ANN WAY INTERCEPTOR I/I REHAB	31-Dec-13		31-Dec-15
OUTER LOOP & CAVEN AREA PIPE UPGRADES	31-Dec-16	31-Dec-16	31-Dec-24
OUTER LOOP & CAVEN AREA PIPE UPGRADES	31-Dec-16	31-Dec-16	31-Dec-24
EDSEL PS I/I INVESTIGATION & REHABILITATION	27-Sep-11 A	30-Sep-11	30-Sep-11
EDSEL PS I/I INVESTIGATION & REHABILITATION	27-Sep-11 A	30-Sep-11	30-Sep-11
CINDERELLA PS ELIMINATION	31-Dec-23	31-Dec-23	31-Dec-23
CINDERELLA PS ELIMINATION	31-Dec-23	31-Dec-23	31-Dec-23
GOVERNMENT CENTER PS ELIMINATION	01-Apr-11 A	31-Dec-24	31-Dec-24
GOVERNMENT CENTER PS ELIMINATION	01-Apr-11 A	31-Dec-24	31-Dec-24
AVANTI PS ELIMINATION	28-Jul-09 A	31-Dec-10	31-Dec-10

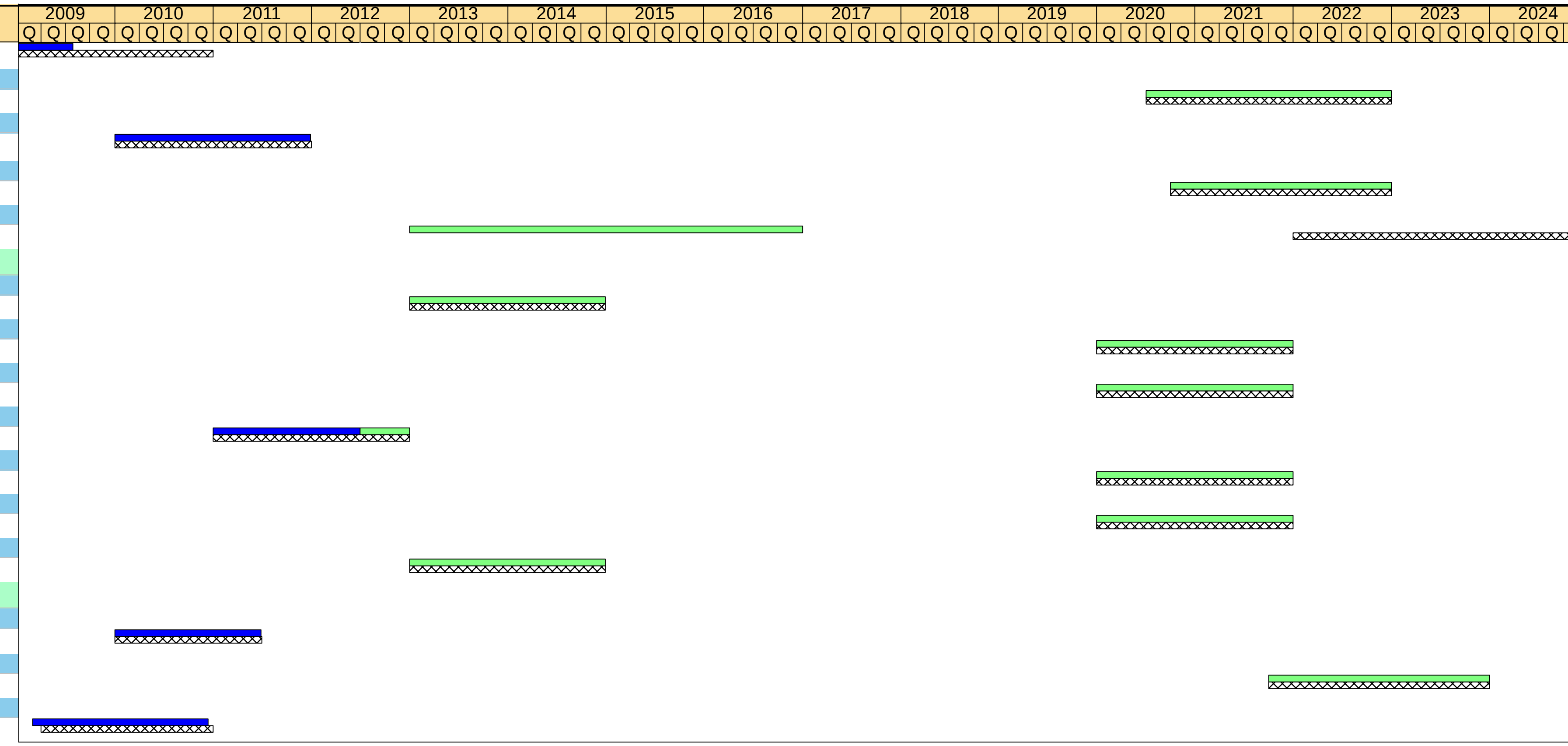


Approved 2009 IOAP Remaining Work
Completed Work

Date Date: 01-Jul-12

MSD Integrated Overflow Abatement Plan Implementation Schedule (01 Jan 2009- 31 Dec 2024)

Activity Name	Scheduled Finish	2009 IOAP Completion	2012 IOAP Modification
AVANTI PS ELIMINATION	28-Jul-09 A	31-Dec-10	31-Dec-10
CHARLESWOOD INTERCEPTOR EXTENSION	31-Dec-22	31-Dec-22	31-Dec-22
CHARLESWOOD INTERCEPTOR EXTENSION	31-Dec-22	31-Dec-22	31-Dec-22
LANTANA PS I/I INVESTIGATION & REHABILITATION	29-Dec-11 A	31-Dec-11	29-Dec-11
LANTANA PS I/I INVESTIGATION & REHABILITATION	29-Dec-11 A	31-Dec-11	29-Dec-11
LEVEN PS ELIMINATION	31-Dec-22	31-Dec-22	31-Dec-22
LEVEN PS ELIMINATION	31-Dec-22	31-Dec-22	31-Dec-22
CAVEN AVENUE WW STORAGE	31-Dec-16	31-Dec-24	31-Dec-16
CAVEN AVENUE PS ELIMINATION	31-Dec-16	31-Dec-24	31-Dec-16
SMALL WWTP AREA	31-Dec-21	31-Dec-21	31-Dec-21
RIDING RIDGE PS IMPROVEMENTS	31-Dec-14	31-Dec-14	31-Dec-14
RIDING RIDGE PS IMPROVEMENTS	31-Dec-14	31-Dec-14	31-Dec-14
LUCAS LN PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
LUCAS LN PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
ST. RENE RD PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
ST. RENE RD PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
LAKE FOREST PS IMPROVEMENTS	31-Dec-12	31-Dec-12	31-Dec-12
LAKE FOREST PS IMPROVEMENTS	31-Dec-12	31-Dec-12	31-Dec-12
GUNPOWDER PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
GUNPOWDER PS INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
FOX HARBOR INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
FOX HARBOR INLINE STORAGE	31-Dec-21	31-Dec-21	31-Dec-21
FAIRWAY VIEW PS IMPROVEMENTS	31-Dec-14	31-Dec-14	31-Dec-14
FAIRWAY VIEW PS IMPROVEMENTS	31-Dec-14	31-Dec-14	31-Dec-14
SOUTHEASTERN DIVERSION AREA	31-Dec-23	31-Dec-23	31-Dec-23
PARKVIEW ESTATES I/I INVESTIGATION & REHABILITATION	28-Jun-11 A	30-Jun-11	30-Jun-11
PARKVIEW ESTATES I/I INVESTIGATION & REHABILITATION	28-Jun-11 A	30-Jun-11	30-Jun-11
SUTHERLAND INTERCEPTOR	31-Dec-23	31-Dec-23	31-Dec-23
SUTHERLAND INTERCEPTOR	31-Dec-23	31-Dec-23	31-Dec-23
BEARGRASS INTERCEPTOR REHABILITATION PH 2	14-Dec-10 A	31-Dec-10	31-Dec-10
BEARGRASS INTERCEPTOR REHABILITATION PH 2	14-Dec-10 A	31-Dec-10	31-Dec-10

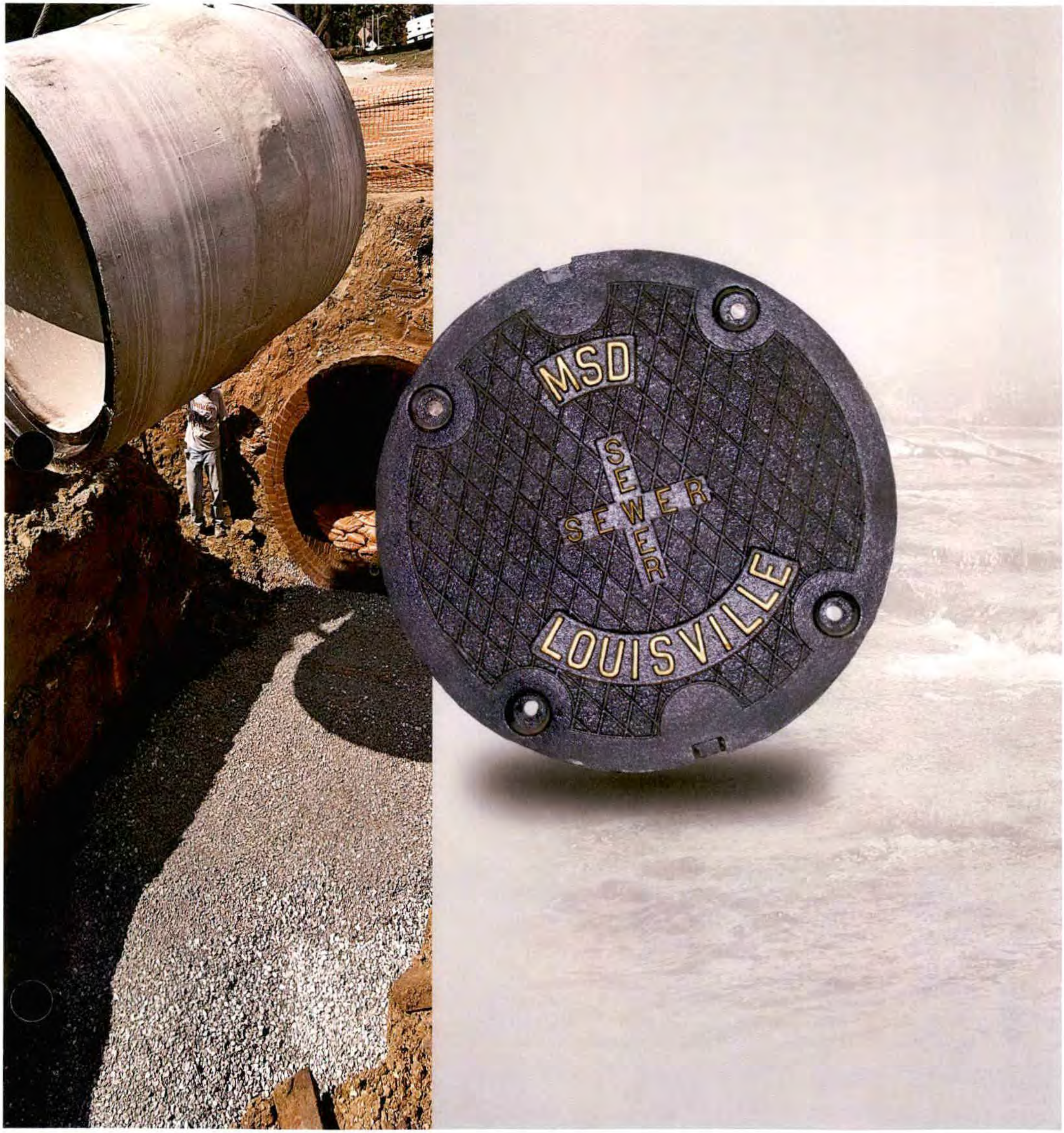


Approved 2009 IOAP
Remaining Work
Completed Work

Date Date: 01-Jul-12

Executive Summary

Attachment 1



MEMORANDUM

TO: Louisville and Jefferson County Metropolitan Sewer District Board

FROM: Stakeholder Members of the Wet Weather Team

DATE: December 10, 2008

SUBJECT: Draft Integrated Overflow Abatement Plan

As stakeholder members of MSD's Wet Weather Team (WWT), we wish to indicate our support for the Final Integrated Overflow Abatement Plan (IOAP) as MSD transmits the plan to the U.S. Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet. The attached document, "Vision for MSD's Integrated Overflow Abatement Plan," summarizes the Wet Weather Team's common understanding of the high-level architecture and components of the IOAP. As stakeholder members of the WWT, we played an active role in developing the IOAP Vision. Our support for the IOAP is based on the expectation that the complete plan is fully reflective of and consistent with the IOAP Vision. We support this vision for improving wet weather sewer overflow management in our community. In this memorandum, we review the composition and charge of the Wet Weather Team, describe the results of the stakeholder subgroup's deliberations, and outline our support for the IOAP.

Wet Weather Team Composition and Charge

The Wet Weather Team consists of community representatives, elected officials, MSD personnel, and technical consultants. The nineteen stakeholders on the Wet Weather Team include individuals recognized as community opinion leaders associated with environmental advocacy, business and industry, elected officials, local government, community neighborhood, recreation, public health, environmental justice, and organized labor interests. WWT stakeholders have not formally represented their specific affiliated organizations as part of the team, but rather have provided input reflective of the broad interest areas in which they lead.

MSD chartered the stakeholder subgroup of the Wet Weather Team to "provide guidance on the development of an integrated Wet Weather Program that will comply with applicable regulatory requirements and will minimize the impacts of wet weather discharges on water quality, aquatic biota, and human health." Through MSD's consent decree with EPA and the Kentucky Environmental and Public Protection Cabinet, the WWT was charged with two primary tasks: (1) preparing a plan for funding MSD's overflow abatement program and (2) developing a program for public information, education, and involvement. In addition to these tasks, MSD sought guidance from WWT stakeholders on MSD's overall investment, policy, and performance choices in the development of the IOAP.

Results of the Wet Weather Team's Deliberations

The Wet Weather Team met 22 times from July 2006 through December 2008 and provided input on all major components of the IOAP, as well as the analytic framework and the public involvement process MSD used to develop the IOAP. The WWT also met to review the public comments submitted on the Draft IOAP and discuss the changes proposed for the Final IOAP. There are four areas of the WWT stakeholder subgroup's deliberations that we would like to highlight, as follows.

1. Development of the Analytic Framework: The WWT stakeholders, along with other WWT members, identified and agreed upon a set of community values to use in the development of MSD's IOAP. We also advised MSD's technical team on a performance evaluation framework for using those values to evaluate project alternatives for MSD's IOAP. The performance evaluation framework includes both a benefit-cost scoring methodology for selecting the best alternatives at the project level and a systematic process for considering values that relate to the program as a whole. (This analytic framework is further described in the attached Vision.) We believe that this analytic framework is rigorous, transparent, and replicable, and that it provides an effective way to understand and balance tradeoffs among potentially conflicting community interests.

2. Application of the Analytic Framework: The WWT stakeholder subgroup has reviewed examples of how MSD's technical team has used the values-based performance evaluation framework to evaluate project alternatives to address combined sewer overflow (CSO) and sanitary sewer overflow (SSO) problems in our community. Moreover, we have also reviewed and provided input on how the technical team has evaluated the IOAP according to the WWT's programmatic community values—customer satisfaction, economic vitality, education, environmental justice and equity, financial equity, and financial stewardship. We believe that the analytic framework has been applied consistent with the WWT's expectations in the development of the IOAP and has produced a robust, replicable, and transparent analysis.

3. IOAP Vision: We helped develop the attached "Vision for MSD's Integrated Overflow Abatement Plan" along with the MSD personnel and technical consultants who are on the Wet Weather Team. The IOAP Vision summarizes the WWT's common understanding of the high-level architecture and components of the IOAP, and it documents the WWT's consensus about several crucial aspects of the IOAP. The Vision outlines and provides highlights of the expected water quality benefits of the IOAP; the levels of control for CSOs and SSOs in our community; the range of control options in the IOAP; the analytic framework and process used to select control options; the public information, education, and involvement program (known as "Project WIN"); the monitoring, evaluation, and adaptive management plan; future development considerations relevant to the IOAP; and the IOAP funding plan. As stakeholder members of the WWT, we support this vision for improving wet weather sewer overflow management in our community.

4. Summary of IOAP Projects: We believe the project mix and outcomes that form the backbone of the IOAP (as captured in the attached IOAP Vision) reflect responsiveness to MSD's consent decree and provide for a critical, first increment of water quality improvement for our community, while ensuring wise and effective use of our community's resources. The IOAP Vision draws on front end consideration of and investment in green infrastructure and other source control approaches, including "private side" inflow and infiltration (I&I) control. These early investments will act to test and demonstrate the effectiveness of these approaches, creating the prospect, based on demonstrated performance, for expanding their role and lowering community costs as MSD implements the IOAP. We understand that MSD, consistent with the Post-Construction Compliance Monitoring Plan, will closely monitor and report on the efforts for both regulatory and public education purposes. We further understand that MSD, over the coming months, will work with community members to further articulate and enhance the scope and scale of its IOAP public education and outreach program, including developing a robust approach for measuring the effectiveness of the program.

As MSD moves forward in coming years with IOAP implementation, we do anticipate the program will face, as all programs of this type do, project-specific challenges related to local community understanding and acceptance. In this context, we understand MSD is committed to using focused and sustained neighborhood education and outreach efforts to support project-specific and overall program implementation and will strive to address localized needs consistent with overall IOAP requirements. At the same time, we believe all localities throughout the MSD system must keep in mind that individual IOAP project locations and types have emerged from a rigorous and consistently applied technical analysis. The IOAP projects exist as critical building blocks for an overall community program framed by federal and state regulatory requirements, community water quality and public health improvement objectives, and overall rate payer capacity.

The stakeholder subgroup of the Wet Weather Team appreciates the opportunity to have contributed to MSD's IOAP development efforts. During our final meeting on December 4, 2008, we discussed the importance of an overarching, sustained community water quality education initiative directed at enhancing appreciation for water quality improvements and building understanding of the actions all members of the community can take to improve water quality. We understand this effort is substantially broader in scope than the CSO and SSO improvements addressed by the IOAP, but we believe it is important to take this opportunity to raise awareness for this need, particularly as our community turns its attention to stormwater management in the context of the multi-jurisdictional Municipal Separate Storm Sewer System (MS4) permit. We appreciate MSD's willingness to be a contributor to such an effort, even as we recognize the need for broader involvement and leadership throughout the Louisville community and across Louisville Metro Government.

We look forward to the MSD Board's review of the Final IOAP and MSD's submittal of the Final IOAP to EPA and the State of Kentucky by December 31, 2008. Thank you for the opportunity to contribute to this critical community improvement initiative. Please feel free to contact us individually or collectively with any questions or perspectives you may have.

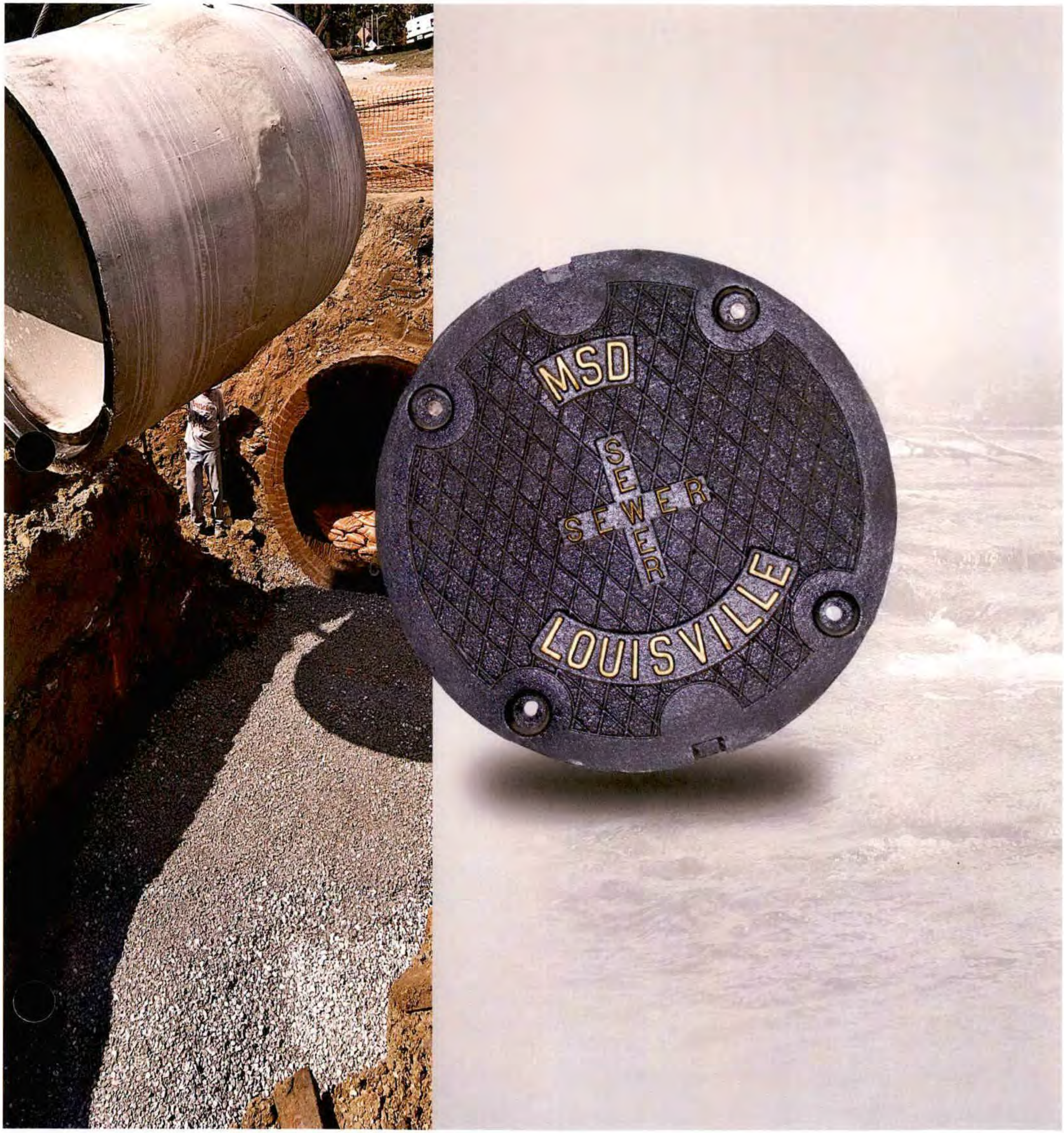
Stakeholder Members of the Wet Weather Team

Member	**Organization***
Steve Barger	Labor
Susan Barto	Mayor of Lyndon
Stuart Benson	Louisville Metro Council, District 20
Charles Cash	Louisville Metro Planning & Design Services
Allan Dittmer	University of Louisville
Laura Douglas	E.ON U.S. LLC
Faye Ellerkamp	City of Windy Hills
Arnita Gadson	West Jefferson County Community Task Force / Kentucky Environmental Quality Commission
Mike Heitz	Louisville Metro Parks Department
Tom Herman	Zeon Chemicals
Rick Johnstone	Deputy Mayor, Louisville Metro Mayor's Office
Bob Marrett	CMB Development Company, LLC
Kurt Mason	Jefferson County Soil and Water Conservation District
Judy Nielsen	Louisville Metro Department of Public Health and Wellness
Lisa Santos	Irish Hill Neighborhood Association
Bruce Scott	Kentucky Waterways Alliance
David Tollerud	University of Louisville, School of Public Health and Information Sciences
Tina Ward-Pugh	Louisville Metro Council, District 9
David Wicks	Jefferson County Public Schools

*Stakeholders on the Wet Weather Team do not formally represent their specific affiliated organizations, but rather seek to provide input reflective of the broad interest areas in which they lead. Along with the stakeholder subgroup, the Wet Weather Team includes MSD personnel and technical consultants.

Executive Summary

Attachment 2



Vision for MSD's Integrated Overflow Abatement Plan
December 10, 2008

This document summarizes the vision for MSD's Integrated Overflow Abatement Plan (IOAP), as understood and endorsed by the Wet Weather Team (WWT).

Scope of the Integrated Overflow Abatement Plan and Expected Water Quality Benefits

The Louisville and Jefferson County Metropolitan Sewer District's Integrated Overflow Abatement Plan is a long-term plan to control combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in the community. The IOAP is expected to improve water quality in both Jefferson County streams and the Ohio River. The expected water quality benefits of the IOAP include: (a) reductions in the peak levels of bacteria in Beargrass Creek and other Jefferson County waterways; and (b) a reduction in the duration of wet weather impairment of local waterways (i.e., the number of days that bacteria levels exceed water quality standards during periods of wet weather). The IOAP—in coordination with other community water quality initiatives (further described below)—will also improve water quality under ambient conditions.

The specific benefits anticipated from the IOAP include the following:

- The suite of projects selected for the Long Term Control Plan (LTCP) for CSOs will result in approximately 95 percent capture and treatment of wet weather combined sewage during an average year. (As a point of reference, the “presumptive approach” in EPA's CSO Control Policy is based on a minimum of 85 percent wet weather capture.)
- Remaining CSO loads (after removing background) will no longer “cause or contribute” (as defined in EPA's CSO Control Policy) to water quality standard violations in the Ohio River. Peak fecal coliform counts are modeled to be reduced by 54 percent, from 100,000 colony forming units per 100 milliliter (cfu/100mL) to 46,000 cfu/100 mL (downstream from Morris Forman Wastewater Treatment Plant).
- In Beargrass Creek peak fecal coliform counts are modeled to be reduced by 18 percent, from 44,300 cfu/100mL to 37,400 cfu/100 mL (at the mouth of Beargrass Creek). The control level associated with these reductions exceeds the EPA CSO Control Policy “presumptive approach,” 85 percent wet weather capture threshold and reflects a point of significantly diminishing returns under the “knee of the curve” benefit-cost analysis.
- The suite of projects selected for the Sanitary Sewer Discharge Plan (SSDP) for SSOs will result in the elimination of capacity-related SSOs up to the site-specific level of protection (described below).
- The SSO projects are anticipated to eliminate an average of 145 SSO events per year, based on 2005–2007 data.
- In terms of water quality, SSO projects will eliminate an average of 290 million gallons of overflow volume per year (average of 2005–2007 normalized for rainfall), eliminating 100 tons of 5-day biochemical oxygen demand (BOD5) and almost 200 tons of solids annually.

Along with delivering water quality improvements from sewer overflow control, MSD participates in other community water quality improvement efforts. Sewer overflow control is essential to improving water quality, but overflow control alone is not enough to meet water quality standards. In light of this challenge, MSD will continue to leverage its role in supporting broader water quality improvement efforts in the community. The IOAP will be one of the key elements of MSD's participation in those water quality improvement efforts. In particular, the IOAP will be complementary to other wet weather and water quality programs managed by MSD and/or by other community partners. These complementary efforts include, but are not limited to, the Mayor's ―Go Green Louisville" Initiative, the Partnership for a Green City, Metro Louisville's Municipal Separate Storm Sewer System (MS4) discharge permit, and initiatives of Jefferson County Public Schools (JCPS), private developers, and other entities.[1]

The specific ways in which MSD is collaborating with other entities on community water quality improvement initiatives include the following:

- Partnership for a Green City: MSD is actively working with Louisville Metro Government, JCPS, and the University of Louisville to improve water quality through the Partnership for a Green City. The Partnership has established a Stormwater Committee that will be identifying opportunities to improve water quality associated with planned capital projects.
- Metro Government: MSD is an active participant in the Mayor's Go Green Louisville Initiative, which includes in its vision a commitment to focus on financially sustainable measures that improve air and water quality, land use, and energy efficiency. In coordination with this initiative, MSD is partnering with Louisville Metro Government on several green infrastructure demonstration projects in the IOAP.
- MS4 Program: MSD will coordinate IOAP implementation with the agencies that share implementation of the MS4 Program—including Metro Louisville government, small cities that handle their own drainage, and the Kentucky Department of Transportation. The MS4 program will draw upon the opportunities identified through the green infrastructure analysis conducted by MSD's IOAP technical team and the ideas suggested by WWT members during the development of the IOAP. MSD further anticipates implementing demonstration projects, such as rain gardens in the separate sewer area, under the MS4 as part of a coordinated effort with the IOAP to test and evaluate green infrastructure approaches to wet weather management.

The IOAP—as part of MSD's wet weather consent decree response—will be a federally enforceable action plan for sewer overflow abatement. Although many IOAP projects and programs will provide multiple benefits to the community, the scope of the IOAP is limited to commitments that directly relate to MSD programs and activities to address combined sewer overflow (CSO) and sanitary sewer overflow (SSO) issues. Other community water quality programs, which may be partly or completely out of MSD's control, can provide synergistic benefits with the IOAP, but they do not fall under the same federal enforcement. These programs may, however, have different mechanisms for ensuring accountability (e.g., the State of Kentucky oversees the MS4 stormwater permit that MSD and several other agencies hold). As noted above, MSD anticipates coordinating IOAP implementation with the water quality improvement initiatives of Louisville Metro Government and other public and private entities, even though these broader initiatives may not explicitly be part of the IOAP.

Values-Based Performance Evaluation Framework Used to Develop the IOAP

MSD developed the IOAP using a values-based performance evaluation framework established by the Wet Weather Team. This analytic framework includes both a robust benefit-cost scoring methodology for evaluating and selecting project alternatives and a systematic process for evaluating the IOAP programmatically. The Wet Weather Team identified and agreed upon the following eleven community values that underpin the analysis and selection of alternatives for the IOAP.

---

[1] More information about these initiatives is available on the following websites: Go Green Louisville (www.louisvilleky.gov/GoGreen), Partnership for a Green City (www.partnershipforagreencity.org), and MS4 program (www.msdlouky.org/insidemsd/wwwq/ms4).

Project-Specific Values

- Asset protection
- Eco-friendly solutions
- Environmental enhancement
- Public health enhancement
- Regulatory performance

Programmatic Values

- Customer satisfaction
- Economic vitality
- Education
- Environmental justice and equity
- Financial equity
- Financial stewardship

Using the structured decision-making process as framed by the Wet Weather Team, MSD developed and evaluated overflow abatement control options for the IOAP based on managing risks to these community values. In particular, MSD's technical team analyzed each project alternative considered for the IOAP in terms of potential benefits and costs, where “benefits” are quantified based on the anticipated reduction in risks to the community values and “costs” reflect the total capital and operational costs of the alternative. The benefit-cost analysis influences the selection of site-specific abatement approaches or technologies, site-specific levels of protection (within the boundary conditions for CSOs and SSOs described below), and the relative priority of projects for implementation.

Several of the Wet Weather Team's community values relate to financial considerations, including the cost-effectiveness of individual solutions and the program as a whole (financial stewardship), the affordability of the program's total costs for the community (economic vitality), and how the costs are allocated among different segments of the population (financial equity). The Wet Weather Team has used the results of the values-based benefit-cost analysis of project alternatives to provide context to discussions about the appropriate level of investment in the IOAP.

The WWT's discussions about total program costs and the selection of projects for the IOAP have considered, as directed in EPA's CSO Control Policy, a “knee of the curve” analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. In addition to this analysis, the community's level of investment in the IOAP has been considered in the context of anticipated future requirements and other needs for MSD services, including stormwater compliance needs associated with Metro Louisville's MS4 permit and requirements to meet the forthcoming total maximum daily load (TMDL) allocations for Beargrass Creek. This consideration of other water quality investment needs is important since sewer overflow control alone will not be sufficient to meet water quality standards.

The technical team's analysis of the IOAP according to the WWT's programmatic values yielded the following conclusions.

- <u>Customer Satisfaction:</u> The IOAP ensures service continuity by eliminating several small wastewater treatment plants and pump stations and by incorporating redundant equipment and standby generators. Odor control guidelines have been consistently applied across all projects. Most storage basins proposed in the IOAP will be covered. Other storage basin and pump station improvement projects incorporate odor control equipment.
- <u>Economic Vitality:</u> MSD's current rates are near the national average. The anticipated annual rate increases of 5–6.5 percent are consistent with initial estimates of program costs, and they include allowances for future MSD programs as well as IOAP implementation. Even with these rate increases, MSD's rates are anticipated to remain at or near the national average, assuming other communities face similar inflation and regulatory pressures. These estimates are based on current data; many unknown factors (e.g., bond market, climate change, etc.) will also affect future rates.

- Education: Education is an integral and essential component of the IOAP. It supports a number of IOAP objectives, including promoting and sustaining participation in green infrastructure and source control efforts, and building a sense of personal responsibility and support for clean water initiatives.
- Environmental Justice and Equity: The site selection process followed uniform criteria across the county, with most solutions placed near overflow points and with no homes or private businesses permanently displaced. Furthermore, the configuration of facilities was based on a uniform application of written design criteria and odor control criteria. Other nuisance conditions will be minimized during the design and construction phases of projects.
- Financial Equity: MSD's rate structure is based on a cost-of-service model tempered by consideration of customers' ability to pay. The rate increases proposed to fund the IOAP and other MSD programs will continue to be based on the cost of service, but MSD will recommend to the Board that the existing low income, senior citizen discount program be expanded. The IOAP also proposes subsidies and incentives for green infrastructure and infiltration and inflow (I&I) control based on their business value for overflow abatement.
- Financial Stewardship: As described above, the IOAP is based upon a rigorous benefit-cost analysis that considered a broad range of technology alternatives and different levels of control that met or exceeded regulatory guidelines. The "knee of the curve" evaluations of IOAP projects demonstrated that the IOAP provides a high level of control, but does not exceed the point of diminishing returns.

Control Levels for Combined Sewer Overflows and Sanitary Sewer Overflows

Under the Clean Water Act, CSOs are permitted discharges in wet weather, as long as they are managed to avoid degradation of water quality in the receiving streams. EPA's CSO Control Policy[2] sets specific abatement targets for CSOs. To be permitted, wet-weather CSOs must be controlled so that either water quality standards are achieved or the permit-holder can show that the CSO discharges do not cause or contribute to exceedances of water quality standards. Based on EPA's CSO Control Policy, EPA may respond to MSD's proposed strategy for controlling wet weather CSO discharges indicating a need for a temporary variance or suspension of water quality standards during wet weather. Variances are temporary, not permanent, solutions to achieve compliance with the Clean Water Act. As stated in EPA's CSO Control Policy, variances are reviewable generally every three years.

CSO projects in the IOAP have the following levels of control:

- 6 projects result in no overflows in a typical year; these locations would only overflow as a result of very large storms.
- 1 project would result in four overflows per year in a typical year.
- 11 projects result in eight overflows per year in a typical year.

MSD's strategy for SSO control reflects the fact that SSOs, unlike wet-weather CSOs, are unauthorized discharges that must be "eliminated" under the Clean Water Act. In the IOAP, the values evaluation framework has been used to evaluate a range of site-specific design storms to establish the appropriate level of control of SSOs. Consistent with an analysis of sixty years of historical weather patterns for Jefferson County, the IOAP uses a three-hour "cloud burst" storm, with a statistically anticipated rainfall of 1.82 inches, as the minimum design storm considered. The Cities of Atlanta, Cincinnati, and Knoxville used similar design storms as the minimum protection level for SSO control. The approach of using the values evaluation framework to determine the SSO control level means that solutions to address certain SSOs have been designed to protect against larger storms (e.g., a 2.25-inch cloudburst storm

[2] EPA's Combined Sewer Overflow Control Policy is available at http://cfpub1.epa.gov/npdes/cso/cpolicy.cfm.

instead of a 1.82-inch cloudburst storm) because they yield a higher benefit-cost ratio in the analysis of project alternatives.

SSO projects in the IOAP have the following levels of control:

- 30 projects eliminate overflows up to a 1.82-inch cloudburst storm.
- 9 projects eliminate overflows up to a 2.25-inch cloudburst storm.
- 7 projects eliminate overflows up to a 2.60-inch cloudburst storm.

Components of MSD's Integrated Overflow Abatement Plan

Control options in the IOAP (the IOAP “toolkit”) include source control (including green infrastructure and infiltration and inflow [I&I] reduction efforts), storage, conveyance/transport, treatment, and sewer separation. MSD's technical team has used the benefit-cost tool to compare the project alternatives and program elements considered for inclusion in the IOAP. The specific mix of control options for individual CSO or SSO locations in the IOAP is driven by the benefit-cost analysis of how the project alternatives affect the WWT's community values and site-specific considerations. Project alternatives are built around MSD's existing infrastructure (e.g., large diameter pipes and wastewater treatment plants) and draw on synergistic benefits from other MSD projects (e.g., the “Big Four” SSO projects). Furthermore, project budgets include an enhanced site restoration allowance to fund localized opportunities to reduce historical overflow impacts on aquatic and riparian environments near the sites of overflow abatement projects.

Driven by the values-based benefit-cost analysis, the IOAP reflects a balanced mix of green and gray solutions to prevent and control sewer overflows. “Green” solutions include options such as green roofs, rain gardens, rain barrels, porous pavement, and bioretention, while “gray” solutions include options such as storage, treatment, conveyance/transport, and sewer separation. As a guiding principle, MSD's IOAP has been developed based on front-end consideration of source control and green infrastructure. This means that more traditional “gray” infrastructure in the IOAP has been sized after considering both (1) the anticipated flow-reduction benefits of programmatic and site-specific green infrastructure solutions and (2) the anticipated effectiveness of other source control approaches, including reduction of private sources of I/I. Green solutions in the IOAP will be implemented as soon as possible, to allow data to be gathered on the flow reduction benefits that occur. Prior to the final design of supporting gray solutions, the actual flow reduction performance will be documented and compared against the estimated targets. The final sizing of the gray solutions will then be based on actual documented performance of green solutions, as well as any further green and source control investments justified by performance information. Green infrastructure investments are estimated to reduce the initial costs of CSO gray infrastructure projects by $40 million; potential future savings could double or triple this figure.

As defined in the IOAP, the 19 gray infrastructure projects to control CSOs include:

- 4 sewer separation projects;
- 13 storage basin projects (This includes in-line and off-line storage; most in-line storage projects have a Real-Time Control component.);
- Replacement and expansion of the Nightingale Sanitary Pump Station; and
- 1 high-rate wet weather treatment project (screening, settling, and disinfection).

The 46 gray infrastructure projects to control SSOs in the IOAP include:

- 15 conveyance capacity upgrades and interceptor relief projects;
- 19 storage projects (in-line and off-line storage, many with pipe upgrades also);
- 1 sewer replacement project for Beechwood Village (one of the —Big 4 SSOs”); and
- 11 pump station and wastewater treatment plant upgrades, eliminations, or replacements. These projects include expanding the wet weather capacity of the Derek R. Guthrie Water Quality Treatment Center, elimination of 5 small wastewater treatment plants in the Prospect area, and potentially the elimination of the Jeffersontown Wastewater Treatment Plant.

The IOAP includes both an annual green infrastructure program and an initial set of green infrastructure demonstration projects. The green infrastructure program is front-end loaded to maximize benefits on downsizing future gray infrastructure. For example, the IOAP project schedule calls for a $40 million investment in green infrastructure programs and projects during the first six years. Programmatic green infrastructure components in the IOAP include a downspout disconnect program, green roof construction subsidies or incentives, green roads and alleys partnership incentives, and pervious pavement sidewalks and parking. MSD has based the proposed incentives and subsidies on a —business case” analysis of the financial benefit of green infrastructure in terms of costs per gallon of flow removed from the combined sewer system. Through the anticipated green infrastructure partnership, incentive, and education programs, MSD's initial $40 million investment in green infrastructure has the potential to leverage $60 million more from other private and public funding sources, thereby yielding up to $100 million in green infrastructure projects.

MSD plans to construct a series of new green infrastructure demonstration projects across Jefferson County. The proposed green infrastructure projects in the combined sewer area will be part of MSD’s IOAP, while the proposed green infrastructure projects outside the combined sewer area will be a part of the community’s MS4 stormwater program. These demonstration projects are designed to achieve three main objectives: (1) improve water quality and reduce sewer overflows, (2) provide data on green infrastructure effectiveness, and (3) educate community members about the value and benefits of green infrastructure. All green infrastructure demonstration projects in the IOAP will incorporate a monitoring component, so that the effectiveness of the projects can be tracked over time and regularly reported to regulators and the public. MSD will then use these monitoring results to guide future IOAP implementation, under the IOAP’s adaptive management plan (further described below).

This vision currently reflects a minimum commitment to 18 green infrastructure demonstration projects in the IOAP. These proposed new green infrastructure demonstration projects (which are subject to partnership and regulatory approval) include:

- 6 bioswale and biofiltration projects (e.g., green parking lots and green streets);
- 4 rain gardens;
- 3 pervious concrete alleys; and
- 5 infiltration dry wells.

MSD plans to expand and enhance this proposed suite of demonstration projects in response to feedback from WWT members that the initial projects might not be sufficient to achieve the objective of educating the public and building support for green infrastructure. In particular, MSD will look to enhance the distribution of demonstration projects in Jefferson County (including considering green infrastructure projects in each Metro Council District) and the numbers of individual project types.

MSD's technical team has analyzed potential options to control private sources of I/I into the sanitary sewer system, including building laterals, downspouts, sump pumps, and foundation drains. This analysis indicates that private-side I/I control is an essential part of the IOAP, and it will reduce the overall anticipated costs of overflow abatement. The technical team has analyzed options for adopting a requirement for inspections of private properties (e.g., during the property transfer process, when building permits are issued, when contractors install roof and gutter systems, when plumbers connect sump pumps, and/or at other times), along with providing some form of cost share and conducting an aggressive education campaign. MSD will work with Metro Government to support further development and adoption of an ordinance supporting these requirements. Although I&I reduction is particularly relevant to SSO control (since the sanitary sewer system was not designed to accept inflow), it may be useful to have similar requirements for the combined sewer system.

Public Information, Education, and Involvement Program

Education and public involvement are critical to the long-term implementation success of the IOAP. MSD uses the term ―Project WIN" (Waterway Improvements Now) to describe its consent decree response activities to the public. The ongoing public information, education, and involvement program for Project WIN is designed to accomplish the following objectives:

1. Generate a sense of personal ownership and responsibility for clean water;
2. Promote and sustain participation in critical voluntary programs in the IOAP, including private-side I&I control and green infrastructure;
3. Promote public acceptance and support for the financial investments required to achieve consent decree and Clean Water Act compliance; and
4. Encourage support for other agency programs or legislation that supports overflow abatement efforts.

To achieve these objectives, the Project WIN education and public involvement program uses a wide range of communication media. In particular, the program includes the following elements:

- Public meetings and community events;
- Enhanced web portal for Project WIN;
- Speaker's bureau and technical support;
- Print and electronic media (e.g., print advertisements, press releases, targeted brochures and pamphlets, reports, newsletters, billing inserts, public TV video, radio announcements, etc.);
- Recognition programs;
- Demonstration projects;
- Tours, demonstrations, and workshops;
- Enhanced school partnerships; and
- Annual effectiveness monitoring through direct mail and phone surveys.

These public involvement efforts are focused on several key audiences, including the general public, schools and children, and target groups such as property owners, project neighborhoods, builders, and restaurants. Focusing education efforts on children is important to ensure the long-term sustainability of voluntary programs in the IOAP. For the general public, MSD is using five key messages:

1. Value clean water.
2. Your investment is paying dividends, and our water is getting cleaner.
3. Protecting public health is critically important.

4. MSD and many community partners are working hard to improve water quality.
5. You can make a difference in improving water quality.

Post-Construction Compliance Monitoring

MSD's IOAP will use an adaptive management implementation approach based on monitoring and evaluation efforts. MSD's post-construction compliance monitoring and evaluation plan for the IOAP includes: (a) water quality monitoring, (b) sewer flow monitoring, (c) overflow events analysis, (d) gray and green infrastructure project performance monitoring, and (e) measurement of the effectiveness of source control and behavior-change efforts. MSD will prepare both required regulatory and public education reports from these data and adapt the CSO management and SSO elimination approaches based on the monitoring and evaluation results. Adjustments may include recalibrating models, "right-sizing" gray solutions, reevaluating the effectiveness of green solutions, and adjusting the types and characteristics of projects planned for later phases of implementation, including additional investments in green infrastructure and source control beyond those proposed in the initial program. At this time there is recognition that historical weather trends may not be as reliable as in the past due to potential changes in the climate. The IOAP's adaptive management approach will allow MSD to monitor evolving weather pattern developments and adjust its plans as more data become available.

Future Development Considerations

Solutions in the IOAP consider future development based on the community's long-term land-use plan, Cornerstone 2020.[3] IOAP solutions are designed to accommodate the anticipated impacts of population growth and land-use development in that the solutions consider the effects of growth on connections to existing infrastructure that is upstream from existing overflow points. The IOAP is not, however, intended to provide capacity for all future growth predicted by Cornerstone 2020. Cases where the growth outlined in Cornerstone 2020 would logically be provided by new infrastructure, and not hydraulically dependent on or connected to the IOAP solution, have not been considered part of the IOAP. In summary, the solutions in the IOAP have been designed and sized to account for the impacts of anticipated growth on existing infrastructure, but the IOAP itself is not intended to build the capacity needed for growth.

MSD's Capacity, Management, Operations, and Maintenance (CMOM) Program, which is part of MSD's Consent Decree response but separate from the IOAP, includes standard operations and maintenance activities practices designed to, among other things, investigate capacity-constrained areas of the sewer system. The CMOM program also includes a System Capacity Assurance Program focused on providing capacity for current and future service needs.

Continued development in the community will require MSD to implement measures to reduce wet-weather flows. MSD will use a three-to-one offset of wet-weather flows from new development. This means that existing flows entering MSD's sanitary sewer systems will be reduced at a ratio of three gallons for every new gallon added. MSD's flow reduction efforts will be designed to correct deficiencies in the existing sewer system in the same geographic areas (sewersheds) of the system affected by the flows from new development. MSD will track flow reduction "credits" to ensure that the flow reductions occur in the appropriate geographic locations to offset the new flows. (This three-to-one offset approach is based on the City of Knoxville's Capacity Assurance Program.) The MSD Board will develop the fee structure for the offset plan.

[3] For more information about the Cornerstone 2020 plan, see www.louisvilleky.gov/PlanningDesign/Cornerstone+2020.htm.

Funding Plan

The funding plan for the IOAP is designed to cover the 15-year period over which IOAP capital projects will be constructed to improve MSD's sewer infrastructure to meet the requirements of the consent decree. The IOAP funding plan is based on the following three principles:

- Rates and fees for the IOAP must pay MSD's operating costs and debt service.
- MSD's current bond rating (AA) should, at a minimum, be maintained.
- Rates and fees should allow for continued economic development in the community and a strong local economy.

These principles for the funding plan affect the amount of money MSD may borrow at any one time and the level of increases in rates and fees needed to fund capital and operating expenses for IOAP implementation.

MSD will fund the IOAP primarily through a combination of annual rate increases and bond issues or other loans. MSD also plans to pursue grants, line-item appropriations, and public/private partnerships (e.g., recapture agreements) to help pay for capital construction costs, as appropriate; however, the funding plan is not built around these funding sources since they are less certain. Using the estimate that the consent decree will cost $843 million in capital expenditures, average bills for residential customers are expected to increase from 5 to 6.5 percent annually through 2021. This means that the average residential bill would increase from $29.58 in 2008 to approximately $63.12 by 2024 due to the consent decree capital construction expenses. Along with these rate increases, MSD expects to borrow approximately $1.25 billion by 2024 based on the estimates of capital costs; this would increase MSD's debt service payments from $94 million annually to $163 million annually by 2025.[4] A mixture of fixed and variable rate borrowings is anticipated. These rate increases and loans would be used to address both IOAP construction costs and other MSD capital needs for infrastructure renewal, replacement, and expansion.

Estimates of IOAP costs appear to be within community tolerance for rate increases; however, the rate increases could nevertheless be difficult for some segments of the population to afford, especially in the context of other expenses. For this reason, the Wet Weather Team has considered potential ways to provide discounts to customers that face financial hardship. In the IOAP funding plan, MSD proposes a few changes to MSD's existing rate structure for the Board to consider. These changes are designed to accomplish two objectives: (1) provide discounts for low-income populations and (2) ensure steady and predictable revenue flows overall. The specific rate structure changes currently under study and reflected in the IOAP funding plan include the following:

- Residential customer billing based on winter consumption;
- Potentially billing customers on a monthly basis (in coordination with the Louisville Water Company).
- Expansion of the senior citizens discount program.

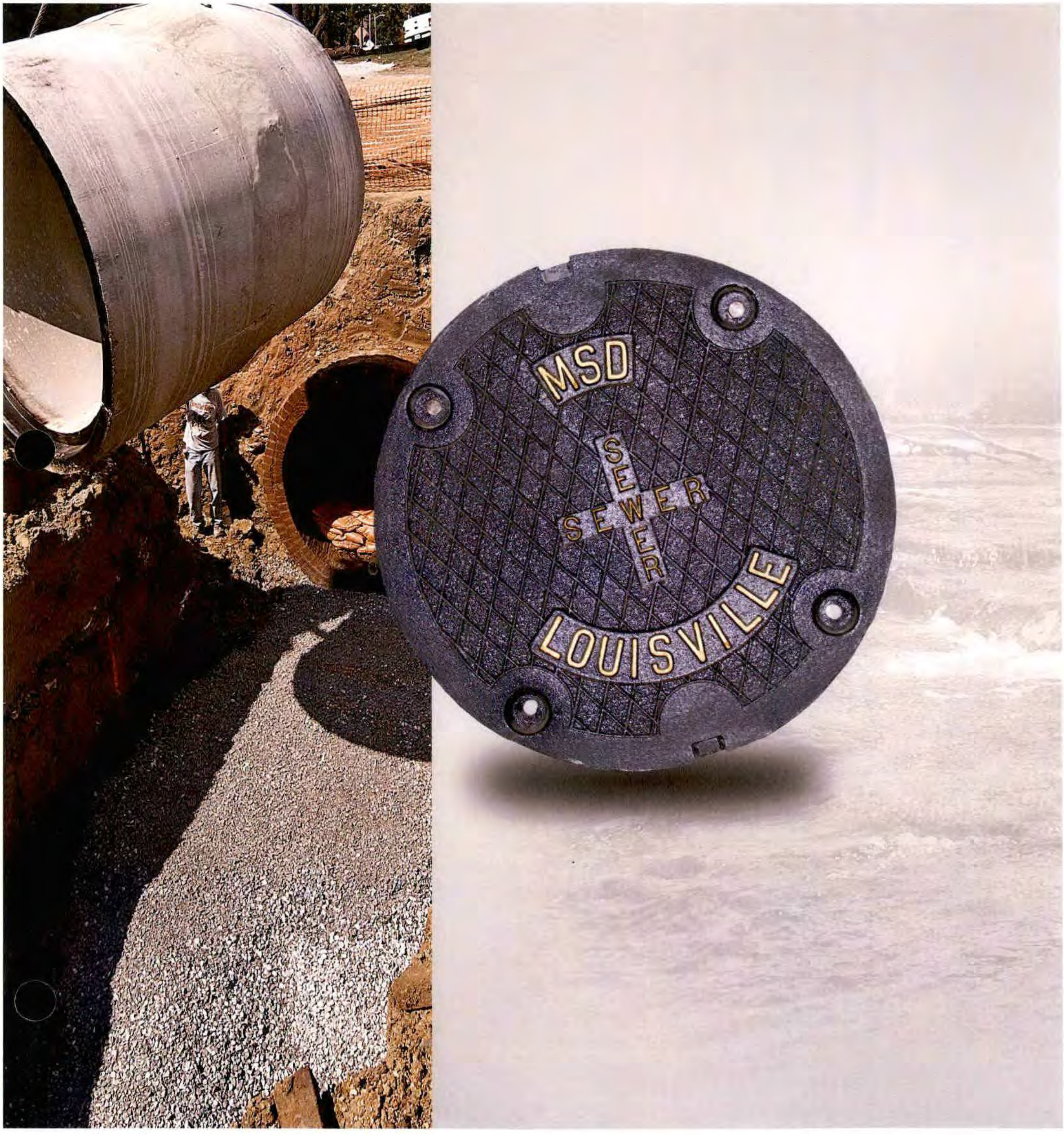
As noted above, MSD will construct the capital projects in the IOAP over a 15-year period, in order to meet the regulatory requirements of the consent decree and achieve compliance with the Clean Water Act. Many of the elements of the IOAP—including the Project WIN education program, operations and maintenance of IOAP projects, and monitoring and evaluation programs—will also continue past the construction phase of the IOAP. MSD is committed to making sure that the IOAP programs and projects provide for long-term improvements in water quality in Louisville and Jefferson County.

---

[4] This estimate assumes that interest rates are in the 5 to 6 percent range.

Executive Summary

Attachment 3



MEMORANDUM

TO: Louisville and Jefferson County Metropolitan Sewer District Board

FROM: Stakeholder Members of the Wet Weather Team

DATE: January 30, 2013

SUBJECT: Draft Integrated Overflow Abatement Plan 2012 Modifications

---

As stakeholder members of MSD's Wet Weather Team (WWT), we wish to indicate our support for the Final Integrated Overflow Abatement Plan (IOAP) 2012 Modifications as MSD transmits the plan modifications to the U.S. Environmental Protection Agency (EPA) and the Kentucky Environmental and Public Protection Cabinet. The attached documents, "Vision for MSD's Integrated Overflow Abatement Plan," and "2012 IOAP Project Modifications" summarize the Wet Weather Team's common understanding of the high-level architecture and components of the IOAP and the proposed 2012 Modification. As stakeholder members of the WWT, we played an active role in developing the IOAP Vision and are pleased to see that the principles of this Vision have been retained in the 2012 Modification. Our support for the IOAP and the 2012 Modification is based on the expectation that the complete plan is fully reflective of and consistent with the IOAP Vision and the 2012 IOAP Project Modifications documents attached. We support this vision for improving wet weather sewer overflow management in our community. In this memorandum, we review the composition and charge of the Wet Weather Team, describe the results of the stakeholder subgroup's deliberations, and outline our support for the IOAP.

Wet Weather Team Composition and Charge

The WWT consists of community representatives, elected officials, MSD personnel, and technical consultants. The stakeholders on the WWT include individuals recognized as community opinion leaders associated with environmental advocacy, business and industry, elected officials, local government, community neighborhood, recreation, public health, environmental justice, and organized labor interests. WWT stakeholders have not formally represented their specific affiliated organizations as part of the team, but rather have provided input reflective of the broad interest areas in which they lead.

MSD chartered the stakeholder subgroup of the WWT to "provide guidance on the development of an integrated Wet Weather Program that will comply with applicable regulatory requirements and will minimize the impacts of wet weather discharges on water quality, aquatic biota, and human health." Through MSD's consent decree with EPA and the Kentucky Environmental and Public Protection Cabinet, the WWT was charged with two primary tasks: (1) preparing a plan for funding MSD's overflow abatement program and (2) developing a program for public information, education, and involvement. In addition to these tasks, MSD sought guidance from WWT stakeholders on MSD's overall investment, policy, and performance choices in the development of the IOAP.

Results of the Wet Weather Team's Deliberations

The WWT met 22 times from July 2006 through December 2008 and provided input on all major components of the IOAP, as well as the analytic framework and the public involvement process MSD used to develop the IOAP. The WWT also met to review the public comments submitted on the Draft

IOAP and discuss the changes proposed for the Final IOAP. There are four areas of the WWT stakeholder subgroup's deliberations that we would like to highlight, as follows.

1. Development of the Analytic Framework: The WWT stakeholders, along with other WWT members, identified and agreed upon a set of community values to use in the development of MSD's IOAP. We also advised MSD's technical team on a performance evaluation framework for using those values to evaluate project alternatives for MSD's IOAP. The performance evaluation framework includes both a benefit-cost scoring methodology for selecting the best alternatives at the project level and a systematic process for considering values that relate to the program as a whole. (This analytic framework is further described in the attached Vision.) We believe that this analytic framework is rigorous, transparent, and replicable, and that it provides an effective way to understand and balance tradeoffs among potentially conflicting community interests.

2. Application of the Analytic Framework: The WWT stakeholder subgroup has reviewed examples of how MSD's technical team has used the values-based performance evaluation framework to evaluate project alternatives to address combined sewer overflow (CSO) and sanitary sewer overflow (SSO) problems in our community. Moreover, we have also reviewed and provided input on how the technical team has evaluated the IOAP according to the WWT's programmatic community values—customer satisfaction, economic vitality, education, environmental justice and equity, financial equity, and financial stewardship. We believe that the analytic framework has been applied consistent with the WWT's expectations in the development of the IOAP and has produced a robust, replicable, and transparent analysis.

3. IOAP Vision: We helped develop the attached "Vision for MSD's Integrated Overflow Abatement Plan" along with the MSD personnel and technical consultants who are on the Wet Weather Team. The IOAP Vision summarizes the WWT's common understanding of the high-level architecture and components of the IOAP, and it documents the WWT's consensus about several crucial aspects of the IOAP. The Vision outlines and provides highlights of the expected water quality benefits of the IOAP; the levels of control for CSOs and SSOs in our community; the range of control options in the IOAP; the analytic framework and process used to select control options; the public information, education, and involvement program (known as "Project WIN"); the monitoring, evaluation, and adaptive management plan; future development considerations relevant to the IOAP; and the IOAP funding plan. As stakeholder members of the WWT, we support this vision for improving wet weather sewer overflow management in our community.

4. Summary of IOAP Projects: We believe the project mix and outcomes that form the backbone of the IOAP (as captured in the attached IOAP Vision) reflect responsiveness to MSD's consent decree and provide for a critical, first increment of water quality improvement for our community, while ensuring wise and effective use of our community's resources. The IOAP Vision draws on front end consideration of and investment in green infrastructure and other source control approaches, including "private side" inflow and infiltration (I&I) control. These early investments will act to test and demonstrate the effectiveness of these approaches, creating the prospect, based on demonstrated performance, for expanding their role and lowering community costs as MSD implements the IOAP. We understand that MSD, consistent with the Post-Construction Compliance Monitoring Plan, will closely monitor and report on the efforts for both regulatory and public education purposes. We further understand that MSD, over the coming months, will work with community members to further articulate and enhance the scope

and scale of its IOAP public education and outreach program, including developing a robust approach for measuring the effectiveness of the program.

After IOAP approval in September 2009, the WWT Stakeholder Group continued to meet twice per year for progress reports and updates. When the need for the 2012 IOAP Modifications became apparent, MSD invited the original members of the WWT Stakeholder Group to continue to serve as a sounding board, ensuring the modifications to the plan and specific project designs remain true to values, priorities and financial plan that was originally developed. Most of the original members chose to continue their active participation in the process.

As MSD moves forward in coming years with IOAP implementation, we do anticipate the program will face, as all programs of this type do, project-specific challenges related to local community understanding and acceptance. In this context, we understand MSD is committed to using focused and sustained neighborhood education and outreach efforts to support project-specific and overall program implementation and will strive to address localized needs consistent with overall IOAP requirements. At the same time, we believe all localities throughout the MSD system must keep in mind that individual IOAP project locations and types have emerged from a rigorous and consistently applied technical analysis that has been continued through the 2012 IOAP Modifications. The IOAP projects exist as critical building blocks for an overall community program framed by federal and state regulatory requirements, community water quality and public health improvement objectives, and overall rate payer capacity.

The stakeholder subgroup of the WWT appreciates the opportunity to have contributed to MSD's IOAP development efforts. During our meeting on December 4, 2008, we discussed the importance of an overarching, sustained community water quality education initiative directed at enhancing appreciation for water quality improvements and building understanding of the actions all members of the community can take to improve water quality. We understand this effort is substantially broader in scope than the CSO and SSO improvements addressed by the IOAP, but we believe it is important to take this opportunity to raise awareness for this need, particularly as our community turns its attention to stormwater management in the context of the multi-jurisdictional Municipal Separate Storm Sewer System (MS4) permit. We appreciate MSD's willingness to be a contributor to such an effort, even as we recognize the need for broader involvement and leadership throughout the Louisville community and across Louisville Metro Government.

We look forward to the MSD Board's review of the 2012 IOAP Modifications and MSD's submittal of the 2012 IOAP Modifications to EPA and the State of Kentucky. Thank you for the opportunity to contribute to this critical community improvement initiative. Please feel free to contact us individually or collectively with any questions or perspectives you may have.

Unanimously Adopted at the January 30, 2013 WWT Meeting
Stakeholder Members of the Wet Weather Team

Member	Organization*
Steve Barger	Labor (retired)
Susan Barto	Mayor of Lyndon
Stuart Benson	Louisville Metro Council, District 20
Jim Mims	Louisville Metro Planning & Design Services
Allan Dittmer	University of Louisville
Arnita Gadson	Kentucky Environmental Quality Commission
Mike Heitz	Louisville Metro Parks Department
Tom Herman	Zeon Chemicals
Rick Johnstone	Deputy Mayor, Louisville Metro Mayor's Office (retired)
Bob Marrett	CMB Development Company, LLC
Kurt Mason	Jefferson County Soil and Water Conservation District
Lisa Santos	Irish Hill Neighborhood Association
Bruce Scott	Kentucky Waterways Alliance
David Tollerud	University of Louisville, School of Public Health and Information Sciences
Tina Ward-Pugh	Louisville Metro Council, District 9
David Wicks	Jefferson County Public Schools (retired)

*Stakeholders on the Wet Weather Team do not formally represent their specific affiliated organizations, but rather seek to provide input reflective of the broad interest areas in which they lead. Along with the stakeholder subgroup, the Wet Weather Team includes MSD personnel and technical consultants.

Chapter 1

CHAPTER 1: INTRODUCTION

Special Note: This chapter was developed in 2008. The statistical data for the CSO's reported, specifically related to individual CSO volumes and frequency in a typical rainfall year, were derived from the CSS model calibrated in 2007. Since then, a more detailed calibration and validation effort has adjusted the average annual overflow volumes and frequencies in the typical year. This information is provided in Chapter 5. The vast majority of the physical system characterization in this chapter is still accurate.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

The Louisville and Jefferson County Metropolitan Sewer District (MSD) owns, operates and maintains the wastewater and stormwater facilities servicing approximately 700,000 residents of the Louisville Metro area. Facilities include six regional and 15 small water quality treatment centers (WQTC), approximately 300 pump stations, and over 3,200 miles of sanitary sewers. The 385 square mile service area managed by MSD includes Louisville Metro and extends into portions of Oldham County. Geographically, the MSD service area includes 11 watersheds, all of which are part of the Ohio River Watershed. MSD also owns, operates and maintains the Ohio River Flood Protection System that includes 16 flood pump stations and 29 miles of floodwall or levee.

Over the last 150 years, MSD's sewer system has extended into a network of both sanitary and combined sewers, diversion structures, and other flow control devices. In the combined sewer system (CSS), dry weather flows are conveyed to the Morris Forman WQTC for treatment prior to discharge into the Ohio River. During wet weather events, when the total combined sewage flow exceed the capacity of the sewer, a mixture of sewage and stormwater runoff is discharged to the South Fork of Beargrass Creek, Middle Fork of Beargrass Creek, Muddy Fork of Beargrass Creek, and the Ohio River. The CSS service area is approximately one-third of the Morris Forman WQTC service area and encompasses approximately 37 square miles of area. Presently there are 102 active combined sewer overflows (CSO) within the MSD area.

To address the wet weather overflows, MSD initiated a CSO abatement program in 1991 dedicated to developing a comprehensive understanding of the CSS and an approach to reducing CSOs. MSD continues to enhance and expand the resources and a significant amount of work has been conducted including: characterization of the system, development of hydraulic computer models, compliance with the U.S. Environmental Protection Agency's (EPA) Nine Minimum Controls (NMC), and implementation of various CSO Long-Term Control Plan (LTCP) elements. Figure 1.1.1 at the end of this chapter shows the CSO abatement program accomplishment timeline. The figure illustrates most of MSD's major activities over the last 15 years that have provided a foundation for the development of this Final CSO LTCP.

MSD's initial efforts at CSO abatement occurred before the EPA issued the final CSO Control Policy in 1994. MSD performed model development and flow monitoring during the early 1990s to help better understand how the CSS functioned during periods of wet weather. In addition, MSD investigated preliminary CSO controls by evaluating potential CSS best management practices (BMP). The implementation of BMPs and NMCs during the mid to late 1990s, provided additional reductions in the frequency of occurrence and volume of CSO discharges, at relatively low capital cost.

From 1998 to 2012, MSD devoted additional resources to more capital-intensive projects such as Real Time Control (RTC), pump station improvements, sewer separation, construction of storage basins, solids and floatables (S&F) removal facilities, and the elimination of several CSOs. Completion of these projects demonstrates the significant impact MSD's CSO initiative of the 1990s has had on the overall progress of the CSO Abatement Program and poises MSD for successful completion of the Final CSO LTCP.

On August 12, 2005, MSD entered into a Consent Decree in Federal Court with the EPA and the Kentucky Environmental and Public Protection Cabinet. The Consent Decree was developed in response to an enforcement action taken by EPA and Kentucky Department of Environmental Protection (KDEP) alleging violations of the Clean Water Act (CWA) primarily related to sewer overflows. One of the requirements of the Consent Decree is the development and submittal of a CSO LTCP.

On December 1, 2008, a draft Amended Consent Decree (ACD) was released for public comment. The draft ACD addressed alleged violations of the CWA primarily related to WQTC performance, record-keeping, and reporting. Public comment closed on the draft ACD on December 31, 2008. The ACD was entered into Federal Court on April 15, 2009.

The Consent Decree amendments were negotiated over several months, and the terms of the draft amendments were known to MSD during the final stages of development of this Integrated Overflow Abatement Plan (IOAP). For the purposes of the IOAP, except where specifically noted otherwise, the term "Consent Decree" will be understood to mean the ACD as it was entered into Federal Court on April 15, 2009.

A significant undertaking that has become the foundation of the current CSO LTCP is the RTC Program. The objective of this ongoing program is to maximize the existing in-line storage capacity of large conduits for cost-effective reduction of CSOs within both the Beargrass Creek and Ohio River basins. The RTC Program is an application of advanced technology which uses available meteorological data and sewer capacity information monitored over the sewer network, and predicted by the Radar Rainfall Data System, to determine the best flow management strategy.

Along with the RTC Program, MSD has implemented other CSO controls, including demonstration programs, to establish the applicability and effectiveness of various CSO technologies. Additional details and an expanded listing of projects are presented in Section 1.6.1.

Design and installation for CSO controls has been completed, and facilities are in operation for the following:

- Established a voluntary plumbing modification program to develop public support for removal of downspouts, sump pumps, etc.
- Installed screens, baffles, and bar racks to capture S&F at individual CSOs.

- Installed an inflatable dam within the Sneads Branch Relief sewer, an 11-foot diameter semi-elliptical drain that recaptures CSS flows from eleven CSOs and pumps the flow back into the sewer for treatment at Morris Forman WQTC.
- Installed a combination of inflatable dams and control gates in the Southwestern Outfall sewer that provides retention of wet weather flows in the system from a large portion (about 7,500 acres) of the CSS in southwestern Louisville Metro.
- Separated combined sewers in several CSO drainage basins, to eliminate CSOs.
- Installed two earthen storage basins for both CSO and surface flooding control with a combined storage volume of 33 million gallons (MG) on the grounds of the Kentucky Fair and Exposition Center.
- Installed three million gallons per day (mgd) screening devices at two CSO locations and a 32 mgd Continuous Deflection Separator (CDS) at one CSO location to screen the CSO discharge.
- Reconstructed a 140 mgd CSO pump station, reducing CSO volume by 70 MG per year.
- Modified flood control protocols for the Ohio River Flood Protection System Infrastructure to reduce CSOs.
- Installed thousands of backwater valves on residential laterals to prevent basement backups.
- Additional activities from 2009 through 2012 within the CSS are described in MSD Quarterly and Annual Reports posted on the Project WIN website at http://msdprojectwin.org/Library.aspx.

Two other key, long-standing, planning projects that have been active for several years and critical to MSD's CSO LTCP planning process for 2008 include the Ohio River Sanitation Commission (ORSANCO) water quality study and the Beargrass Creek Total Maximum Daily Load (TMDL) project. The ORSANCO water quality study includes a preliminary analysis of the bacterial impacts of CSO on the Ohio River and the Beargrass Creek TMDL project uses the Water Quality Tool (WQT) to determine TMDL allocations for bacteria. Both of these projects play important roles in the development of the Final CSO LTCP.

MSD completed and submitted a draft CSO LTCP for the Beargrass Creek area in 1996 and a draft CSO LTCP for the Ohio River area in 1997. Both plans were required by the EPA CSO Guidance Policy of April 1994. These plans presented the current plan to address CSOs within the MSD service area. Upon submittal of these plans, MSD appropriately began initiating implementation of the CSO LTCP.

This document is the Final CSO LTCP, which is a major modification of the 1996 and 1997 draft LTCPs and an expansion of the Interim LTCP submitted in September 2006. As its name implies, the Final CSO LTCP defines the long-term objectives of MSD's CSO control objectives, the analyses undertaken to arrive at the appropriate CSO control solution, a detailed description of the various measures recommended for implementation, and a schedule of implementation based on MSD's financial capability and water quality compliance needs.

1.2 HISTORY OF CSO CONTROL POLICY

The CSO Control Policy published by EPA on April 19, 1994, provided guidance to permittees with CSOs, National Pollutant Discharge Elimination System (NPDES) authorities and State water quality standards authorities on coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA. The policy contains provisions for developing appropriate, site-specific NPDES permit requirements for all CSS that overflow due to wet weather events and allows for public involvement during the decision-making process.

Four key principles of the policy ensure that CSO controls are cost effective and meet the requirements of the CWA. These principles are as follows:

- Provide clear levels of control that would meet appropriate health and environmental objectives.
- Provide sufficient flexibility to municipalities, especially financially disadvantaged communities, to consider the site specific nature of CSOs and to determine the most cost-effective means of reducing pollutants and meeting CWA objectives and requirements.
- Allow a phased approach for implementation of CSO controls considering a community's financial capability.
- Review and revise, as appropriate, water quality standards and their implementation procedures when developing CSO control plans to reflect the site-specific wet weather impacts of CSOs.

The CSO Control Policy became law in December 2000 and establishes two main objectives for permittees: implementation of the NMCs, and the development and implementation of a CSO LTCP. A separate report entitled "NMC Compliance Report" details the implementation and status of the NMCs and was originally submitted by MSD to the regulatory authorities in February 2006 and ultimately approved in 2007.

The CSO Control Policy directs the permittee to develop and implement a LTCP based on system characterization, water quality and quality monitoring, and stream and sewer system modeling of the CSS. To develop a comprehensive plan, the LTCP should consider the site-specific nature of CSOs and utilize a public participation process involving stakeholders such as the ratepayers, industrial users, persons residing downstream of CSOs, and other interested parties. The CSO Policy also requires that the plan give highest priority to controlling overflows in sensitive areas.

A major part of the LTCP is the CSO alternatives. To develop and evaluate the alternatives, MSD conducted a review of the current and proposed water quality standards to define the levels of pollutant load reductions that are required to meet water quality standards, and thus set the performance expectations for the CSO controls.

General indications of past water quality studies throughout the United States show that CSOs are only one of several sources that can significantly affect the pollutant concentrations in the receiving waters. Control of CSOs alone may not be sufficient to achieve the standards or restore the water bodies to their designated uses. Various wet weather source discharges also exist within the MSD service area. Under the Continual Planning Process in the CWA, an appropriate approach for dealing with these complex combinations of pollutant sources is to evaluate the effectiveness of controls and, from time-to-time, the appropriateness of the water quality standards.

As MSD implements CSO controls and conducts post-construction compliance monitoring of the Final CSO LTCP, review and revision of the water quality standards may be appropriate as indicated by the EPA 2001 Guidance: “Coordinating CSO Long-Term Planning with Water Quality Standards Reviews” (EPA-833-R-01-002). ORSANCO also adopted a provision in its water quality standards for the Ohio River allowing for development and application of alternative criteria if CSO communities have submitted a LTCP and a Use Attainability Analysis (UAA) (ORSANCO, 2006). Therefore, the intent of MSD is to implement the controls recommended in the updated LTCP and then evaluate whether developments of a UAA or additional CSO or other pollutant source controls are warranted.

1.3 KEY ELEMENTS OF CSO CONTROL POLICY

EPA developed guidance documents to assist agencies in preparing CSO LTCPs in compliance with the CSO Policy. MSD’s Consent Decree requirements generally follow existing EPA guidance, with the inclusion of additional requirements to address specific MSD issues, such as overflows from the flood pump stations. The Consent Decree specifies that MSD’s LTCP shall achieve the following three goals:

- Ensure that if CSOs occur, it is only as a result of wet weather (this goal shall include addressing those discharges resulting from MSD’s compliance with the requirements of the United States Army Corps of Engineers’ {USACE} “Ohio River Flood Protection System Pumping Operations Manual,” dated 1954 and revised 1988).
- Bring wet weather CSO discharge points into compliance with the technology-based and water quality-based requirements of the CWA; and,
- Minimize the impacts of CSOs on water quality, aquatic biota, and human health.

Additionally, as specified by the Consent Decree, the MSD Final CSO LTCP shall include, at a minimum, the following elements:

- The results of characterization, monitoring, modeling activities, and design parameters as the basis for selection and design of effective CSO controls (including control to address those discharges resulting from MSD's compliance with the requirements of the USACE's "Ohio River Flood Protection System Operations Manual," dated 1954 and revised 1988.
- The results of an evaluation of WQTC peak flow treatment capacity for any WQTC, other than Morris Forman WQTC, that will receive additional flow based on the MSD LTCP project. Such evaluation shall be consistent with the EPA publications "Improving POTW Performance Using the Composite Correction Approach," (EPA CERI, October 1984), and "Retrofitting POTWs," (EPA CERI, July 1989).
- A report on the public participation process.
- Description of how the MSD Final CSO LTCP addresses sensitive areas as the highest priority for controlling overflows.
- A report on the cost analyses of the alternatives considered.
- Operational plan revisions to include agreed-upon long-term CSO controls.
- Maximization of treatment and evaluation of treatment capacity at Morris Forman WQTC.
- Identification of and an implementation schedule for the selected CSO controls.
- A post-construction compliance monitoring program adequate to verify compliance with water quality-based CWA requirements and ascertain the effectiveness of CSO controls.

1.4 GUIDANCE TO SUPPORT IMPLEMENTATION OF THE CSO CONTROL POLICY

Implementation of the Consent Decree program and both the CSO LTCP and the Sanitary Sewer Discharge Plan (SSDP), will continue for many years. Recognizing the need for consistent, long-term direction for the Consent Decree, along with planning, coordination, and reporting activities, MSD initiated Project WIN (Waterway Improvements Now). As presented in Volume 1, Project WIN's mission is to provide oversight and guidance of the activities required to comply with the terms and conditions of the Consent Decree. This requires initiating, organizing, coordinating and managing a diverse set of elements, programs, and projects to successfully discharge all Consent Decree obligations.

Project WIN's goals are as follows:

- Identify, design, and implement projects and programs that reduce CSO events and mitigate their impact to comply with the CWA and the CSO Policy.
- Identify, design, and implement projects and programs that eliminate unauthorized discharges in both the separate SSS and the CSS, providing the level of protection indicated by the selected design event.
- Select projects and programs that satisfy the Consent Decree requirements, and at the same time support and protect a broad spectrum of community values.
- Implement the projects and programs in a manner that will efficiently use MSD's available resources while creating benefits related to Louisville Metro's community values.

1.5 CSO LTCP DOCUMENT ORGANIZATION

As the second volume of the IOAP, the Final CSO LTCP focuses on the control and mitigation of CSOs. The LTCP outline as well as a brief description of each chapter is given below. The second volume of the IOAP focuses on the control and mitigation of the CSOs.

Chapter 1 Introduction

This chapter includes a history of MSD's control policy for CSOs and a summary of the policy's key elements. Also provided are general descriptions of the current CSO control efforts, control processes, and criteria for success. Sections outlining the public's participation and agency interactions specifically relative to the Final CSO LTCP are included.

Chapter 2 System Characterization

This chapter provides extensive analysis of CSO areas. Analysis includes existing baseline conditions of the CSO area, monitoring of CSO flows, CSO quality sampling, and combined modeling of the sewer system and receiving waters.

Chapter 3 Development and Evaluation of Alternatives for CSO Control

This chapter discusses the approach and factors used to identify, develop, evaluate, and select projects that make up the recommended projects and programs in the Final CSO LTCP.

Chapter 4 Selection of the Long-Term Control Plan

This chapter includes an explanation of the values-based risk management process used to select and prioritize the Final CSO LTCP alternatives. Issues discussed include community values, benefit/cost analysis, environmental impact, technical concerns, prioritization of projects, and implementation schedules compatible with the Consent Decree requirements.

Chapter 5 2012 Project Modifications

This chapter includes requested project modifications to the approved 2009 IOAP project suite resulting from the ongoing adaptive management strategy. The project modification approach centers around the utilization of monitoring data, improved modeling and a better operation understanding of MSD's sewer system. The full project suite related to the Final LTCP is defined including all proposed schedule and budget revisions.

1.6 LONG-TERM PLANNING APPROACH SUMMARY

1.6.1 Initial Activities

Since the development of MSD's initial LTCP, MSD has been implementing plan elements to reduce the pollutant load on receiving streams from CSOs. The following sections provide a summary of CSO LTCP Implementation accomplishments through December 2008.

1.6.1.1 January 1991 to December 1992

During 1991 and 1992, MSD's CSO program focused on characterization, monitoring, and modeling activities to assist in the selection and design of effective CSO controls. Specific activities included the inventorying of CSS assets and developing the tools required to move forward with the development of a CSO LTCP.

The accomplishments achieved during this period included:

- Maintenance Programs for CSS Assets: Development of a detailed inventory that determined the operational status of all assets.
- System Evaluated: Evaluation of CSS included pump stations, overflows and regulators.
- Flow Monitoring Program: Conducted a program to provide calibration data for the CSO Stormwater and Wastewater Management Model (SWMM) model and developed a SWMM model of the CSS.
- CSO and Stream Sampling Program: Executed a CSO and stream-sampling program to quantify the impact of CSOs on the receiving streams.
- CSO Nutrient Release Estimates: Estimated annual CSO nutrient release to quantify the impact of CSOs on the receiving streams.

- CSS Flooding Analysis: Performed a flooding analysis associated with the CSS focused on the Ohio River North and Ohio River West regions.
- Evaluated Impacts to CSS: Evaluated major stormwater impacts and industrial loadings to the CSS.
- Public Education Program Summary: Summarized MSD's public education program relative to the CSS.

1.6.1.2 July 1993 to November 1998

During this period, MSD continued to focus on the development and implementation of a long-term capital program for planning, design, and construction of new facilities and the improvement of existing facilities and systems to minimize the frequency and volume of CSS overflows.

MSD evaluated alternatives in its plan based on cost, performance in meeting the programmatic objectives, contribution toward attainment of water quality standards, and operational performance. The prioritized projects were incorporated into a rolling five-year Capital Improvement Program and budget. Specific program accomplishments from 1993 - 1998 relative to implementation of the LTCP are summarized below:

- LTCP for Beargrass Creek Region developed.
- LTCP for the Ohio River North and Ohio River West Regions developed.
- System Flow Monitoring and Sampling: Setup at selected CSO outfalls.
- Evaluated localized surface flooding issues: Evaluations at various locations throughout the CSS that were typically a result of limited inlet capacity.
- CDS Unit at CSO050 for S&F control: Constructed and installed a CDS which is a liquids-solids separation technology typically used for stormwater management. The facility began operations in February 1998 and is used for S&F control.
- Wheeler Avenue CSO/Flood Control Basin: Constructed the basin to provide flooding relief for the area and to reduce overflows at CSO015. The project was accomplished by constructing a 4.9 MG flood control basin, constructing a 553,000-gallon CSO Basin inside the flood control basin, providing 1.1 MG of storage in the 78-inch combined sewer, regulating the rate of flow to the Mill Creek Trunk and preventing the Mill Creek Trunk from backing up into the area. The conveyance pipe for Wheeler Avenue storage basin is operated as part of the RTC System. The RTC component of the Wheeler Avenue storage basin conveyance was completed in December 2008.

- Plumbing Modification Program: Implemented on a countywide basis. The Plumbing Modification Program was initially intended to provide protection to designated critical areas in the CSS experiencing chronic problems due to basement backups. A major accomplishment was the minimization of public health concerns resulting from the combined and sanitary sewer systems backing up into customer basements. The program resulted in the removal of downspouts directly connected to the CSS thereby reducing storm flow into the CSS. To-date over 8,100 backflow prevention devices have been installed. This program is currently being implemented on a priority area and evaluated need basis.

1.6.1.3 December 1998 to September 2009

During this period, MSD's CSO LTCP continued to focus on program development and implementation to achieve compliance with the CSO policy through the continued evolution and development of its LTCP efforts. Below is a summary of specific accomplishments during this period.

- CDS Unit: Installed a CDS Unit as a demonstration project for S&F control on CSO108. This liquids-solids separation technology had typically been applied to stormwater management. The CDS facility project became part of an EPA and National Sanitation Foundation International partnership with the Environmental Technology Verification Program and Water Quality Protection Center program to verify commercial-ready technologies that protect surface waters from contamination.
- Screenings Facility: Installed gross screenings facility at Beargrass Creek using two diversion booms and two trash baskets to collect S&F from the creek. This concept differed from other S&F control facilities because it screened the entire stream channel. The objective was to remove S&F within the stream channel, capture S&F originating from point and non-point sources, and create a more aesthetically pleasing environment suitable for recreation.
- Sewer Separation on CSO206, located in Cherokee Park: Evaluated, designed, and initiated construction for sewer separation on CSO206. The field investigation was completed during October 1999. Recommendations included a three-phased sewer separation project for the elimination of CSO206. Projects included reconnection of sanitary and storm sewers to their proper conveyance pipe, manhole remodeling, downspout disconnection, relining of sanitary sewers and relining of home services that run under the parallel storm sewers. Design of the sewer separation for the CSO206 area was initiated in 1999. The CSO206 Project was separated into 15 sub-areas, the design was completed, and construction began in 2000. Sub-areas 1 through 9 were completed by 2005 and remaining sub-areas will be completed by March 31, 2009.

- CSO211 In-line Storage Project: Constructed the CSO211 In-line Storage Project located at the main diversion structure. The goal of this project was to reduce overflow volume and maximize flows to the Morris Forman WQTC (up to the full Morris Forman WQTC capacity) from the Southern Outfall during wet weather. To provide treatment for the maximum flow possible, an inflatable gate was placed at the overflow from the main diversion structure. The gate provides the ability to raise the water level to provide sufficient head to provide the short duration peak 350 mgd flow rate to the Morris Forman WQTC. The gate reduces the annual overflow volume at CSO211. Operation of the gate will ultimately be incorporated into the RTC effort for achieving in-line storage of wastewater.
- Eliminated CSO209 through Sewer Separation: The 105-acre area served through CSO209 consists of approximately 350 residential properties. The system was separated and the CSO permanently closed in September 2005 following completion of the related downspout removal project.
- Constructed the Sneads Branch Relief In-line Storage Facility: The facility uses the Sneads Branch Relief Drain as a CSO storage facility via the operation of an inflatable rubber gate. The gate is located approximately 200 feet from the outlet of the Sneads Branch Relief Drain to the South Fork of Beargrass Creek channelized section. The storage capacity of this facility when the gate is fully inflated is approximately 2.5 MG. The facility is designed to capture flows from the eleven CSOs tributary to the Sneads Branch Relief Drain and pump the stored volume to the Beargrass Interceptor to be conveyed to the Robert J. Starkey Pumping Plant (formerly known as the Buchanan Street Pump Station) and then on to the Morris Forman WQTC for treatment. Cleaned the Northeastern Sanitary Trunk Sewer: Cleaning increases the sewer's carrying capacity and reduce overflows. The Northeastern Sanitary Trunk Sewer Cleaning project involved the removal of an estimated 15-inch of deposition within the 5.5-foot diameter Northeastern Sanitary Trunk Sewer. The cleaning restored full capacity to the Northeastern Sanitary Trunk Sewer and greatly increased usable storage volume for smaller, more frequent storm events.
- Expanded the Robert J. Starkey Pumping Plant: The expanded plant increased pumping capacity from 125 mgd to 140 mgd and reduced overflows at CSO020 and CSO062. Estimates show this project resulted in a reduction of approximately 70 mgd in the average annual overflow volume (AAOV). The upgraded pumping plant included a new wet well adjacent to the old wet well; four new variable speed, submersible pumps capable of handling 35 mgd each; two channel grinders with hydraulic motors for screening; hydraulically operated slide and sluice gates for control of flow through the pump station; a new electrical substation; new instrumentation and control, and included provisions for telemetry.
- Constructed the Upper Dry Run Trunk Storage Basins (Executive Inn and Brady Lake Basins): Basins provide flooding relief and reduce overflows at CSO015. The project included the construction of two earthen basins (17.3 MG and 15.3 MG) on the Kentucky Fair and Exposition Center property, and the construction of 1,922 linear feet of 60" diameter sewer. Both the Executive Inn Basin and the Brady Lake Basin are operated as part of the RTC System.

- Implemented Phase One of the RTC Program: The initial phase of RTC consisted of remotely controlling five sites by means of a centralized-decision-making system. The objectives for this program are a better use of the existing in-line storage capacity, a decrease of CSO volumes in the Beargrass Creek and Ohio River Watersheds, and an increase of the wastewater volume conveyed to the Morris Forman WQTC. The RTC approach is both global and predictive, which means that the decision making system will use available information monitored on the sewer network, and predicted by the Radar Rainfall Data System, to determine the best flow management strategy. The initial phase included the set up of a centralized decision making system, a radar rainfall data system to predict weather over a two-hour window, and remote control of five sites within the CSS. The initial five sites included Southeastern Diversion Structure, Nightingale Pump Station (CSO018), Southwestern Pump Station (CSO015), Upper Dry Run Trunk Storage Basins (CSO015), and Sneads Branch Relief In-line Storage Project.
- Developed Radar Rainfall Data System: The intent of the Radar Rainfall Data System project is two-fold: to calibrate Next-Generation Radar (NEXRAD) radar with rain gauge data, and to provide predictive rainfall data two hours in advance of rainfall. The information provided by the Radar Rainfall Data System is utilized by the RTC system in an effort to better utilize the in-line storage capacity of the existing CSS.
- Remediated the 11th Street and Rowan Street Connections: The project corrected improperly connected property service connections tied to the storm sewer system near the intersection of 11th Street and Rowan Street, and the sanitary services located at the 10th Street Flood Pump Station.
- Completed Riverside Area Sewer Reconnection Project: Separate storm and sanitary sewers were provided at the area west of the Beargrass Creek Pump Station, east of Second Street and inside the floodwall. However, 27 commercial and residential properties were left connected to the storm sewer resulting in dry weather overflows. These properties were successfully reconnected to the sanitary sewer in 1997 and the dry weather overflows were eliminated.

Other accomplishments during 1998 to present include:

- Installed S&F controls on CSO109, CSO113, CSO126, CSO127 and CSO166 using Copa Cross Wave Static Screens. The static screen reduces the volume of S&F within the overflow stream.
- Installed S&F controls on CSO028, CSO030, CSO034, CSO054, CSO082 and CSO119 using Copa Cyclone Screen. The device is a low maintenance S&F screen.
- Installed S&F controls on CSO125 and CSO144 using Hydro International Wave Static Screens. Both of the CSOs utilized static screens to reduce the amounts of S&F within the overflow stream.
- Eliminated CSO123 through sewer separation.

- Reduced the AAOV at CSO088 through sewer separation. The original combined sewer was transformed into a sanitary sewer and a new storm sewer was constructed.
- Eliminated CSO080 through sewer separation.
- Upgraded wet weather capacity at Morris Forman WQTC which was completed in 2000.
- Modified the headworks at Morris Forman WQTC which was completed in 2000.
- Eliminated CSO209, CSO087 and CSO147 through sewer separation by transforming the existing combined sewer into a sanitary sewer and a new storm sewer.
- Replaced the four Northern Ditch Pump Station Pumps with new 14,000 gallons per minute (gpm) submersible tubular casing pumps. These renovations of the pump station greatly increase the station reliability and improve the functioning of the RTC system.
- Eliminated CSO030, CSO032, CSO033, CSO081 and CSO194 based on quick closure effort.
- Willow Pond Disconnection Project at CSO127 in progress.
- CSO131 S&F control device replaced baffle with cyclone screening device.
- CSO206 sub-areas 10-15 sewer separation completed.

1.6.1.4 October 2009 thru June 2013

Activities completed during this time period are included in MSD's Quarterly and Annual Reports, which can be found at http://msdprojectwin.org/Library.aspx#. Activities related to the first years of IOAP implementation such as project completion green implementation are detailed in these reports as well as various CMOM and NMC related activities.

1.6.2 Public Participation

To meet the requirements of the CWA, the public program as required by the CSO Control Policy was based upon two concepts: public notification and public participation. The CSO Policy (NMC 8) requires public notification of overflows. Public participation includes public engagement in the decision making process and selection of long-term controls. Volume 1 of the IOAP presents a detailed description of the public participation program.

In addition to the requirements of the CSO Policy, MSD considered the public participation program essential to ensure public acceptance of the Final CSO LTCP priorities and projects and to ensure there is public willingness to pay for the infrastructure program over a long time period. Additionally, the public needs to be informed that the Final CSO LTCP will not eliminate all overflows under all conditions nor will it guarantee that no harmful pollutants will be discharged to Beargrass Creek and the Ohio River under certain conditions.

MSD's Public Program is made up of four major components; Public Notification, Wet Weather Team (WWT) Engagement, General Programmatic Outreach and Educational Activities, and Regulatory Reporting and Agency Meetings. A continued participation of the public and a continued public outreach program will be essential throughout the entire life of the program in order to continue the support for ongoing rate increases and tolerance for the nuisance and inconvenience of project construction.

1.6.2.1 Public Notification

Public notification, as required by the CSO policy, is intended to inform the public of potential CSOs, their location, and the possible public health and environmental effects of the overflows. The public notification of potential or actual CSOs also informs the public to curtail recreational activities or commercial activities in areas directly or indirectly affected by overflows. MSD's public notification efforts include permanent CSO signage, temporary overflow warning signs, email notification of events (public and regulators), and Web page notification.

1.6.2.2 Wet Weather Team (WWT) Engagement

MSD assembled a WWT to participate in the development and implementation of the Final CSO LTCP. To address the engineering, economic, environmental, and institutional issues raised during the evaluation and implementation of the Final CSO LTCP, local WWT members included elected officials, union and community leaders, and other stakeholders. The WWT was charged with preparing a plan for funding the MSD Wet Weather Program, and developing a program for public information, education and involvement. Other objectives of the WWT were to advise MSD on overall investment, policy, and performance choices in the development, and implementation of the Wet Weather Program.

MSD's public outreach program successfully gained the approval of the elected officials to enter into debt and raise rates to cover that debt in order to finance Project WIN projects. MSD fully understands that it was not only the WWT team process, but also the public meetings and the public hearing that helped MSD establish the priorities and schedule for the overflow abatement program. All documents from the WWT meetings are available on the Project WIN website.

MSD continues to meet with members of the WWT Stakeholder Group twice a year to report progress on implementation and gather feedback on project or program modifications.

1.6.2.3 Public Meetings

To gain public input and acceptance of the recommended plan, MSD convened four rounds of public meetings. The first round of meetings, held in April and May of 2007, provided the public with the history and evolution of MSD's sewer system, how the proposed sewer rate increase is related to the Consent Decree, as well as to identify the actions individual property owners can implement to help improve stream water quality within Louisville Metro.

The second round of public meetings held October through December 2007, provided an update on the LTCP planning process and obtained feedback from the public on the proposed rate increase necessary to fund the plan. The third round of public meetings, held in May 2008, was designed to give the public and impacted neighborhoods details of the types, locations, and size of facilities that would be constructed as well as their proposed schedule of construction. The fourth round of public meetings held in November 2008, continued a dialogue and created a level of interest with the public about the content of the Final CSO LTCP.

Periodic public meetings are currently ongoing throughout IOAP implementation. Details of this process are described in Volume 1 of the IOAP.

1.6.3 Regulatory Reporting and Agency Meetings

Throughout the development of the LTCP, MSD scheduled meetings with regulatory agencies having jurisdiction over the program in order to facilitate open communication between MSD and the regulators regarding progress and compliance with Consent Decree requirements. Electronic reporting updates requested by KDEP and EPA were developed and implemented to provide current information. The electronic reporting tools developed by MSD to improve communication with EPA/KDEP and the public are described below:

- The Initial Discharge Report for any overflow that reaches the Waters of the US is sent to EPA and KDEP via email. If the overflow report has not been closed when initially sent because data is not yet available, a second email is sent with updated information when the report is closed. This Initial Discharge Report system polls the Hansen database twice a day and sends emails on qualifying overflows.
- MSD posts the Discharge Monitoring Reports for all WQTCs on the Project WIN webpage. DMRs are posted within 10 days of the required submittal date.
- MSD posts information on any blending event at the Jeffersontown WQTC on the Project WIN webpage.
- MSD enhanced the overflow notification system. Emails are automatically sent to subscribers to inform them when a rain event has occurred that may trigger overflows or when a large volume dry weather overflow has occurred. A second email is sent 48 hours after the end of the event to notify subscribers that conditions have returned to normal.
- On both the MSD and Project WIN webpages, the Overflow Advisory Level displays green when conditions are normal, yellow when a dry weather overflow over 2,000 gallons has occurred, and red during a rain event.
- MSD added an interactive CSO/SSO Location Maps webpage on the Project WIN website. The interactive maps and tools allow the public to select an area and view active CSOs or documented SSOs. The user can also review a fact sheet with detailed information about each site. Refer to the following webpage to use this tool, http://www.msdlouky.org/projectwin/county_cso_sso.htm.

MSD prepares reports for each of the four quarters of the calendar year and submits them to EPA and KDEP within 30 days of the end of the new quarter. MSD also prepares and submits annual reports to the respective agencies. MSD posts these reports on its website at http://msdprojectwin.org/Library.aspx# for public review.

Quarterly reports include specific information about activities consistent with the requirements of the Consent Decree, and the progress toward the development of the Final CSO LTCP. In addition, MSD initiates periodic face-to-face meetings with technical team members from the KDEP and EPA to discuss the progress of the Project WIN overflow abatement program.

1.6.4 Coordination with State Water Quality Standards Authority

Water quality standards are intended to protect human health, aquatic life and its habitat, and recreational use of the nation's waterways. CSOs can cause water quality standards exceedances because of the pollutants that are present in sanitary sewage and stormwater runoff. The CSO Policy requires permittees to evaluate whether CSOs are causing exceedances of the water quality standards and to develop "clear levels of control that would be presumed to meet appropriate health and environmental objectives" (59 Federal Register 18689). The CSO Policy also recognizes the site-specific challenges that CSO communities can face in determining cost-effective controls to meet water quality standards at all times, under all conditions.

A key principle of the CSO Policy is the "[r]eview and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect site-specific wet weather impacts of CSOs" (59 (Code of Federal Register {CFR} 18689). Coordinating CSO Long-Term Planning with Water Quality Standards Reviews (US EPA, 2001) provides guidance on conducting these reviews. Some states, such as Indiana (IDEM, 2008); Massachusetts (MassDEP, 2007), and Maine (MDEP, 2003), have established revisions to their water quality standards to specifically address the challenges associated with CSO control.

If current standards cannot be met in a reasonable timeframe with cost-effective levels of control, permittees will work with the state water quality standards authority (KDEP) to determine the appropriate mechanism for ensuring that the LTCP will meet water quality standards. The role of the Kentucky water quality standards authority is to review standards in CSO-impacted receiving water bodies; coordinate the review with the LTCP development; and revise the standards as appropriate. These revisions can include development of site-specific criteria modification of the designated use or establishing a temporary variance.

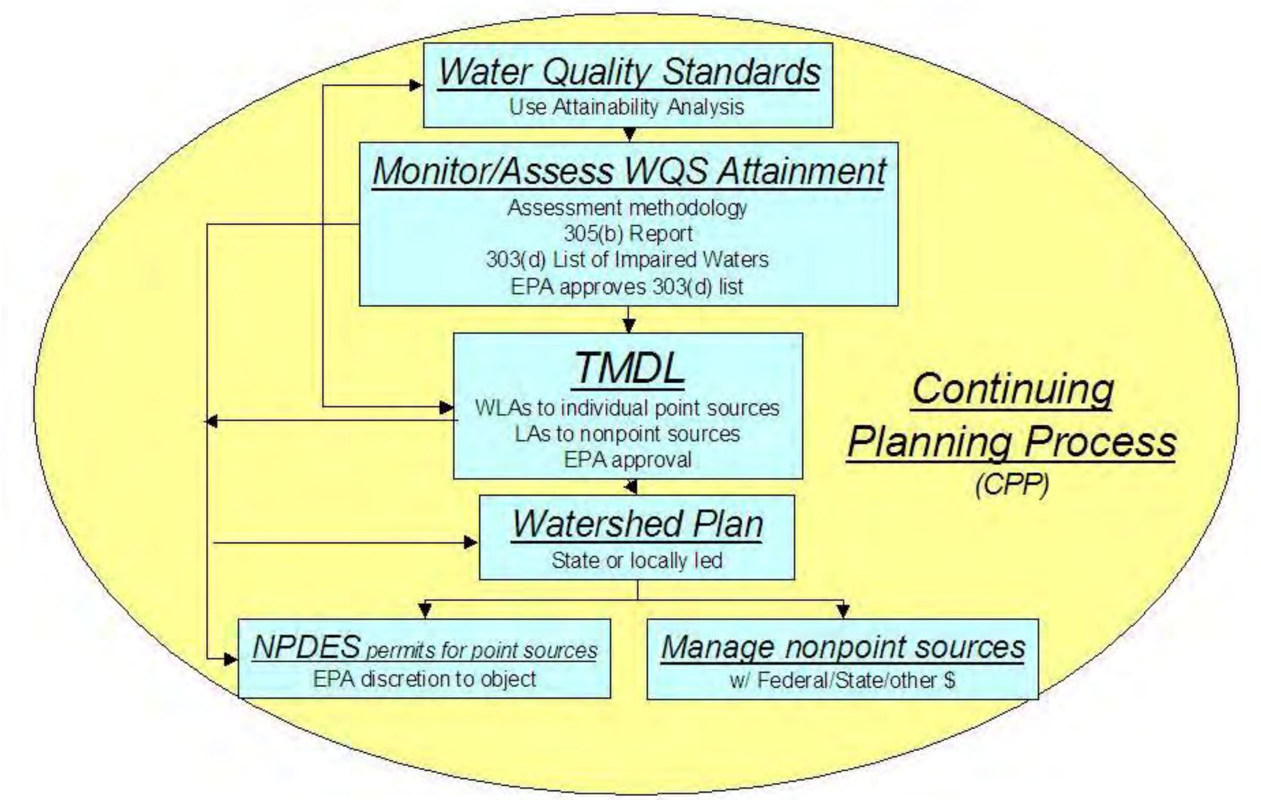
This approach is consistent with the Continual Planning Process contained in the CWA, as shown in Figure 1.6.1. This figure shows how the CWA framework result in appropriate water quality standards and reasonable TMDLs, NPDES permit limits, and nonpoint source controls.

The first step is to start with appropriate water quality standards, and monitoring and assessing whether a water body is meeting these standards. If not, a TMDL is required to establish allowable loads for point sources (such as WQTCs, CSOs, or stormwater discharges) and nonpoint sources (like agriculture runoff).

A watershed or implementation plan is then developed to identify how to achieve these load reductions. This can be challenging since load reductions, particularly for bacteria, can often be 90 percent (or more) of current loads because of the existing water quality standard. If the load reductions are not feasible, then the process for establishing achievable and appropriate water quality standards is the UAA, which is shown at the top of Figure 1.6.1.

As MSD implements CSO controls and conducts additional updates to its LTCP, review and revision of the water quality standards may be appropriate. ORSANCO adopted a provision in its water quality standards for the Ohio River allowing for development and application of alternative criteria if CSO communities have submitted a LTCP and a UAA (ORSANCO, 2006). MSD intends to implement the controls recommended in the updated LTCP and then evaluate whether development of a UAA or additional CSO or other pollutant source controls are warranted.

FIGURE 1.6.1 USE ATTAINABILITY ANALYSES IN THE CONTINUAL PLANNING PROCESS (US EPA, 2006)



1.6.4.1 Kentucky's Water Quality Use Classifications

Kentucky's Water Quality Regulations establish surface water use classifications for all waters of the Commonwealth. Table 1.6.1 summarizes the identified use classifications.

TABLE 1.6.1

KENTUCKY'S WATER QUALITY REGULATIONS

SURFACE WATER USE CLASSIFICATIONS

Kentucky's Water Quality Regulations	Surface Water Use Classifications
WAH	Warm Water Aquatic Habitat
CAH	Cold Water Aquatic Habitat
PCR	Primary Contact Recreation
SCR	Secondary Contact Recreation
DWS (Domestic Water Supply)	Applicable at existing points of public water supply disposal
OSRW	Outstanding State Resource Water

Table 1.6.2 summarizes the designated stream uses for the surface water bodies within the Ohio River near Louisville Metro and the Beargrass Creek Basin.

TABLE 1.6.2

STREAM USE DESIGNATION

Stream	Use Designation
Ohio River - Main Stem	WAH, PCR, SCR, DWS
South Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Middle Fork Beargrass Creek and Tributaries	WAH, PCR, SCR
Muddy Fork Beargrass Creek and Tributaries	WAH, PCR

For warm water aquatic habitat, the water quality standards require the following:

- The dissolved oxygen is to be maintained at a minimum concentration of 5.0 milligrams per liter (mg/l) daily average; the instantaneous minimum shall not be less than 4.0 mg/l.
- Total dissolved solids and total suspended solids (TSS) are not to be changed to the extent that the indigenous aquatic community is adversely affected.
- The addition of settleable solids that may alter the stream bottom and adversely affect productive aquatic communities is prohibited.
- The concentration of un-ionized ammonia shall not be greater than 0.05 mg/l at any time in-stream after mixing.

For recreational waters that are designated for primary contact recreation, the fecal coliform or Escherichia Coli (E. Coli) shall not exceed 200 colonies/100 milliliter (ml) or 130 colonies/100 ml, respectively, as a geometric mean based on not less than five samples taken during a 30-day period. Further, the fecal coliform concentration shall not exceed 400 colonies/100 ml in 20 percent or more of all samples taken during a 30-day period, or 240 colonies/100 ml for E. Coli. The above limits apply to the recreational season defined as May 1 to October 31.

For the non-recreational period from November 1 to April 30, the fecal coliform concentration criteria are the same as the criteria for secondary contact recreation. These criteria require that the fecal coliform content be no greater than 1,000 colonies/100 ml as a 30-day geometric mean, and no greater than 2,000 colonies/100 ml in 20 percent or more of the samples taken during a 30-day period.

For the main stem of the Ohio River, the dissolved oxygen is to be 5.0 mg/l or higher per day, and shall not be less than 4.0 mg/l, except during the August 15 through June 15 spawning season when a minimum of 5.1 mg/l is to be maintained.

Kentucky Department for Environmental Protection (KDEP) 2004 303(d) listing of impaired water in Kentucky provides additional insight into the ability of these surface waters to meet its designated uses, and lists the pollutants of concern that are the likely causes of the impairments. See Table 1.6.3 for details.

TABLE 1.6.3

2004 KENTUCKY 303(D) LIST

Streams	Priority	Impaired Use	Pollutant of Concern
Beargrass Creek of Ohio River (mile 0.0 to 1.5)	**First**	Aquatic Life (Nonsupport)	Metals, Organic Enrichment/Low dissolved oxygen
Middle Fork of Beargrass Creek (mile 0.0 to 2.3)	**First**	Aquatic Life (Nonsupport) Swimming (Nonsupport)	Organic Enrichment/Low dissolved oxygen, Habitat Alteration (other than flow), Metals (Cadmium), Pathogens
Middle Fork of Beargrass Creek (mile 2.3 to 15.2)	**First**	Aquatic Life (Partial support) Swimming (Nonsupport)	Metals (Cadmium), Pathogens
Muddy Fork of Beargrass Creek (mile 0.0 to 6.9)	**First**	Swimming (Nonsupport)	Pathogens
South Fork of Beargrass Creek (mile 0.0 to 2.7)	**First**	Swimming (Nonsupport) Aquatic Life (Partial Support)	Metals (Cadmium), Pathogens, Organic Enrichment/Low dissolved oxygen
South Fork of Beargrass Creek (mile 2.7 to 14.6)	**First**	Aquatic Life (Partial Support) Swimming (Nonsupport)	Pathogens, Organic Enrichment/Low dissolved oxygen
Ohio River (main stem) (mile 317.1 to 981.0)	**Second**	Fish Consumption (Partial Support)	Chlordane
Ohio River of Mississippi River (mile 609.7 to 617.6)	**Second**	Swimming (Partial Support)	Pathogens
Ohio River of Mississippi River (mile 606.8 to 609.7)	**Second**	Swimming (Nonsupport) Fish Consumption (Partial Support)	Pathogens, Poly-chlorinated Biphenols (PCBs), Dioxin
Ohio River of Mississippi River (mile 617.6 to 629.9)	**Second**	Swimming (Nonsupport), Fish Consumption (Partial Support) Domestic Water Supply (Nonsupport)	Pathogens, PCBs, Dioxin

1.6.4.2 Ohio River Considerations

ORSANCO conducted a study of wet weather impacts on the Ohio River beginning in 2000, concluding with a final report in late 2004. The report is entitled, "Wet Weather Impact Study on the Ohio River - Louisville/Southern Indiana Area, 2004." This study examined on a preliminary basis the impacts on water quality from wet weather discharges from major tributaries, WQTCs and CSOs in Kentucky and Indiana. The study area lay within the McAlpine Locks and Dams and Cannelton pools of the Ohio River, with the major communities of Louisville Metro, Kentucky, and Jeffersonville, Indiana being the major communities in the study area. The following is a summary of the major conclusions from the ORSANCO study.

- CSO sources account for about 18 percent of the fecal coliform load and 22 percent of the E. Coli load to the Ohio River on an annual basis. Louisville Metro's share of the total annual fecal coliform load was 15.7 percent, and 16.9 percent of the annual E. Coli load.
- CSOs cause the pathogen criteria to be exceeded between five percent and 10 percent of the days during the recreation season. Although other days exceeded criteria, sources other than CSOs (tributary and upstream loads) were believed to be the causes.
- The ORSANCO model was believed to be very useful as a planning tool, but was not well-suited for use as a predictor of absolute concentrations in the river.
- The report indicated that the most realistic CSO reduction scenario (control of most, but not all CSOs) would have very little benefit in reducing the frequency of days that exceed the single sample maximum water quality standard. Although, the report noted that the alternative would have a noticeable benefit in reducing peak in-stream concentrations.
- Eliminating CSOs appeared to be less beneficial than eliminating upstream and tributary sources (by five to 10 percent). It appears that either CSOs or tributaries alone will cause water quality exceedences because removing either one alone will not significantly reduce the days of exceedences; rather, reducing both would achieve significant benefits. This supports the watershed approach to achieving water quality standards.

The ORSANCO study also showed that controlling CSOs by 100 percent could reduce the number of days exceeding the fecal coliform and instantaneous maximum criterion from 60 percent to 40 percent, a 20 percent reduction. Data was presented for the removal of the total CSO load (without stormwater), and for the removal of only the sanitary component of the wet weather load (with stormwater). The latter includes the wet weather stormwater runoff loads that would continue to discharge to the river if sewer separation were implemented. Comparison of the two options indicate that sewer separation would be of negligible benefit, since the number of days exceeding the instantaneous maximum would be nearly the same for the sewer separation case as it is for the existing condition case. Thus, the 20 percent reduction seems to be achievable only if both the CSO and stormwater loads of bacteria were substantially reduced (>95 percent).

1.6.4.3 Beargrass Creek Watershed

Many efforts have been undertaken over the past 13 years to obtain better information on the pollutant load characteristics being discharged into Beargrass Creek from CSOs, sanitary sewer overflows (SSOs), and stormwater discharges. One effort included a sampling program in 1992 and 1993 in which samples were taken at several CSOs and at several locations in-stream. Other sources of data were included in The Synthesis Report of 1999, which summarized sampling results taken in the Beargrass Creek Basin over several years.

Beginning in 2005, a significant monitoring and modeling effort was undertaken to support the development of TMDLs as well as development of a WQT model. The continuous monitoring effort consisted of 14 in-stream, "continuous" monitors collecting water temperature, pH, dissolved oxygen, dissolved oxygen saturation (percent dissolved oxygen), and specific conductance at 15-minute intervals. Ammonia data were also collected using continuous monitors at some locations. Three United States Geological Survey (USGS) gauges monitored "continuous" (15-minute interval) stream flow data. Discontinuous data was collected during both dry and wet weather conditions. Sampling occurred within the stream, at CSO locations, and from runoff from specific landuses according to the Quality Assurance Project Plans (QAPPs) developed specifically for the Beargrass Creek WQT/TMDL project.

An additional discrete event sampling project was conducted to support the WQT Model calibration/validation. Eight CSOs in the Beargrass Creek watershed were selected based on a sample population of 15 percent of the total CSO population. Each of these sites was sampled for E. Coli, total phosphorus, total nitrogen, TSS, and biochemical oxygen demand. The eight sites also had flow meters in place recording flow and probes were in place measuring temperature, conductivity, pH, and dissolved oxygen. The maximum CSO samples collected per site is nine, which include eight grab samples and one event composite at a time interval of 15 minutes for the first hour and every two hours up to six hours.

In-stream samples were collected to define background loading as well as to characterize the individual impacts of the CSOs on the receiving waters of Beargrass Creek. A total of 23 sites are currently being sampled for the same parameters as CSOs.

1.6.4.4 CSO Discharges and Water Quality Issues

The ORSANCO study showed that CSOs are a significant source of bacteria loadings to the Ohio River. However, other sources, such as tributaries and stormwater discharges, also contribute substantially to the bacteria loadings. Further definition of the relative significance of these sources has been undertaken during the development of the Final CSO LTCP. Dissolved oxygen was not identified as a concern in the 303(d) listing for the Ohio River (see Table 1.6.3).

In the Beargrass Creek watershed, the presence of pathogens, organic enrichment, some metals and low dissolved oxygen, is common in all the tributaries. The Beargrass Creek TMDL effort currently under way in the watershed will identify the respective contributions of CSOs, stormwater discharge loads, and potential other sources, and develop a strategy for controlling the varied sources to meet water quality standards, if possible.

1.6.5 Integration of Current CSO Control Efforts

In accordance with Paragraph 24a of the Consent Decree, MSD was required to implement an Early Action Plan (EAP). The purpose of the EAP is the immediate reduction of overflow events through improved operation and control of MSD's collection, conveyance, and treatment system.

As outlined in Volume 1, Chapter 4, MSD's EAP for CSO Program is based on the EPA document, "Combined Sewer Overflows Guidance for Nine Minimum Controls", plus capital improvements and SSO related initiatives. The NMC are technology-based actions or measures designed to reduce the number of CSO events and to mitigate their effects on water quality. As required by the Consent Decree, MSD submitted a NMC Compliance Report to the EPA and the KDEP on February 10, 2006. MSD received an approval letter dated February 22, 2007, for the NMC Compliance Report.

The following is an overview of MSD's implementation of the NMCs.

NMC 1- Proper Operation and Maintenance Program

MSD established an integrated program to train responsible staff on the inspection and maintenance of critical assets of the CSS system to allow for their effective operation. These critical assets included the collection system, catch basins, CSO structures, pump stations, and the Morris Forman WQTC.

NMC 2- Maximization of Storage in the Collection

MSD maximized the in-system storage capacity of the existing CSS, thereby reducing the discharge volume, frequency, and duration of CSO events. MSD achieved compliance by documenting actions that increased the usable storage capacity of the CSS. Examples of maximizing in-system storage capacity included installation of flap gates on selected CSO outfalls tributary to Beargrass Creek and the Ohio River and raising the dams and weirs of selected CSO structures to achieve an increase in available storage capacity. Other actions taken by MSD to reduce the flow of water into the CSS included the repair of a leaking water reservoir and the installation of pervious pavement to reduce the volume of stormwater runoff entering the CSS during wet weather events. Additionally, the Plumbing Modifications Program was expanded to increase the removal of direct downspout and sump pump connections from the CSS. A significant increase of in-system storage capacity was also achieved with the implementation of the Supervisory Control and Data Acquisition (SCADA) and RTC systems that allow MSD to maximize the storage capacity of the CSS by predicting wet weather events, and monitoring and controlling the flow through the CSS.

NMC 3- Review and Modification of Pretreatment Requirements

MSD routinely inventories and inspects the facilities of private businesses within its service area when necessary, evaluates feasible modifications to the existing Pretreatment Program, Hazardous Materials Ordinance/Spill Prevention and Control Plan and the Industrial / Commercial Plumbing Plan Review Program.

NMC 4- Maximization of Flow to the Publicly Owned Treatment Works for Treatment

Using the RTC system to divert wet weather flow from CSO locations to the Morris Forman WQTC, MSD developed and implemented a program to increase the wet weather treatment capacity of the Morris Forman WQTC. The wet weather treatment capacity of the Morris Forman WQTC was increased from 225 mgd to a short duration peak flow capacity of 350 mgd with a sustainable capacity of 325 mgd via construction completed in 2000. In addition, MSD increased the capacity of select pump stations to convey additional wastewater flow to the Morris Forman WQTC. Upgrades and modifications of certain pump stations have allowed MSD to further increase wet weather flow to the Morris Forman WQTC. Typical modifications at these pump stations included increasing their wet well volume, or raising the dam levels to allow more wastewater to be stored in-system. The stored wastewater is then pumped to the Morris Forman WQTC as capacity becomes available.

NMC 5- Elimination of CSOs during Dry Weather

MSD reviewed and assessed the causes of previous dry weather overflows and took immediate corrective actions necessary to remediate each occurrence. Examples included mechanical repairs or upgrades at the WQTCs and pump stations, installment of back-up power generators, increasing the elevation of overflow dams, and removal of CSS blockages. To prevent the occurrence of additional dry weather overflows, MSD uses a variety of programs such as routine inspection and maintenance of the CSS as well as computer models simulations of the CSS to predict the location of potential DWOs and evaluate cost-effective solutions.

NMC 6- Control of Solids and Floatable Materials in CSOs

MSD evaluated modifying in-line controls such as dams and weirs and installing end-of-pipe control devices to remove S&F materials from CSO discharges. In-line control devices function by keeping S&F within the CSS, thereby preventing them from exiting the system and entering the receiving waters. End-of-Pipe control devices also remove S&F, but are placed external to the CSS. MSD has installed appropriate S&F controls on CSOs including constructed steel screen/cages placed over the discharge points as well as constructed baffles immediately upstream of the CSO dam. MSD personnel maintain manual cleaning of the S&F devices on a regular basis to maintain the effectiveness. MSD routinely cleans approximately 30,000 catch basins in the CSS per year. Additionally, MSD partnered with the Louisville Metro Government and other community organizations to implement watershed level activities to reduce S&F from entering the CSS.

NMC 7- Pollution Prevention Programs to Reduce Contamination in CSOs

MSD administers several programs to address pollution prevention. These include the Erosion Prevention and Sediment Control Program and the Hazardous Materials Ordinance Program. MSD also takes an active role in administering the Industrial Pretreatment Program and the distribution of educational materials discussing BMPs for fats, oils, and grease (FOG) and mercury disposal. Wet weather flow minimization and water conservation are also relevant factors to this minimum control because they can reduce the frequency, volume, and duration of CSO events. MSD promotes water conservation by providing incentives for significant industrial users to reduce their discharge volumes and promotes and financially supports rain barrel and rain garden programs. MSD also supports and participates in numerous public education programs that target pollution prevention, including mass media campaigns and involvement with the Beargrass Creek Watershed Council, and the Youth Environmental Leadership Institute.

NMC 8- Public Notification

To ensure the public is aware of potential and actual overflows, MSD informs the public as to the location of existing CSO outfalls, as well as ongoing programmatic outreach and educational activities. Event based activities are initiated when a CSO event occurs, or is likely to occur. Examples of event based notification activities include door hangers, verbal and e-mail alerts, as well as a Sewer Overflow Advisory Level on MSD’s website. Programmatic outreach and educational activities vary in an effort to reach the public and include warning signs posted at all CSO outfalls and at public access areas that are downstream of CSO outfalls. Lastly, MSD mails and posts on its website newsletters to notify, inform, and update the public as to the progress of various programs and efforts of programs and projects to reduce the frequency, volume, and duration of CSOs.

NMC 9- Monitoring to Characterize CSO Impacts and the Efficacy of CSO Controls

MSD updates infrastructure mapping and databases to record the geographical locations and physical conditions of existing CSS and CSO structures. In addition, MSD collects an extensive number of measurements and stores this data in a database. The measurements taken describe the quantity of CSO, and the quantity and quality of both the CSS waste stream and the receiving waters. Measured values include flow rates, nutrients, pH, biochemical oxygen demand, chemical oxygen demand, TSS, temperature, and dissolved oxygen. Using this information, MSD is able to assess the effectiveness of previously implemented CSO control measures. An important outcome of such extensive monitoring and documentation are the production of computer simulations of the existing CSS. The computer simulations allow MSD to estimate the impact of CSO events upon the receiving waters, and to predict the effect of implementing various alternatives upon the frequency, volume, and duration of CSOs.

1.6.6 Watershed Approach to CSO Control Planning

MSD has promoted the use of a watershed approach for improving water quality. The watershed approach, as it is commonly defined, provides a holistic framework for managing all the factors that influence water quality with a specific drainage area. MSDs watershed overall approach is described in Volume 1 of the IOAP.

For the Final CSO LTCP, the watershed approach is multi-scale, ranging from a site-specific end-of-pipe solution to a regional scale source reduction program. The watershed approach incorporates both "gray" technologies and "green" infrastructure solutions as well as other solutions that bridge the separate SSS and CSS.

1.6.6.1 Integration of SSS and CSS

The current CSS baseline condition receives approximately 45 percent of the total sanitary flow conveyed to Morris Forman WQTC from the separate SSS. Six boundary points separate sanitary flows that contribute to the CSS.

The boundary points are shown on the system map in Chapter 2, Figure 2.4.27 and are as follows:

- Beargrass Creek Interceptor, downstream of Southeastern Diversion Structure
- Goldsmith Lane Trunk Sewer
- Middle Fork Trunk Sewer at Park Boundary Road
- Northern Ditch Pump Station
- Ohio River Force Main (ORFM)
- Mellwood Trunk Sewer

The approach taken to integrate the SSS and the CSS for development of the Final CSO LTCP was to apply the benefit/cost analysis to projects at or near these six boundary points. Chapter 3 details a comprehensive list of projects developed at the onset of the CSO LTCP process. Some projects evaluated included benefit for both the SSS and the CSS. Examples of solutions developed within the SSS that also benefited the CSS included traditional end of pipe control technologies and separate SSS projects that off-loaded flow upstream of the CSS. Likewise, CSS projects, which reduced the inflows, created capacity in the interceptor pipe and thus benefit the SSS projects. As presented in Chapter 4, several of these projects were selected as the best alternatives.

1.6.6.2 Green Infrastructure Initiative

Throughout the public outreach program, MSD received a recurring appeal to integrate green technologies to reduce the frequency and volume of CSO discharges. Because of this encouragement and the dedication of leadership, MSD made a commitment to integrate green technologies into the Final CSO LTCP.

Green opportunity evaluations were performed on each sewershed that contained an active CSO. This process was a coarse evaluation to determine potential opportunities to implement green infrastructure within each sewershed. The goal of this exercise was to identify strategies to reduce the amount of stormwater runoff that enters the CSS, thus reducing overflow frequency, duration and volumes. This evaluation led to the identification of specific green projects and programs that could be implemented throughout the combined system.

The system-wide evaluation led to a recommendation to develop and implement a series of Green Infrastructure Programs that includes downspout disconnection, residential rain gardens, a rain barrel program, and green roof incentives. In an effort to estimate conservatively the net benefits of these programs in terms of CSO mitigation, MSD considered only the reductions from the proposed downspout disconnect program in the modeled reduction in runoff volume.

To determine the impact of the disconnection program on CSO activity, each sewershed was evaluated in terms of the anticipated number of downspouts that could reasonably be expected to be removed. This value was translated into a total impervious area removed from the CSS. This reduction was then applied uniformly across each sub-sewershed in the model, resulting in an estimated reduction in CSS activity. It is important to note that very conservative estimates were used in the basic assumptions from which these CSO reductions are derived. Chapter 3 Section 2.5 provides a detailed description of this analysis.

In addition to the proposed green programs, 19 green demonstration projects sites have been identified and evaluated. Project site locations were selected based on soils, geology, public visibility, property ownership, etc. For each proposed demonstration project, a project location and associated drainage area was determined. Each proposed project was then evaluated to estimate the effective reduction in impervious area for that particular site. This information was then input into the CSS model to evaluate the impact on CSO activity associated with the particular project.

It is important to note that the location of the project within the site drainage area as well as the overall size of the CSO drainage area has a significant bearing on the impact of the proposed project. For example, when evaluating the impact of a single project located within a large sewershed with an active CSO, the model may indicate little benefit in terms of reducing CSO activity. However, when this same project is evaluated on a site level comparing existing runoff to post development runoff using green infrastructure, significant reductions in loadings to the CSS are usually realized. In addition, cumulative effects of numerous site level reductions will, over time, result in overflow reductions. Therefore, when evaluating the benefits of green infrastructure, care should be taken in the interpretation of the results to ensure that a fair and accurate assessment is made.

Once the green demonstration projects and programs have been implemented, monitoring and modeling will determine the effectiveness of these controls on the reduction of stormwater runoff entering the CSS and the corresponding impact on CSO activity. The net result of the Green Infrastructure Program will potentially allow the proposed gray CSO controls, such as tanks and pipes, to be downsized or possibly eliminated due to the reduction in stormwater runoff entering the CSS.

1.6.7 Sensitive, Priority, and Recreational Use Areas

EPA's CSO Control Policy requires a recreational use survey and a sensitive area study be performed in preparation of a CSO LTCP. This work is to assist with identifying locations along the stream with the greatest potential for public contact and to prioritize implementation of CSO controls.

1.6.7.1 Sensitive Areas

EPA's CSO Control Policy requires that sensitive areas be given the highest priority for implementation of CSO controls. Typically, identifying sensitive areas within the watershed of concern provides a framework for developing a cost-effective, phased approach to CSO control implementation and selection of abatement alternatives. However, all waters of Beargrass Creek within the CSS have been identified as sensitive, based on their designation as primary contact waters and their potential to contain species identified as threatened, endangered, or of special concern. Thus, additional prioritization was necessary to develop a phased approach to implementing CSO controls.

MSD conducted an ecological reach characterization of Beargrass Creek, in support of the CSO control decision-making process, to implement effectively a phased approach to CSO control in the Beargrass Creek watershed. A characterization framework for prioritizing sensitive areas was constructed based on the degree of benefit anticipated to be gained by various control measures. A summary of this work is below. A more detailed presentation of this work follows in Chapter 2, Section 2.8 of this Volume.

The basis of this characterization framework was to segment Beargrass Creek within the CSS into discreet stream reaches and rate them based on an ecologically-sensitive, multi-parameter approach. This framework addressed ecological factors for evaluating CSO control project alternatives, which were then used in conjunction with the various other factors for overall control efforts prioritization. The rating scale reflects the ecological condition of each stream reach and the degree of benefit to be gained by water quality improvements. "Ecological condition" for these purposes was considered to be the existing, or realistic potential of, stream-related communities in terms of biological integrity, ecological function, and aesthetic/public health value. Based on this approach, reaches with high ratings would realize greater benefit from water quality improvements and, therefore, should be given higher priority during the CSO control and implementation decision process.

Ten parameters were identified to measure the ecological condition of each stream reach. A multi-parameter approach was necessary to accurately characterize existing/potential condition of stream reaches, especially in this highly urbanized environment. The parameters used for this characterization include:

- Accessibility – A measure of the potential for human contact with the creek. Data was obtained through field observations.
- Threatened/Endangered Species – A defined component of sensitive area study. This data was obtained from the Kentucky State Nature Preserves Commission.
- Stream Rapid Bioassessment Protocol – A method for assessing stream habitat quality and its ability to harbor a healthy ecological community.
- Bank Erosion Hazard Index – A measure of the potential for streambank erosion.
- Index of Biotic Integrity – An index developed for rating fish community assemblages as an indicator of the degree of impact from pollutants.
- CSO AAOV – Discharge modeled for each CSO for a synthetic typical year rainfall.
- Landuse – A classification system describing the types of human activities for a given area. For example, parks, residences, industrial uses.
- Landcover – Types of vegetative or manmade features covering a landscape.
- Restoration Potential – A qualitative assessment of benefits a stream reach may realize considering the level of effort required to restore aquatic/riparian habitat functions.
- Reach Length – The physical measurement of each reach.

Because CSOs impact a diverse set of constituents, numerous factors must be considered when prioritizing and evaluating CSO control alternatives. The ecological reach characterization is one component of a multifaceted decision process framework that was used in CSO LTCP development. The tool provided a means for comparing individual stream reaches of Beargrass Creek within the CSS in terms of ecological condition. The results do not imply that stream reaches with high priority ratings should be the sole target for CSO abatement activities since all portions of Beargrass Creek must meet water quality standards. Results of this prioritization process and ecological reach ranking were one of several variables integrated into the Final CSO LTCP projects selection process and implementation schedule.

1.6.7.2 Recreational Use

EPA's CSO Control Policy also requires that a Recreational Use Survey be performed to assist in identifying the locations with the greatest potential for public contact with sewer overflows. MSD conducted a Recreational Use Survey within the Beargrass Creek and Ohio River Watersheds. An overview of the study is below and details are presented in Chapter 2, Section 2.7 of this Volume. The Beargrass Creek watershed was further subdivided into three forks: Muddy Fork Beargrass Creek; Middle Fork Beargrass Creek; and South Fork Beargrass Creek.

TABLE 1.6.4

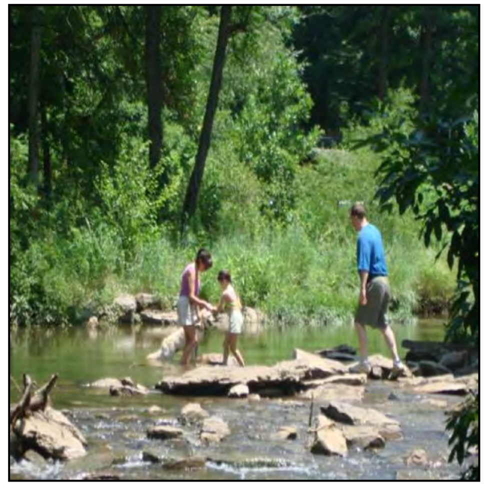
LIST OF RECREATIONAL USE SURVEY SITES

Site Number	Site Name	Watershed
1	Riverside, Farnsley-Moremen Landing	Ohio River
2	Riverview Park	Ohio River
3	Waterfront Park	Ohio River
4	Cox Park (Public Boat Ramp)	Ohio River
5	Louisville Soccer Park	Beargrass Creek Muddy Fork
6	Cherokee Golf Course	Beargrass Creek Middle Fork
7	Cherokee Park	Beargrass Creek Middle Fork
8	Seneca Park (Scenic Loop and Maple)	Beargrass Creek Middle Fork
9	Seneca Park (Big Rock)	Beargrass Creek Middle Fork
10	Seneca Golf Course (1 mile stretch)	Beargrass Creek Middle Fork
11	Brown Park	Middle Fork Beargrass Creek
12	Joe Creason Park	Beargrass Creek South Fork
13	Louisville Junior Academy	Beargrass Creek South Fork
14	Eva Bandman Park	Ohio River
15	Eva Bandman Park	Beargrass Creek Confluence
16	Beargrass Creek at Irish Hill	Beargrass Creek Middle Fork
17	Butchertown Trail	Beargrass Creek Confluence

The Recreational Use Survey was conducted from May 1, 2007, through November 29, 2007, to coincide with the Kentucky recreational season. During site visits, field data at each site was reported on a form entitled, "Field Data Sheet for Recreational Use Stream Survey." Additionally, a minimum of three photos were taken per site (upstream, downstream, and observed recreational activity). Field data reported on the form included:

- Site Information: Name, Location Description, Global Positioning Satellite (GPS) Coordinates

- Photo IDs
- Date and Time
- Personnel
- Current Weather Conditions
- Weather Conditions for Past Seven Days
- Number of People Observed
- Recreational Activities Observed
- Type of Water Contact



A summary sheet was created to summarize the field data for all the survey sites. Field data included on the summary sheets include the site description, number of people observed, recreational activities observed, and magnitude of water contact.

Results were divided in the following categories:

- Adults observed at the site
- Children observed at the site
- Adults observed participating in non-contact activities
- Children observed participating in non-contact activities
- Adults observed participating in contact activities
- Children observed participating in contact activities
- Contact observed

In order to provide assistance in evaluating and selecting overflow control approaches that protect public health, the recreational use survey site locations with the greatest potential contact with CSOs were identified and prioritized. The final results of this survey were used in the evaluation of overflow control measures.

The following four parameters were selected to rank and prioritize the survey site locations:

- Average number of people observed per site visit
- Percent contact observed
- Potential for water contact
- Percent children observed

1.6.8 Measures of Success

The NMC and the LTCP requirements under the CSO Policy require that the effectiveness of the controls be measured to determine if the goals of the Policy and the requirement of the CWA have been met. The evaluation of the effectiveness of the IOAP against the NMC and CSO LTCP requirements will be measured based upon the EPA published guidelines. In addition to these required measures of success, the IOAP will also focus on five project specific values as identified by the stakeholders (refer to Volume 1, Chapter 2). These five project specific values are:

1. Enhancement of public health
2. Enhancement of the environment
3. Regulatory performance
4. Implementation of eco-friendly solutions
5. Protection of the community's assets

REFERENCES

US EPA (2001) Guidance: Coordinating CSO Long Term Planning With Water Quality Standards Reviews. EPA-833-R-01-002. http://www.epa.gov/npdes/pubs/wqs_guide_final.pdf.

Meunier, D., T. Rider, G. Currey, M. Zobrist, and P. Bradley (2006).Water Quality Management Using the National Pollutant Discharge Elimination System (NPDES) Watershed Framework: EPA's New Technical Guidance. WEFTEC.06. Dallas, TX. October 21-25, 2006.

Ohio River Valley Water Sanitation Commission (ORSANCO) (2006). Pollution Control Standards for Discharges to the Ohio River: 2006 Revision.

Indiana Department of Environmental Management (IDEM) (2008). TITLE 327 WATER POLLUTION CONTROL BOARD Proposed Rule LSA Document #08-324. May 7, 2008. (3 pp.)

Maine Department of Environmental Protection (MDEP) (2003). 38 MRSA Section 464. November 10, 2003.

Massachusetts Department of Environmental Protection (MassDEP) (2007). 314 CMR 4.00: Massachusetts Surface Water Quality Standards.

FIGURE 1.1.1
CSO PROGRAM ACCOMPLISHMENTS

MILESTONE:	YEAR:
MSD Initiated CSO Abatement Program	1991
First Combined Sewer Operational Plan (CSOP) to KDOW	1993
Yearly Reporting to KDOW	1994
CSO LTCP Submittal	1996
Nine Minimum Controls	1998
	2000
	2001
	2002
	2004
Entered Into Consent Decree	2005
Interim LTCP	2006
	2008

CSO ABATEMENT PROJECTS:

1991–1993

- BMP Evaluations Conducted
- Sewer System Flow Monitoring
- CSO Inventory
- CSO & Stream Sampling
- CSO Model Developed

1994–1998

- Solids & Floatables Demonstration Projects
- Central Relief Drain Cleaning
- BMP Evaluations
- Increase Overflow Weir Height
- CSO143 Elimination
- CSO065 Elimination
- CSO162 Elimination

1998–2001

- Sneads Branch In-Line Storage
- Increase Overflow Weir Height
- Upper Dry Run Trunk Storage
- Wheeler Basin Storage
- Robert J. Starkey Pumping Plant Modification
- CSO108 CDS Facility
- CSO123 Elimination
- CSO088 Sewer Separation Project
- CSO080 Elimination
- CSO209 Sewer Separation Project
- CSO147 Sewer Separation Project
- CSO049 Elimination
- CSO204 Elimination

2001–2005

- Airport Deicing Project
- Stormwater Drainage Improvements
- Pumping Station Upgrades
- Morris Forman WWTP Upgrade
- MDS Inflatable Dam
- Flow Maximized to Morris Forman WWTP
- Real Time Control Studies
- Real Time Control Phase I Improvements
- Sewer Diversions
- Solids & Floatables Facilities
- Sewer Cleaning at NSTS
- CSO080 Elimination
- CSO145 Elimination

2005–2006

- Prepared Consent Decree Documents
- Real Time Control Phase I Implementation Project
- CSO209 Elimination Project

2006–2008

- Solids & Floatables Control - System Wide
- CSO206 Sewer Separation Project (On-Going)
- CSO147 Elimination Project
- CSO087 Sewer Separation and Elimination Project
- Real Time Control Phase II Implementation Project
- CSO081 Elimination Project
- CSO194 Elimination Project
- CSO032 Elimination Project
- CSO033 Elimination Project
- CSO030 Elimination Project

MSD Metropolitan Sewer District
PROJECT WIN Waterway Improvements Now

Chapter 2

CHAPTER 2: SYSTEM CHARACTERIZATION

Special Note: This chapter was developed in 2008. The statistical data for the CSO's reported, specifically related to individual CSO overflow volumes and frequency in a typical rainfall year, were derived from the CSS model calibrated in 2007. Since then, a more detailed calibration and validation effort has adjusted the average annual overflow volumes and frequencies in the typical year. This information is provided in Chapter 5. The vast majority of the physical system characterization in this chapter is still accurate.

TABLE OF CONTENTS

SUPPORTING INFORMATION

Appendix 2.3.1 USACE Flood Pump Station Operation Modification Technical Memorandum

Appendix 2.4.1 Rainfall Selection Analysis Technical Memorandum
Appendix 2.4.2 Louisville/Jefferson County MSD Sewer Modeling History Report
Appendix 2.4.3 Hydraulic Sewer System Modeling Guideline Manual
Appendix 2.4.4 Beargrass Creek Integrated Hydraulic Model Peer Review Report
Appendix 2.4.5 RTC Incorporation Technical Memorandum
Appendix 2.4.6 CSS Model Calibration/Validation Report
Appendix 2.4.7 CSS Model QA/QC
Appendix 2.4.8 CSO LTCP Characteristics Summary Report
Appendix 2.4.9 Non-CSO Sewer Sampling Data Characterization

Appendix 2.5.1 CSO Fact Sheets

Appendix 2.7.1 Recreational Use Survey Technical Memorandum
Appendix 2.8.1 Beargrass Creek Ecological Reach Characterization Report

Appendix 2.9.1 Beargrass Creek Water Quality Tool Model Calibration and Validation Report
Appendix 2.9.2 Wet Weather Impact Study on the Ohio River (Louisville/Southern Indiana Area)
Appendix 2.9.3 Ohio River Water Quality Model Calibration Report

CHAPTER 2: SYSTEM CHARACTERIZATION

Special Note: This chapter was developed in 2008. The statistical data for the CSO's reported, specifically related to individual CSO overflow volumes and frequency in a typical rainfall year, were derived from the CSS model calibrated in 2007. Since then, a more detailed calibration and validation effort has adjusted the average annual overflow volumes and frequencies in the typical year. This information is provided in Chapter 5. The vast majority of the physical system characterization in Chapter 2 is still accurate.

2.1 OBJECTIVE OF SYSTEM CHARACTERIZATION

The purpose of combined sewer system (CSS) characterization, monitoring, and modeling is to better understand the response of the system to various wet weather events, the characteristics of the overflows, and the water quality impacts that could result from combined sewer overflow (CSO) discharges. The CSS characterization information is imperative to developing a CSO control plan adequate to meet the Clean Water Act (CWA) and Amended Consent Decree (ACD) requirements. For the purposes of the Integrated Overflow Abatement Plan (IOAP), except where specifically noted otherwise, the term "Consent Decree" will be understood to mean the ACD as it was entered into Federal Court on April 15, 2009.

The major elements of a sewer system characterization are listed below with the description from the United States Environmental Protection Agency (EPA) Guidance: Combined Sewer Overflows Guidance for Long-Term Control Plan (EPA 832-B-95-002). Subsequent sections of this Volume describe major elements in more detail:

- Rainfall Records - "permittee should evaluate flow variations in the receiving water body to correlate between CSOs and receiving water condition"
- CSS Characterization - "permittee should evaluate the nature and extent of its sewer system through evaluation of available sewer system records, field inspections and other activities..."
- Monitoring - "monitoring program that measures the frequency, duration, flow rate, volume and pollutant concentration of CSO discharges and assesses the impact of the CSOs on the receiving waters." This includes the following: number of CSOs, locations of CSOs, frequency of CSOs, volume of CSOs, concentration and mass of pollutants discharged at CSOs, impacts of the CSOs on the receiving waters and their designated uses, and mathematical modeling.

The characterization of the Louisville and Jefferson County Metropolitan Sewer District's (MSD) CSS was performed as outlined above, through review of existing information, field investigation, monitoring, and mathematical modeling of the sewer system.

2.2 IMPLEMENTATION OF NINE MINIMUM CONTROLS

The EPA CSO Control Policy, published April 19, 1994, provides guidance to stakeholders for coordinating the planning, selection, and implementation of CSO controls that meet the requirements of the CWA. Among other things, the Policy establishes two main objectives for permittees: implementation of nine minimum controls (NMC), and development and implementation of a Long-Term Control Plan (LTCP).

As the name implies, a LTCP is intended to be a far-reaching plan that presents a comprehensive approach to the identification, evaluation, and implementation of long-term, capital-intensive controls to reduce the impact of CSOs. The development and implementation of a LTCP can take several decades to complete.

Conversely, it was intended that the NMCs "reduce CSOs and their effects on receiving water quality, do not require significant engineering studies or major construction, and can be implemented in a relatively short period of time." [1] The EPA envisioned that "implementing the nine minimum controls is among the first steps a municipality should take to reduce combined sewer overflow impacts." [2] Similar to the intent of the LTCP, efforts undertaken for the NMCs are not considered as temporary measures. They should be integrated into a community's long-term efforts to control CSOs. The intent of the nine minimum controls is as follows:

- Proper operation and regular maintenance programs for the CSS and the CSOs
- Maximize use of the collection system for storage
- Review and modification of pretreatment requirements to assure CSO impacts are minimized
- Maximization of flow to the publicly owned treatment works (POTW) for treatment
- Elimination of CSOs during dry weather
- Control of solid and floatable materials in CSOs
- Pollution prevention programs to reduce contaminants in CSOs

[1] US EPA, Combined Sewer Overflows, Guidance For Nine Minimum Controls, EPA 832-B-95-003, 1995 § 1.6

[2] ibid., § 1.8

- Public notification to ensure that the public receives adequate notification of CSO occurrences and combined sewer impacts
- Monitoring to characterize effectively CSO impacts and the efficacy of CSO controls

Communities with collection systems that contain CSOs were to implement the NMCs by January 1, 1997.

2.2.1 History of Nine Minimum Controls

MSD began the initial phase of a CSO abatement program in 1991, prior to the release of the EPA guidance. These initial efforts included work on both the NMC and the CSO LTCP. This initial effort culminated in the development of a Combined Sewer Operational Plan, which is contained in two documents: Combined Sewer Operational Plan 1996 Update, and 1997 Update. Also in 1997, MSD prepared the NMC Compliance Report, which summarized NMC activities completed to date, showing compliance with EPA's Combined Sewer Overflow Control Policy January 1997 deadline for NMCs. Since 1997, MSD has continued to implement the NMC program and has prepared regular updates to the original Combined Sewer Operational Plan. In June of 2003, MSD prepared the NMC Compliance Report Update, which summarized the continuation of implementation of NMC activities from January 1997 through June 2003.

Additionally, as part of the Consent Decree, another updated compliance report was required. This comprehensive report titled, "Nine Minimum Controls Compliance Report," dated September 15, 2006, contains an updated summary of NMC activities completed throughout the life of the program up to September 2006. This report is available on the MSD website http://www.msdlouky.org/projectwin/ in the public document repository.

In addition to the compliance report requirement in the Consent Decree, there were specific NMC activity requirements. A summary of the NMC Early Action Plan (EAP) requirements completed, as required by Paragraph 24a of the Consent Decree, are summarized in Volume 1, Chapter 4, Section 4.1.4 of this IOAP.

2.2.2 Continuation of Nine Minimum Controls

MSD continues its efforts for NMCs with a focus on high value and sustainable activities. An example is proper operation and sustained maintenance of the collection system through inspection and cleaning of catch basins and sewer mains. Another example is reducing the potential for dry weather overflows through increased inspection and maintenance of "hot spots," such as areas impacted by fats, oils or grease (FOG). These activities are managed through MSD's Hansen Information Management System (Hansen). Other examples include pollution prevention efforts that are being expanded through greater enforcement of current pretreatment and hazardous materials ordinances, and increased interaction with non-domestic dischargers and significant industrial users.

Public notification is continually being enhanced through the "Project Waterways Improvement Now" (Project WIN) website, which is regularly updated to include current and pertinent information related to the implementation of the NMCs and LTCP. Moreover, the frequency of public meetings is increasing and the content of these meetings is expanding with the implementation of the NMCs and development of the Final CSO LTCP.

MSD continues to submit quarterly and annual status reports documenting the accomplishments of the NMC program as required by the Consent Decree. These reports are available on MSD's website for the public to review.

Detailed examples of MSD's efforts for continuation of NMC activity as a long-term program include:

1. Proper operation and maintenance (O&M) programs

    - In-field inspection of CSOs
    - Regular cleaning and tele-inspection of CSS pipes and siphons
    - Regular updating of the CSO inventory which contains drawings and key physical data of each CSO asset
    - Work order management system (Hansen) for inspection, maintenance, and documentation of CSOs
    - Annual training for personnel who inspect and maintain CSOs; this training also includes topics such as coding of field data and overflow response

2. Maximize use of the collection system for storage

    - Regular hydraulic analysis of the CSO overflow structures, seeking new opportunities to remove regulators or raise dams for additional in-system storage
    - Evaluating and revising the operational set points of the Real Time Control (RTC) system to increase in-system storage
    - Maintaining a robust hydraulic computer model of the CSS as an evaluation tool for improvement to maximize storage options

3. Review and modification of pretreatment requirements to minimize CSO impacts

    - Field inspection of streams and creeks for illicit discharges
    - On-going quality and quantity monitoring of non-domestic discharges that discharge to the CSS
    - Notification to non-domestic discharges of upcoming rain events requesting "wet weather control strategies" be implemented for upcoming event

- Required wet weather control strategies (that is, hold and release and/or delayed cleaning operations during and for a certain time after wet weather events of a defined level by receiving CSO) for new wastewater discharge permits issued to facilities discharging to the CSS
- Evaluated green infrastructure opportunities for existing permittees undergoing expansions

4. Maximization of flow to the POTW for treatment

   - On-going tracking of flow at Morris Forman Water Quality Treatment Center (WQTC), striving for increased treatment at the plant
   - Regular analysis of the Morris Forman WQTC for operational changes to increase combined sewage flow treated

5. Elimination of CSOs during dry weather

   - Weekly inspections of CSOs to address potential dry weather overflows
   - On-going monitoring of possible dry weather overflow data to address recurring dry weather overflows situations programmatically

6. Control of solid and floatable materials in CSOs

   - Regular maintenance of installed solids and floatables (S&F) devices at the CSOs
   - Regular cleaning of trapped street curb inlets, to collect and remove trash and grit from street runoff
   - Commitment to install more robust S&F control technologies at CSO LTCP projects

7. Pollution prevention programs to reduce contaminants in CSOs

   - Regular cleaning of trapped street curb inlets, to collect and remove trash and grit from street runoff
   - On-going coordination with Louisville Metro Public Works to maintain commitment to regularly clean streets and pick up litter

8. Public notification to ensure that the public receives adequate notification of CSO occurrences and combined sewer impacts

   - Annual inspection and maintenance of overflow advisory signage along the Ohio River and forks of Beargrass Creek

- Annual mailing of information about CSOs to customers within 500 feet of the Ohio River and forks of Beargrass Creek
- Maintaining the Project WIN website which includes public document repository of program outreach and documents and quarterly and annual reports
- Automatic email service that sends emails notifying customers of possible CSO events
- Publishing MSD "Update" and MSD "Crosscurrents" which is sent to customers to inform them of various program activities. Examples include not pouring grease down the sink, and staying out of streams after a rain event, etc.

9. Monitoring to characterize effectively CSO impacts and the efficacy of CSO controls

- Monitoring the largest CSOs for overflow volume and frequency
- Monitoring streams to obtain data such as stream flow, pH, dissolved oxygen and other environmental data
- Expanding CSS flow monitoring as part of each of the Final CSO LTCP projects
- Maintaining the existing rain gauge network which covers the entire MSD service area

2.3 USACE FLOOD PUMP STATION OPERATIONS

MSD has the responsibility for the operation and maintenance of an extensive flood protection system that was developed by the US Army Corps of Engineers (USACE) in the 1950s. A significant portion of this flood protection system, 11 of 16 flood pump stations and 162 flood control gates, are associated with MSD's CSS. Therefore, the flood protection system and the CSS operate in an integrated manner when the flood protection system is activated as a result of elevated Ohio River levels. When the USACE developed the flood protection system, their focus was to protect the community from flood damage. The minimization of overflows from the CSS was not the priority.

As a provision under the Consent Decree, entered into Federal Court April 15, 2009, MSD is required to provide for the following outcomes:

- Paragraph 25b, (2) A. (i) - "The final Long-Term Control Plan shall meet the following goals: Ensure that if CSOs occur, they are only as a result of wet weather (this goal shall include addressing those discharges resulting from MSD's compliance with the requirements of the USACE' Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988);"

- Paragraph 26b, (2) B. (i) - "The final Long-Term Control Plan shall include, at a minimum, the following elements: The results of characterization, monitoring, modeling activities and design parameters as the basis for selection and design of effective CSO controls (including controls to address those discharges resulting from MSD's compliance with the requirements of the USACE' Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988);"

Pursuant to this requirement of the Consent Decree, the flood pump station projects identified by this evaluation process to eliminate dry weather overflows will become a component of the selected plan and not be subject to a cost benefit analysis.

The USACE designed and constructed two types of flood pump stations within the CSS. There are dual-purpose flood pump stations that serve as both a sanitary pump station that conveys dry weather flow (DWF) to the interceptor and a flood pump station that conveys wet weather flow to the river during elevated river stages. Also, there is single-purpose flood pump station that serves only to convey wet weather flow to the river during elevated river stages. The following describes the various modes of operation that can exist at a flood pump stations and the potential for them to result in a dry weather overflow.

- **Sanitary Mode** – this mode only applies to dual-purpose flood pump stations. Sanitary pumps at the flood pump stations are set to discharge DWF to the interceptor, flood pumps are deactivated, and flood control gates are positioned to discharge wet weather overflows directly to the Ohio River as a permitted CSO. The dual-purpose flood pump stations are in this mode until the river level reaches the elevation of the top of the CSO dam and before the river mixes with the DWF. This USACE prescribed mode of operation does not result in dry weather overflows.
- **Plant Idle Mode** – this mode is different for the two types of flood pump stations and can be defined for each as follows:
    - Single-Purpose flood pump stations – the plant idle mode for single-purpose flood pump stations means that the facility is inactive and that flood control gates are positioned to convey wet weather flows directly to the Ohio River as a permitted CSO. This USACE prescribed mode of operation does not result in a dry weather overflow.
    - Dual-Purpose flood pump stations - the plant idle mode for dual-purpose flood pump stations means that all pumping at the facility has stopped, the flood pump stations have been isolated from the CSS and all flow is conveyed to the river during both dry and wet weather. During dry weather periods this USACE prescribed mode of operation results in a continuous dry weather overflow. During wet weather it results in a permitted CSO.

- **Minor Flood Mode** – this applies to single-purpose flood pump stations and indicates a mode of operation between plant idle and flood mode which requires the repositioning of selected flood control gates. The flood pumps are deactivated during this mode. There is the potential that the USACE prescribed mode of operation can result in a dry weather overflow.
- **Flood Mode** – this mode is different for the two types of flood pump stations and can be defined for each as follows:
  - Single-Purpose flood pump stations – the flood mode for single-purpose flood pump stations means that the flood pumps have been activated (energized) and are available to pump wet weather flows to the Ohio River as permitted CSOs and that all flood control gates are positioned to prevent the river from backing up into the CSS due to elevated river levels. This USACE prescribed mode of operation does not result in dry weather overflows.

  - Dual-Purpose flood pump stations - the flood mode for dual-purpose flood pump stations means that the flood pumps have been activated (energized) and are available to pump both wet and dry weather flows to the Ohio River and all flood control gates are positioned to prevent the river from backing up into the CSS due to elevated river levels. During dry weather periods this USACE prescribed mode of operation results in a continuous dry weather overflow. During wet weather it results in a permitted CSO.

Throughout the development of MSD's CSO Abatement Program, specific opportunities were identified where modifications in the original procedures outlined in the USACE's Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988 (USACE Manual) could be modified to reduce overflows from the CSS and still maintain the integrity of the level of flood protection provided by the system. During 2002, MSD modified operating parameters at three flood pump stations (4th Street Flood Pump Station, 34th Street Flood Pump Station and Paddy's Run Flood Pump Station) and respectively modified the USACE Manual upon approval from USACE. These modifications reduced the frequency and volume of CSOs at these locations.

The following flood pump stations within the CSS were evaluated to define specific physical and/or operational modifications necessary to ensure that the USACE prescribed modes of operation, as described above, do not result in dry weather overflows:

- 4th Street Flood Pump Station and 17 flood control gates
- 5th Street Flood Pump Station and 7 flood control gates
- 10th Street Flood Pump Station and 11 flood control gates
- 17th Street Flood Pump Station and 10 flood control gates

- 27th Street Flood Pump Station and 12 flood control gates
- 34th Street Flood Pump Station and 20 flood control gates
- Beargrass Creek Flood Pump Station and 13 flood control gates
- Paddy's Run Flood Pump Station, Sluice Gate Chamber, and 15 flood control gates
- Shawnee Flood Pump Station and 24 flood control gates
- Starkey Flood Pumping Station and 8 flood control gates
- Western Flood Pump Station and 25 flood control gates

Figure 2.3.1 at the end of the chapter provides a location map for the eleven flood pump stations evaluated.

Appendix 2.3.1 is a USACE Flood Pump Station Operation Modification Technical Memorandum which provides a detailed summary of the current operational modes of each of the considered flood pump stations and recommendations for operational and/or physical modifications. The results of the evaluation revealed that six of the flood pump stations require operational modifications and five require physical modifications to ensure that dry weather overflows do not result from mandated operational procedures as outlined in the USACE Manual. To implement the projects identified in the Technical Memorandum the following actions will need to taken:

- Develop plans and specifications for each of the identified projects.
- Prepare revisions to the USACE Manual that reflects the operational and physical modifications proposed by this Technical Memorandum.
- Secure review and approval by the USACE. Coordination with, and approval by the USACE will be required prior to any modifications being made to the congressionally authorized flood protection works for Louisville, Kentucky. A reasonable amount of time for USACE involvement has been included in the scheduled completion dates for the proposed projects. However, although it is not anticipated, delays in USACE approval and responses beyond these time estimates could impact scheduled completion dates.

2.4 DESCRIPTION OF SYSTEM/COMPILATION OF EXISTING DATA

The objective of the system characterization is to understand the complete CSS and receiving water to establish the existing baseline conditions. This section presents a detailed description of the physical characteristics of the CSS and receiving stream watersheds, as well as a description of the pipe network flow monitoring and CSS water quality sampling.

2.4.1 Overview of CSO System and Watershed/Sewershed Mapping

The sewer system owned, operated and maintained by MSD has evolved for almost a century and a half into an extensive network of both sanitary and combined sewers, diversion structures, mechanical regulators and other flow control devices, WQTCs, and pump stations. The expanse of the overall separate sanitary sewer service area and the limit of the older combined sewer area are exhibited in Figure 2.4.1 at the end of this chapter. The combined sewer area encompasses 24,000 acres (37 sq. miles) which is about one-third of the Morris Forman WQTC service area. MSD has subdivided the combined sewer area into three regions for study and evaluation purposes. A detailed description of the CSS within each region is provided in the following sections. See Figure 2.4.2 at the end of this chapter. As part of the green infrastructure analysis, MSD performed additional characterization of the entire combined system along with more detailed evaluations of each sewershed with active overflows.

An important element of this analysis was a detailed evaluation of the impervious area characteristics across the entire CSS. The goal of the exercise was to determine the distribution of impervious area, including roadways, rooftops, parking lots and sidewalks, in an effort to understand the major sources of stormwater runoff to the CSS.

This data was further analyzed to calculate the distribution of impervious areas within each of the following landuse classifications.

- Residential
- Commercial
- Industrial
- Parks/Open Space
- Vacant Land
- Public Space

Based on this evaluation, green infrastructure programs were developed targeting specific landuse types. For example, downspout disconnection, and rain barrel and rain garden programs focus on residential landuses. In addition, MSD evaluated each CSO sewershed with an active overflow for the following information:

- Total area of roadways
- Total area of rooftops
- Total area of miscellaneous transportation (parking lots and sidewalks)
- Area of public rooftops

- Area of public parking lots
- Number of catch basins
- Area of single family rooftops
- Number of single family homes
- Suitability for downspout disconnect

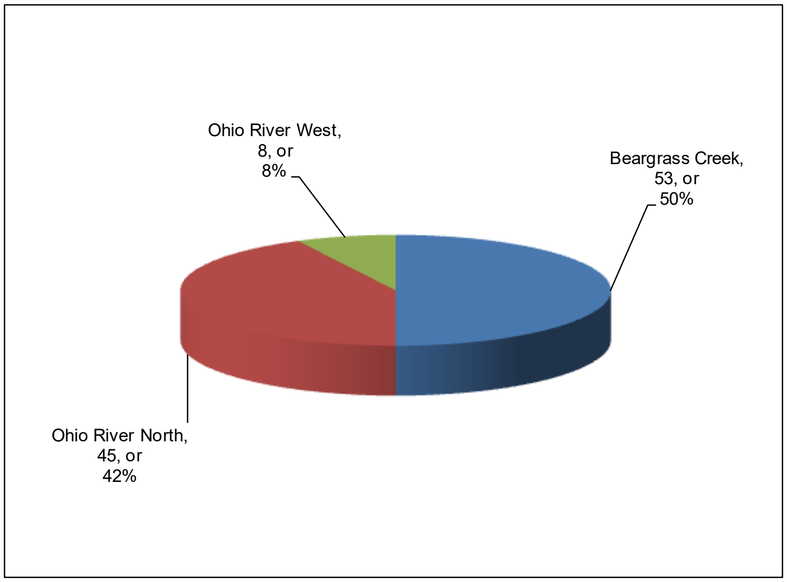
This higher level of characterization allows MSD to properly evaluate and select green infrastructure techniques for individual sewersheds as well as the entire CSS. For specific results and a more elaborate explanation of this characterization effort, please refer to Chapter 3, Section 2.1.4.

2.4.2 Collection System Understanding

In the CSS, DWFs are conveyed to the Morris Forman WQTC to remove pollutants before discharging to the Ohio River. During wet weather conditions, when capacity of the CSS is exceeded, the excess flow, a mixture of sewage and stormwater runoff, is discharged to the South Fork Beargrass Creek, Middle Fork Beargrass Creek, Muddy Fork Beargrass Creek, and the Ohio River. The typical system constrictions are presented schematically and graphically in Figures 2.4.3 through 2.4.6 at the end of this chapter. The CSS receives flows from upstream separate sewer areas at six major boundary locations. Approximately 45 percent of the total sanitary flow conveyed to the Morris Forman WQTC is contribution from the upstream separate sewer system.

There are 106 active CSOs within the MSD service area. Figure 2.4.7 presents the distribution of CSO locations within each major geographical area: Ohio River North, West and Beargrass Creek.

FIGURE 2.4.7 NUMBER OF CSOS PER REGION



A computer model was utilized to project the average annual hydraulic volume within the CSS. Figure 2.4.8 presents a summary of the Average Annual Overflow Volume (AAOV) by major geographical region, along with the percentage of the total CSO system volume by region. A comparison of the AAOV expressed as a percentage of the receiving stream flow to which the CSOs discharge is provided in Table 2.4.1.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 2.4.8 VOLUME OF CSOS PER REGION

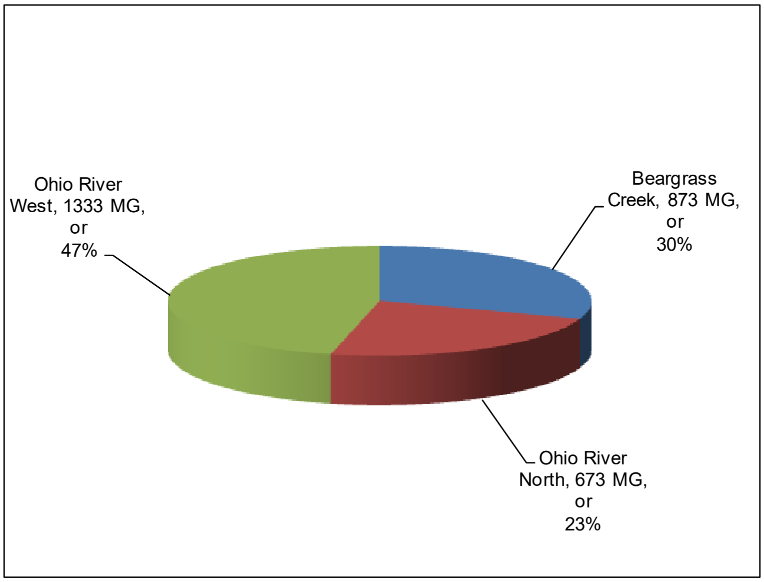


TABLE 2.4.1
CSO AAOV AS PERCENTAGE OF RECEIVING STREAM FLOW

CSO Volume Outdated

Refer to Chapter 5

CSO Region	Volume of Stream Flow MG/Yr	Volume of CSOs MG/Yr	CSO Volume as Percentage of Stream Flow
Beargrass Creek	27,989	873	3.119%
Ohio River North	[illegible]	[illegible]	0.001%
Ohio River West	65,838,307	1,333	0.002%
MG – million gallons			

To project annual hydraulic loads, the following information was used:

- Typical rainfall year information described in Chapter 2, Section 4.3
- Calibrated computer simulation model described in Chapter 2, Section 4.6.
- Three United States Geological Survey (USGS) Stream Flow gauges were used to estimate the volume of stream flow on Beargrass Creek and Ohio River: USGS 03292500 South Fork of Beargrass Creek at Louisville, USGS 03293000 Middle Fork of Beargrass Creek at Old Cannons Lane, and USGS 03294500 Ohio River at Louisville.

2.4.3 Rainfall Monitoring

Having accurate rainfall data is critical for proper CSS characterization, as well for performance monitoring of CSO controls that are in place. The EPA CSO Policy requires that the permittee evaluate flow variations in the receiving water body to correlate between CSOs and receiving water condition. This cannot be done without accurate rainfall monitoring.

2.4.3.1 Rainfall Monitoring History

MSD has been monitoring rainfall since 1991. The initial rain gauges were installed in 1991 as a joint effort between MSD and the USGS and the information was to be used for MSD studies and USGS research.

In 1997, MSD took over sole responsibility for the rain gauge network. Because the data logger type rain gauges were non-telemetered, MSD personnel was required to download the information stored within each of the rain gauges. Though labor intensive, these rain gauges worked extremely well.

The rain gauges recorded total rainfall in five-minute increments. Eight of these gauges were located within or adjacent to the combined sewer drainage area and the data from these gauges were used in the model calibration process. The locations of these eight gauges are listed in Table 2.4.2 and are shown in Figure 2.4.9 at the end of this chapter.

TABLE 2.4.2
ORIGINAL RAIN GAUGE LOCATIONS

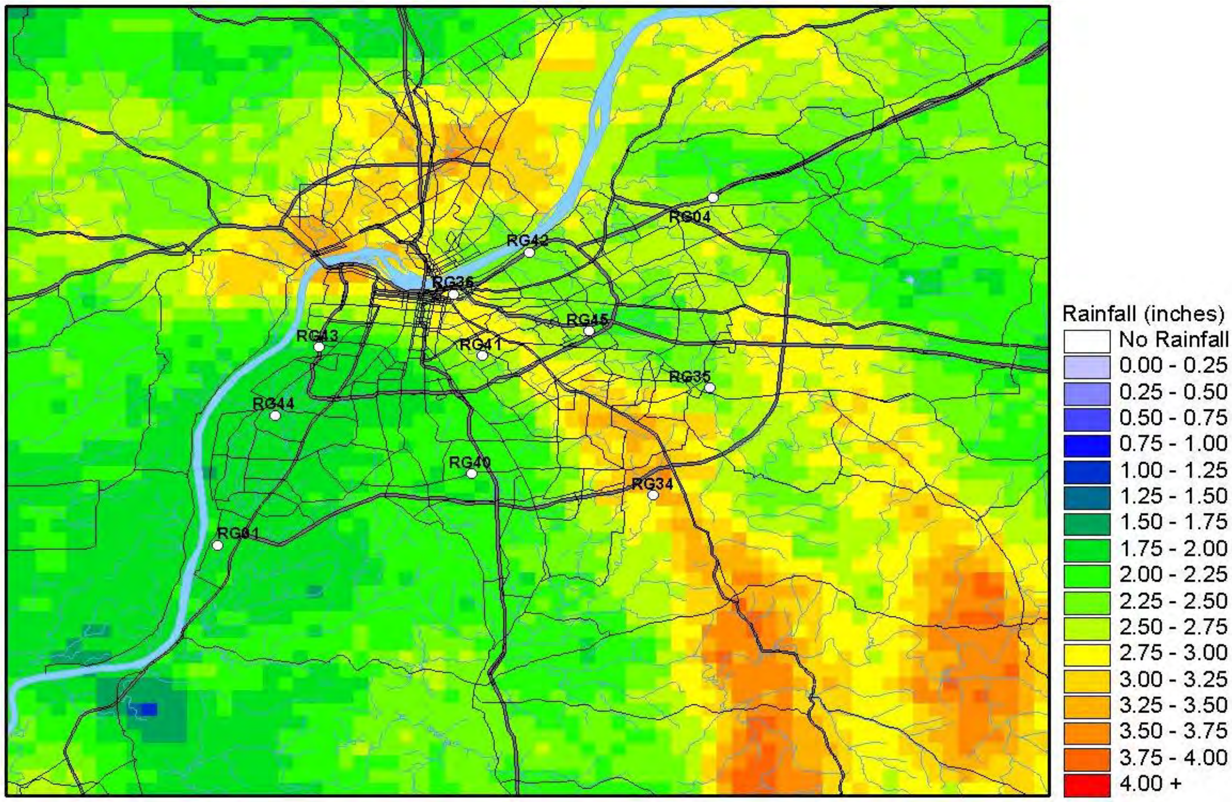
RAIN GAUGE NO.	LOCATION
6	Seneca Golf Course along Bon Air Avenue
7	Louisville Water Tower at Zorn Avenue
9	Iroquois Golf Course along Taylor Boulevard
10	Morris Forman Treatment Plant along Algonquin Parkway
14	Standiford Field along Standiford Avenue
19	South Fork Beargrass Creek at Trevilian Way
20	USGS Office on Bradley Avenue
29	Downtown Louisville at MSD Headquarters, 6th & Cedar
Source: 1993 Combined Sewer Operational Plan	

In 1997, 11 telemetry-equipped rain gauges were installed. The primary purpose of these rain gauges was to provide real-time data for emergency response and engineering support. The majority of these rain gauges were installed at MSD facilities located throughout Jefferson County. For the purposes of emergency response support, the rain gauges performed adequately. However, with the implementation of the RTC project, these telemetry-equipped rain gauges did not meet the requirements of RTC because the geographic distribution and the telemetry system used at the time were deemed insufficient to provide the needed information in a timely manner. In order to meet the goals of the RTC project and to provide better emergency response support, the telemetry-equipped rain gauge system required modification.

In the Spring of 2003, 15 new telemetry-equipped rain gauges, replacing original 11 gauges were installed throughout Jefferson County. This updated rain gauge system serves two primary functions - to calibrate weather service Next-Generation Radar (NEXRAD) with rain gauge data, and to assist in providing accurate two-hour predictive rainfall data. Currently, this information is utilized by MSD's RTC project and for emergency response preparation. The new rain gauge network also provides a better geographical coverage of Louisville Metro as shown in Figure 2.4.10 at the end of this chapter.

The majority of the storms approaching Louisville Metro approach from the northwest. Therefore, MSD established three additional satellite-enabled rain gauges in the Southern Indiana counties of Harrison, Floyd, and Clark. These rain gauges provide MSD with the ability to better calibrate rainfall predictions based on storms approaching from the northwest. Since the RTC project requires a two-hour predictive capability, rain gauges located outside Jefferson County provide MSD with the data needed to make these predictions. Figure 2.4.11 is a graphical presentation of radar rainfall.

FIGURE 2.4.11 EXAMPLE OF RADAR RAINFALL



2.4.3.2 Basis of Typical Year Analysis

EPA's CSO Control Policy (1994) requires the effectiveness of CSO controls to be evaluated on a "system-wide, annual average basis." Identification of annual average rainfall conditions is a fundamental step in the LTCP process.

At the time of the initial model development (early 1990s), 31-years of rainfall records (1960 to 1991) were obtained from National Oceanographic and Atmospheric Administration (NOAA) as recorded at the National Weather Service (NWS) at Standiford Field. The rainfall records data was categorized by peak intensity, total rainfall, and duration.

Several approaches were available to analyze the performance of the CSS. Continuous simulation of long-term rainfall records was thought to provide more reliable predictions of overflow quantity on a regional basis than other methods considered at that time. However, due to limitations in computer processing time and data storage considerations that existed in the early 1990s, continuous simulation of an annual rainfall record was a significant limiting factor.

An alternate approach was developed which used detailed simulations for a number of discrete events. This approach allowed for generation of detailed model output (volumes, durations, peak rates) that would be useful for preliminary engineering planning, as well as data that would be useful for developing long-term overflow statistics. This approach was used in the initial stages of the project to estimate AAOVs.

A series of reference storms of varying return frequency were extracted from the NWS 31-year rainfall record based on a statistical analysis of key parameters in the rainfall record (total precipitation, intensity, duration). Ten actual historical storms were simulated using the sewer system model, and overflow volumes for each CSO and runoff volume for each drainage catchment were obtained. A mathematical regression of the data points provided predictive equations for overflow volume and runoff based on total rainfall for each storm in the historical record. The predicted volumes for all storms over the years provided an estimate of the AAOV for each CSO.

The combination of improvements in computer hardware technology and improvements in the model software since the early 1990s made continuous model simulation over long periods significantly more feasible. One of the many benefits from continuous simulation was that this technique automatically accounted for intermittent dry periods between rain events and for consecutive, closely spaced events. In 2004, MSD changed its method of calculating AAOV from a reference storm approach to a typical rainfall year approach using continuous model simulation. The analysis methodology currently being used is described in further detail in the following paragraphs.

A statistical analysis of a 54-year historical rainfall record (1948-2002) at KY4954 - Louisville Standiford Field gauge, was performed for the Jefferson County region in 2003 and updated in early 2008. The characteristics of a typical yearly rainfall that could be used for continuous simulation to obtain estimates of AAOV were determined. Individual rain events were sorted and ranked according to six characteristics: number of events, total precipitation, average intensity, maximum intensity, duration, and antecedent dry period.

Two different methods were used to determine the typical year. One method was to determine the typical year by selection of an entire historical year that most closely matched the average rainfall characteristic values from 54 years of record. Each individual year was compared to the average values for the six statistics noted above, and the year having values closest to the means was selected as the typical year. From this method, historical year 2001 was selected as the historical typical year.

Another method of establishing a typical year was also examined. This method consisted of “building” a year comprised of 12 individual months, wherein each month was extracted from the historical database based on matching the average characteristics on a monthly basis rather than an annual basis. The details of this analysis were provided in a Technical Memorandum in March 2008 Appendix 2.4.1 includes the Rainfall Selection Analysis Technical Memorandum with a full description of the methodology applied.

The overall 55-year mean for each of the six storm statistics, along with the mean statistics for 2001 and the monthly synthetic year as described above are presented below in Table 2.4.3.

TABLE 2.4.3
OVERALL MEAN FOR 2001 AND A SYNTHETIC YEAR

Parameter	Overall Mean 1948 - 2002	Year 2001	Synthetic Year
Number of Events	92	91	91
Total Duration, Hours	530	516	568
Total Depth, Inches	41.25	42.83	40.84
Maximum Storm Average 60-Minute Intensity, Inch/Hour	1.19	0.83	0.84
Average Storm Intensity, Inch/Hour	0.08	0.08	0.07
Time From Last Event, Hours	92	91	89

Sewer system model simulations were conducted for both the typical years selected using each methodology described above. Ultimately, application of the 2001 historical precipitation event sequence was selected as the more appropriate method to use in evaluating CSO control alternatives for the following reasons:

- Represented a typical year of precipitation characteristics reasonably well, although not quite as well as a synthetic year might
- The receiving water models used for the Water Quality Tool (WQT) and Ohio River water quality impact analyses used the rainfall history and stream flow data from the same time, year 2001.
- Sewer system modeling required to establish baseline CSO loadings, size CSO control alternatives and evaluate their performance also utilized the 2001 rainfall year to:
- Maintain consistency between the CSO load projections and water quality impact analyses
- Maximize use of available overall system configuration and operating data for assessment of results
- Avoid potential confusion with regulatory agencies, stakeholders and the public that could arise by applying different precipitation records over different timeframes in the analyses.

2.4.4 Flow Monitoring

Monitoring programs for CSO control planning serve many objectives, including those listed in the CSO Guidance for LTCPs (EPA, September 1995):

- Define the CSS hydraulic response to rainfall
- Determine CSO flows and pollutant concentrations/loadings
- Evaluate the impacts of CSOs on receiving water quality
- Support the review and revision of water quality standards
- Support implementation and documentation of the NMC
- Support the evaluation and selection of long-term CSO controls
- Gain a thorough understanding of the CSS
- Adequately characterize the CSS response to wet weather events, such as the number, location, and frequency of the CSOs and the volume, concentration and mass of pollutants discharged
- Support a mathematical model to characterize the CSS
- Support the development of appropriate measures to implement the NMC
- Support LTCP development
- Evaluate the expected effectiveness of the NMCs and, if necessary, the long-term CSO controls

Achievement of these objectives requires both monitoring for flows and sampling for water quality characteristics. Flow monitoring in the combined sewer service area, including CSOs, is commonly used to refine understanding of the system and to calibrate and verify models used to evaluate impacts of potential CSO control alternatives. Water quality sampling in the CSS, including CSOs, is commonly used to characterize the contents of the combined sewer over flows, identify "hot spots" of higher strength sewage, and characterize the quality of CSO discharges.

The combination of flow monitoring and sampling is used to characterize pollutant loadings from CSOs into the receiving waters. Sampling in the receiving waters is used to evaluate impacts from CSOs relative to other pollutant loadings in the receiving waters and to calibrate and verify models for evaluation of alternative loading scenarios.

MSD flow monitoring includes data from receiving water flow monitoring stations operated by USGS, data from long-term sewer flow monitoring stations, and data from several study-specific short term flow monitoring locations. The locations of the long-term sewer system and receiving water monitoring stations are located in the September 15, 2006, submittal of the NMC Compliance Report.

The sewer system flow monitoring data was coupled with episodic CSO flow monitoring to calibrate and verify models that both expand the characterization of CSOs and allow evaluation of the effectiveness of CSO control alternatives. Table 2.4.4 describes the locations of long-term CSO flow monitors.

TABLE 2.4.4
SUMMARY OF 22 LONG-TERM SEWER FLOW MONITORS

CSO No	Sites	Description	Receiving Water	Installation Date
127	Etley Avenue	Etley Avenue	MF BGC	Jun-05
140	Locust Street	Locust Street	MF BGC	Jun-05
166	Lexington Rd @ I-64 Over Pass	Beals Branch Sanitary Diversion	MF BGC	Dec-06
206	Cherokee Park	Cherokee Park @ Spring Dr	MF BGC	Jun-05
125	Grinstead Dr & I-64 near entrance ramp	REG NO 24 - Grinstead Dr	MF BGC	Nov-07
132	Brownsboro Rd @ Storage Co.	REG NO 35 - Brownsboro Rd.	Muddy Fork BGC	Dec-06
019	34th Street & Rudd	34th Street Pump Station	Ohio River	May-05
105	Broadway & Western Pkwy	Western Outfall @ Broadway	Ohio River	Dec-06
189	Shawnee Park Pump Station	Northwestern Sanitary Diversion	Ohio River	Apr-06
190	Northwestern Pkwy	Seventeenth St Sanitary Diversion	Ohio River	Jul-06
191	Bells Lane	Southwestern Pump Station	Ohio River	Jul-06
210	Whayne Supply @ Diversion Structure	45th Street-Greenwood	Ohio River	Jul-06
211	Whayne Supply @ Diversion Structure	Main Diversion Structure	Ohio River	Jul-05
108	Newburg Road	REG No 1 - Newburg	SF BGC	Jun-05
117	Dry Run Sewer @ Beargrass Creek	REG No 11 - Dry Run	SF BGC	Jun-05
118	Broadway & Beargrass Creek	REG No 15 - East Broadway	SF BGC	Jul-06
151	Castlewood Avenue	REG No 5 - Castlewood	SF BGC	Jun-05
152	Ruffer Avenue	REG No 7 - Southeastern	SF BGC	Jun-05
182	Shelby & Burnett Street	SBR Shelby & Burnett	SF BGC	Jul-06
146	Swan Street South Fork of BGC	Sneads Branch Diversion	SF BGC	Mar-08
88	Brownsboro Rd @ Beargrass FPS	Mellwood Avenue Interceptor	SF BGC	Jun-06
110	Eastern Parkway	REG No. 3-Gross Avenue	SF BGC	Jul-05

The models use proven engineering principles, primarily hydrologic calculations, conservation of mass and conservation of energy, to estimate flows at unmonitored locations. In addition, the accuracy of flow monitors is highly dependent upon the ability to calibrate and verify the installed monitor for the range of flow conditions. It is impossible to calibrate or verify monitors for peak flow conditions in the field; hence, monitored flow data during CSOs is far less accurate than monitored data for non-overflow conditions. Hydraulic models are proven by testing them against measured conditions at the monitored locations during non-surcharged (non-peak) flow conditions when data are most reliable, then by comparing them to the less accurate data collected during peak flow conditions.

MSD performed flow monitoring specifically to calibrate the model during the years 1993, 2002, and 2007. The work done in 1993 was to provide data for the initial calibration of the model. In 2002 and 2007, flow monitoring was performed to re-calibrate the model. A discussion of the results of the flow monitoring and sampling programs is described later in this Chapter under the respective discussions of the Beargrass Creek regional facilities and the Ohio River regional facilities.

MSD maintains the long-term flow monitors to observe flow rates and to monitor changing system conditions in its systems. MSD operates six permanent, hard-wired monitors, four in the combined sewer area, and two in the west county area. The permanent monitors are integrated into the RTC systems. The monitors in the combined sewer area provide a strong base for quantifying the flows in the CSS and for calibrating hydraulic models of the combined sewer area. MSD deploys temporary monitors when necessary to further refine or confirm the understanding of the flows in the CSS. MSD will also deploy several simpler devices (floats, chalk lines) and post-storm inspections to confirm the frequency of CSOs.

MSD resolved to monitor all CSOs which have an estimated overflow exceeding 10 MG AAOV as predicted by the XP-SWMM model. MSD remains committed to monitoring flows from these sites where feasible. MSD will re-evaluate the CSOs which have overflows exceeding 10 MG AAOV, using InfoWorks CS model and develop a plan to monitor these locations.

Since the last sewer calibration effort, MSD has greatly expanded its long-term monitoring network, including numerous monitors on the combined sewer outfalls. This expansion and the use of the data for project modifications is discussed in Chapter 5.

2.4.4.1 Flow Monitoring – 1992 Program

During the original development of the CSS model, flow monitoring was conducted in two phases due to the large combined sewer area and complexity of the system. For Phase I, the installation of the flow meters began in late November and early December 1991. By the first week of January 1992, 23 flow meters were installed at various locations in the central and western part of Louisville Metro and in the area around the Robert J. Starkey Pumping Plant, formerly known as the Buchanan Street Pump Station. The 24th flow meter was installed on the Northwestern Sanitary Trunk Sewer during the third week of January. The flow meter locations for Phase I are shown on Figure 2.4.12 at the end of this chapter.

Phase II of the flow monitoring program commenced in April 1992. For this phase, 17 of the 24 flow meters from Phase I were relocated from the western and central portions of the combined sewer area to the basins of the Middle and South Forks of Beargrass Creek. The flow meter locations for the Phase II flow monitoring are shown on Figure 2.4.13 at the end of this chapter.

This particular flow monitoring effort officially ended on June 20, 1992. Nine different storm events were chosen from the information obtained by the rain gauges and flow monitors during Phase I, and four different storm events were chosen from data recorded during Phase II for calibration purposes. A separate report, titled "Report on Combined Sewer System Flow Monitoring" (Tenney Pavoni Associates Inc., 1993) details the flow monitoring conducted on the CSS.

2.4.4.2 Flow Monitoring – 2002 Program

During the year 2002, additional flow monitoring of the CSS was performed as a part of the model maintenance activity. A total of 19 flow meters were installed for the monitoring period of January 29, 2002, to April 11, 2002. Upon completion of this monitoring period, data from the flow monitors were analyzed to establish baseline flow(s) for DWFs characteristics in each basin. Additionally, wet weather and DWFs analyses were performed and the information was utilized to update the original model calibration. During the year 2002 monitoring period, five significant storm events (that is, rain events exceeding 0.5 inches) occurred. For calibration, the fourth and fifth events were selected for simulation. The fourth storm event, March 19, and the fifth storm event, March 25, recorded totals of 2.9 inches and 2.8 inches of rainfall, respectively. Figure 2.4.14 at the end of this chapter shows the flow meter sites. A separate report, titled "Flow Monitoring Report" (GRW Engineers Inc., 2002) details the flow monitoring conducted on the CSS.

2.4.4.3 Flow Monitoring – 2007 Program

During the year 2007, additional flow monitoring of MSD's system was performed to support hydraulic modeling. Approximately 145 flow monitors were temporarily installed by a contractor beginning in January 2007 through mid June 2007 throughout the MSD service area. Of the 145 monitors, 25 monitors were located within the CSS area. Upon completion of this monitoring period, data from the flow monitors were analyzed to establish baseline flow(s) and diurnal patterns for each basin. The flow monitor sites within the CSS area are exhibited in Figure 2.4.15 at the end of this chapter.

2.4.4.4 Flow Monitoring – 2012 Program

MSD is in the process of finalizing an expanded long-term flow monitoring program. According to the "Combined Sewer Overflows - Guidance for Monitoring and Modeling" (EPA, 1999) document, a CSS monitoring program will support in-depth system characterization and post-construction compliance monitoring that are central elements in the LTCP.

MSD currently has various long-term sewer flow monitors in place throughout the Louisville Metro area and is proposing additional locations. Temporary flow monitors will supplement long-term flow monitors in key areas of the sewer system at a minimum of every two years to assist in monitoring the IOAP capital projects. The temporary monitors will be placed in areas affected by capital construction, green infrastructure, and sewer rehabilitation. MSD will supplement long-term flow monitor data to express a more accurate portrayal of the effectiveness of the projects and the data collected will support the recalibration of the hydraulic and water quality models. Figure 2.4.16, at the end of this chapter, exhibits the locations of the long-term flow monitors currently installed. Refer to Chapter 5 and IOAP Volume 1 Chapter 6 titled "Post Construction Compliance Monitoring" for more details.

2.4.5 CSO Water Quality Characteristics

Monitoring data available for CSO characterization and planning includes both monitoring for flows and sampling for water quality characteristics. Section 10.4 of the NMC Compliance Report (MSD, September 15, 2006) provides a summary of past flow monitoring and sampling activities, while the Post Construction Compliance Monitoring Plan addresses ongoing monitoring, sampling and modeling activities in Volume 1 Chapter 6.5 of the IOAP.

The environmental data collected through stream and sewer monitoring as well as grab samples during dry and wet weather are analyzed every two years in a synthesis report. MSD published its most recent report in December 2007 in cooperation with the University of Louisville. The report assesses to some degree, the full set of environmental data collected within MSD's long term monitoring network, identify correlations between data sets and associate probable water quality, stream health, and habitat impacts. The report also provides recommendations for improvements in data collection and quality control. The first report, published in 1999, provided recommendations to establish MSD's current monitoring network and MSD continues to implement additional recommendations from this and the 2007 report to improve data quality. The next synopsis report, which will further this analysis, will be completed in December 2009.

While the majority of the collected data sets shows high variability, this aspect is characteristic of most other long term monitoring efforts for complex, highly urbanized watersheds. The variability does not indicate that the data is unreliable, only that system model calibration efforts and outputs must be reviewed cautiously and that solutions to improve water quality should be applied conservatively.

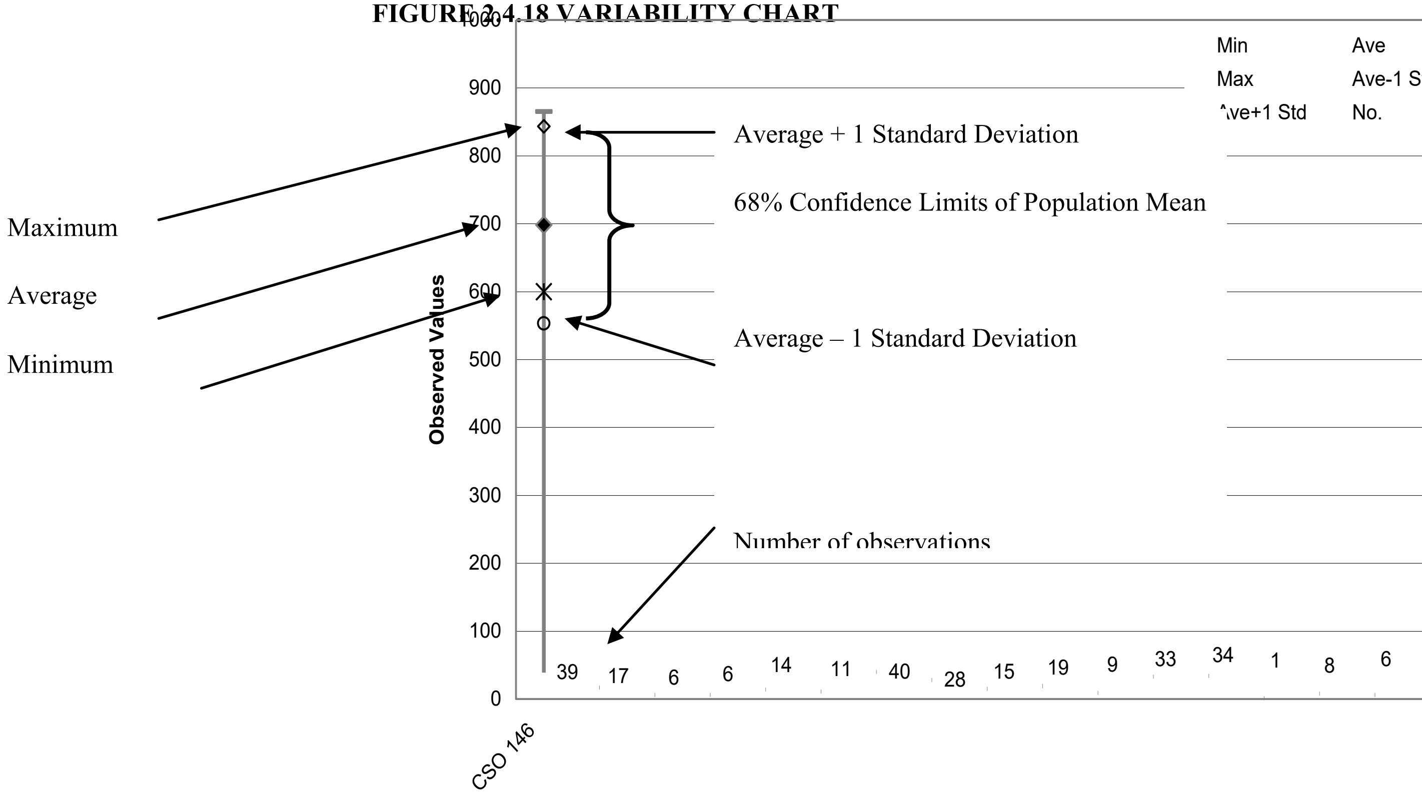
2.4.5.1 CSS Sampling of CSOs

Past sampling of CSOs in MSD sewers yielded a multitude of observations of numerous distinct analyzes. The full range of analyzes and their observations are listed in a Technical Memorandum titled Interim CSO LTCP Addendum in November 2006. Figure 2.4.17, at the end of this chapter, shows the location of the CSO and CSS sites monitored to-date within the MSD system.

Most samples were collected by automated samplers using consistent sampling protocols that included more frequent sampling early in a storm, tapering off to less frequent through the remainder of the first three hours of the storm. This sampling protocol is biased toward the early "first flush" portion of the overflow hydrograph. Site storm samples were composited on a flow proportional basis prior to analysis; thus, each data point approximates an event mean concentration for that particular storm and event.

Table 2.4.5 at the end of chapter, summarizes the data collected to-date in the CSOs for TSS, biochemical oxygen demand, and fecal coliform. As previously noted, the samples show a variability that is characteristic of environmental sampling, and even more prevalent in wet weather sampling. The standard deviation of the observations is the selected measure of the variability. If the data are normally distributed, one can be 68 percent confident that the average of the population is within one standard deviation of the average calculated from the observations. The significance of multiple observations at one site is commonly graphed as explained in Figure 2.4.18.

FIGURE 2.4.18 VARIABILITY CHART



Statistically, the population mean is somewhere within the confidence limits. Any value within those limits is not statistically different from the sample average. TSS, biochemical oxygen demand, and fecal coliform data are summarized here because of the perceived significance to CSO LTCP planning. TSS are summarized because it is commonly of interest in wastewater impact evaluations and is used as a surrogate for pollutants known to 'attach' to sediments.

Biochemical oxygen demand is summarized because it is commonly of interest in wastewater impact evaluations and because it is related to dissolved oxygen, one of the two parameters cited by Kentucky Department of Environmental Protection (KDEP) as out of compliance in the receiving waters. Fecal coliform is summarized because it is commonly of interest in wastewater impact evaluations and because it is cited by KDEP as "out of compliance" in the receiving waters.

Figure 2.4.19 illustrates that the TSS data in the CSOs show a high degree of variability. With the degree of variability evidenced, it is not possible to conclude that any site has a total suspended solids (TSS) concentration that is significantly different from any other site. CSO019 shows some evidence of a higher concentration, but with only six observations, it shows only weak evidence of a higher TSS concentration. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. All of the sites with more than six observations have data consistent with a mean event concentration of 200 million gallons per liter (mg/l) TSS. That is to say, 200 mg/l TSS is within one standard deviation of the mean for all sites with multiple observations.

FIGURE 2.4.19 SUMMARY OF CSO WATER QUALITY DATA FOR TOTAL SUSPENDED SOLIDS

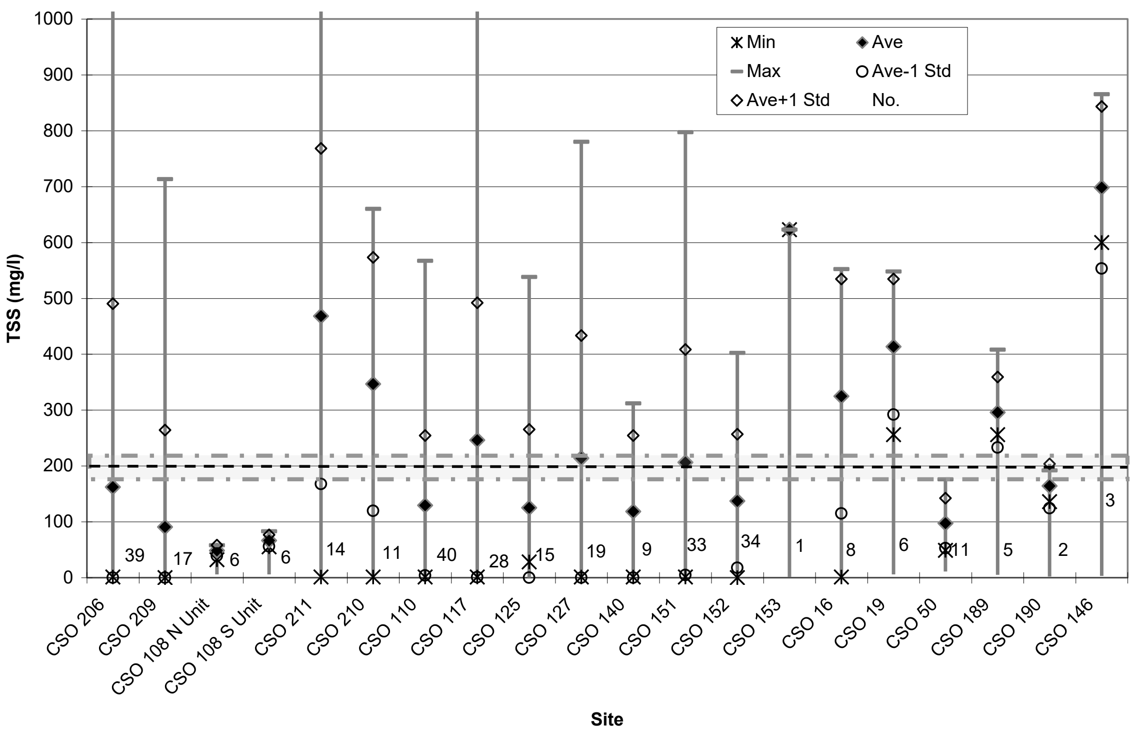


Figure 2.4.20 illustrates that the biochemical oxygen demand data in the CSO samples show a high degree of variability as well. With the degree of variability evidenced, it is not possible to conclude that any site has a biochemical oxygen demand concentration that is significantly different from any other site. There is no statistically significant difference between sites draining highly commercialized or industrialized zones. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. Most of the sites, particularly those with more than six observations, are consistent with a mean event concentration of 75 mg/l biochemical oxygen demand. That is to say, 75 mg/l biochemical oxygen demand is within one standard deviation of the average for the sites. The exceptions would indicate that some sites (for example, CSO 140) might have lower average concentrations.

FIGURE 2.4.20 SUMMARY OF CSO WATER QUALITY DATA FOR BIOCHEMICAL OXYGEN DEMAND

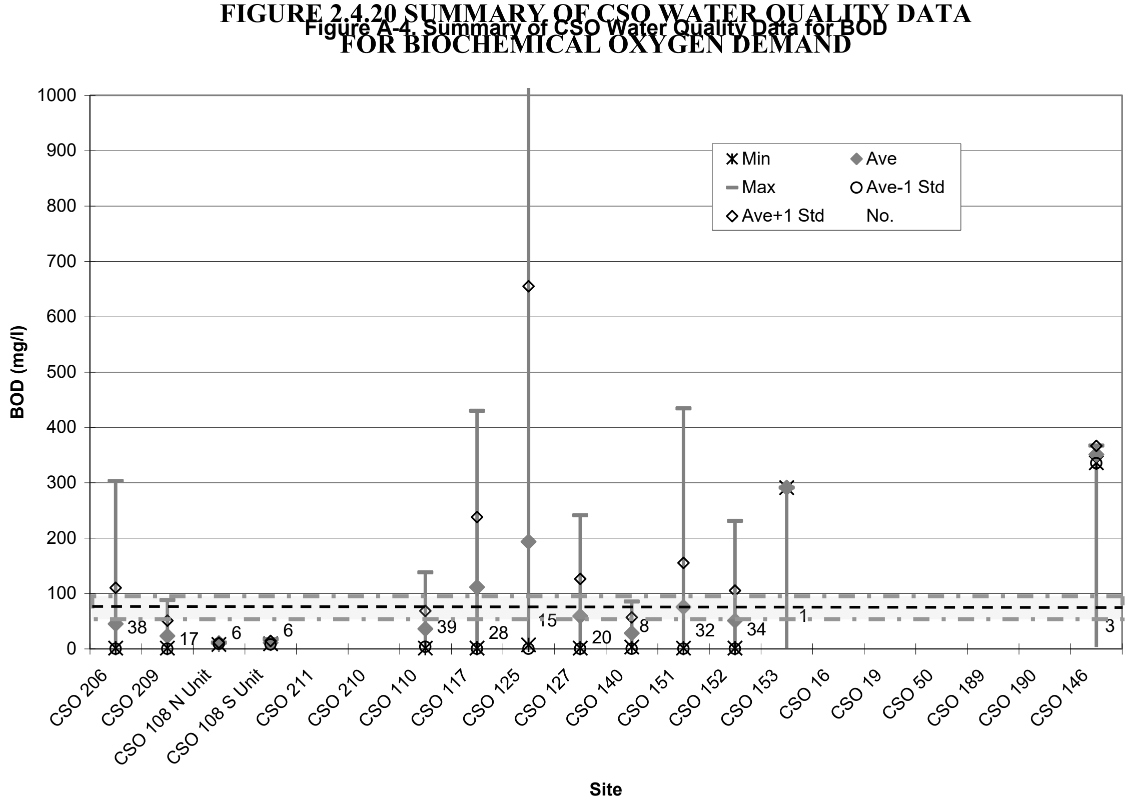
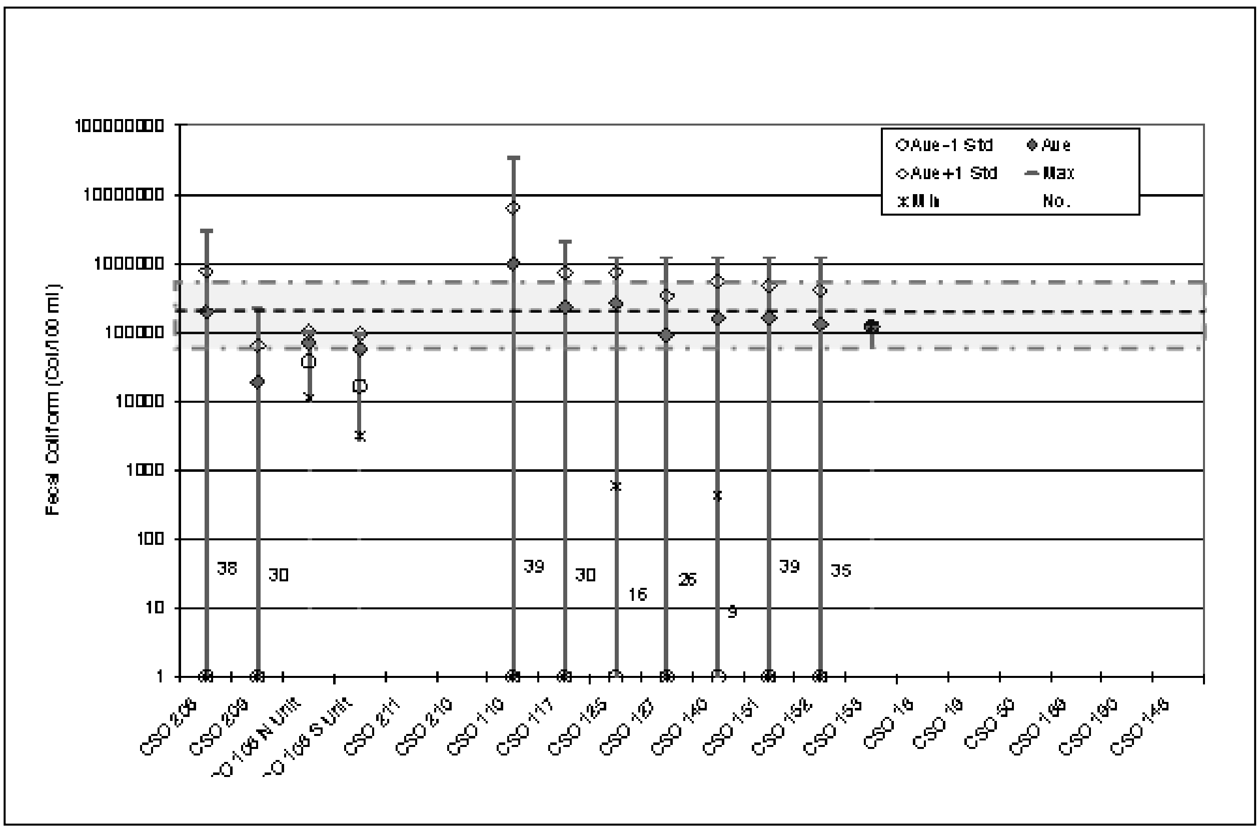


Figure 2.4.21 illustrates that the fecal coliform data in the CSO samples show a higher degree of variability. Measurement of fecal coliform is itself imprecise, with expectations that duplicate measurements from one sample will often vary by an order of magnitude. Consequently, variations less than an order of magnitude are arguably insignificant. With the degree of variability evidenced in the CSOs, it is not possible to conclude that any site has a fecal coliform concentration that is significantly different from any other site. There is no distinguishable difference between sites draining highly commercialized or industrialized zones. Given the inherent variability evidenced in the data, it is unlikely that more samples would result in concentrations that show significant variation between the sites. All of the sites have observations consistent with an event mean concentration of 250,000 col/100 ml fecal coliform. That is to say, 250,000 col/100 ml fecal coliform is within one standard deviation of the mean for all sites.

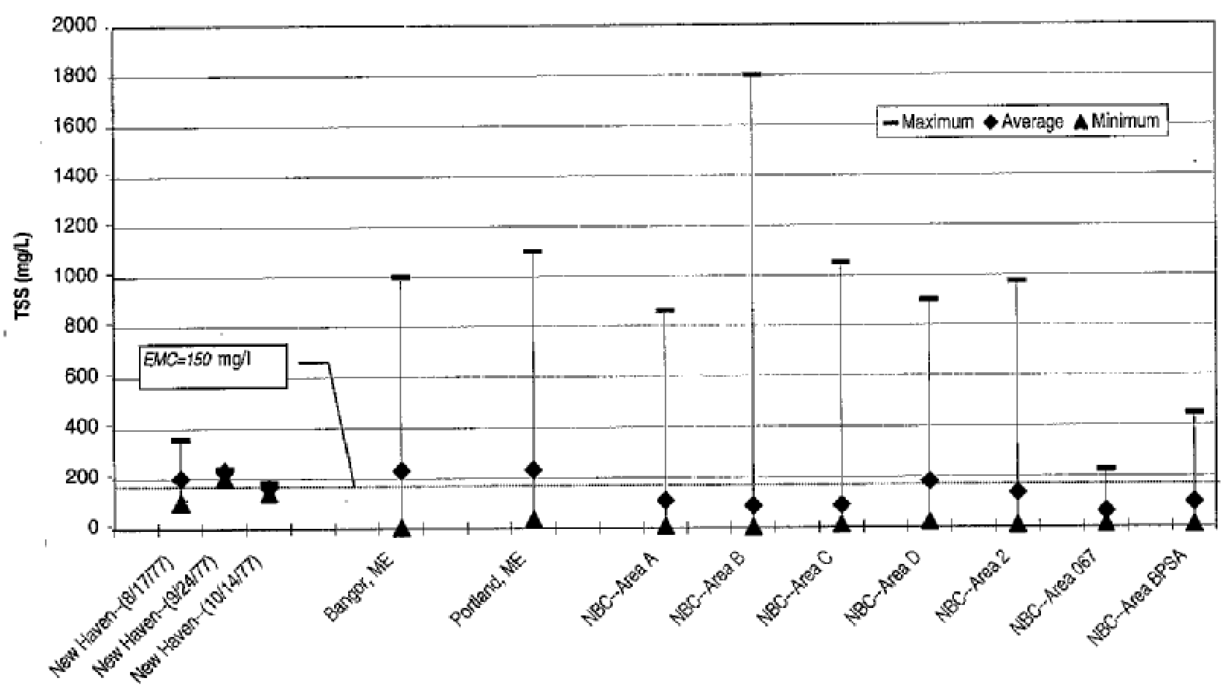
FIGURE 2.4.21 SUMMARY OF CSO WATER QUALITY DATA FOR FECAL COLIFORM



The extreme variability shown in the data is expected. Indeed, CSO long-term control planning in several municipalities (Bangor ME, Portland ME, New Haven CT, Narragansett Bay Commission RI, Milwaukee WI, and Atlanta GA) have observed similar variations and an inability to distinguish CSO concentrations from different landuse areas. For example, Figure 2.4.22 shows TSS data from 12 New England sampling sites where all were deemed consistent with as single event mean concentration of 150 mg/l.

For purposes of analyzing loadings from CSOs, the mean concentrations cited above have been used for all CSO sites and all storm conditions. The data, and the precedents set in numerous other CSO planning studies, do not support varying the concentration estimates by site characteristics or by storm characteristics. That is not to say that variations do not exist. Even though the data do not show statistically valid higher concentrations for more urbanized sites, it is commonly assumed that more urbanized sites have a higher risk of spills of highly contaminated materials.[6] Consequently, CSOs from highly urbanized sites may be prioritized for control independent of sampling data that demonstrate a higher strength discharge.

FIGURE 2.4.22 SUMMARY OF CSO WATER QUALITY DATA FOR MULTIPLE NEW ENGLAND SITES



2.4.5.2 CSS Sampling of Non-CSOs

Data for the non-CSO sites within the MSD combined sewer service were summarized in Technical Memorandum titled Interim CSO LTCP Addendums. These data, too, show a high variability. The ranges of TSS, biochemical oxygen demand and fecal coliform data observed in the non-CSO CSS samples are charted in Figures 2.4.23, 2.4.24 and 2.4.25, respectively. The non-CSO CSS data are often higher than the means (dashed lines) used for the CSO data. The non-CSO CSS data include primarily observations during dry weather conditions that are far different from the conditions prevailing when the CSOs can be sampled. The non-CSO CSS samples, however, provide observations of the constituents that potentially could flush into the CSOs.

MSD continues to scrutinize the non-CSO sampling data to identify impacts, if any, from significant industrial dischargers or other non-domestic dischargers of concern that have been issued general discharge permits. The grab sample concentrations at these sites are highly variable and water quality modeling using continuous simulations was used to estimate the systematic impact of the proposed CSO control plan. Due to the sample variability, any particular grab sample or set of samples for one parameter is not reliable for direct application of a CSO control. The best available water quantity and quality models calibrated using the full environmental data set is relied upon for overflow control assessment. The additional data tables and possible uses of the data are described in Appendix 2.4.9 Non-CSO Sewer Sampling Data Characterization.

FIGURE 2.4.23 SUMMARY OF NON-CSO CSS WATER QUALITY DATA FOR TOTAL SUSPENDED SOLIDS (TSS)

Figure A-6. Summary of Non-CSO CSS Water Quality Data for TSS (page 1 of 2)

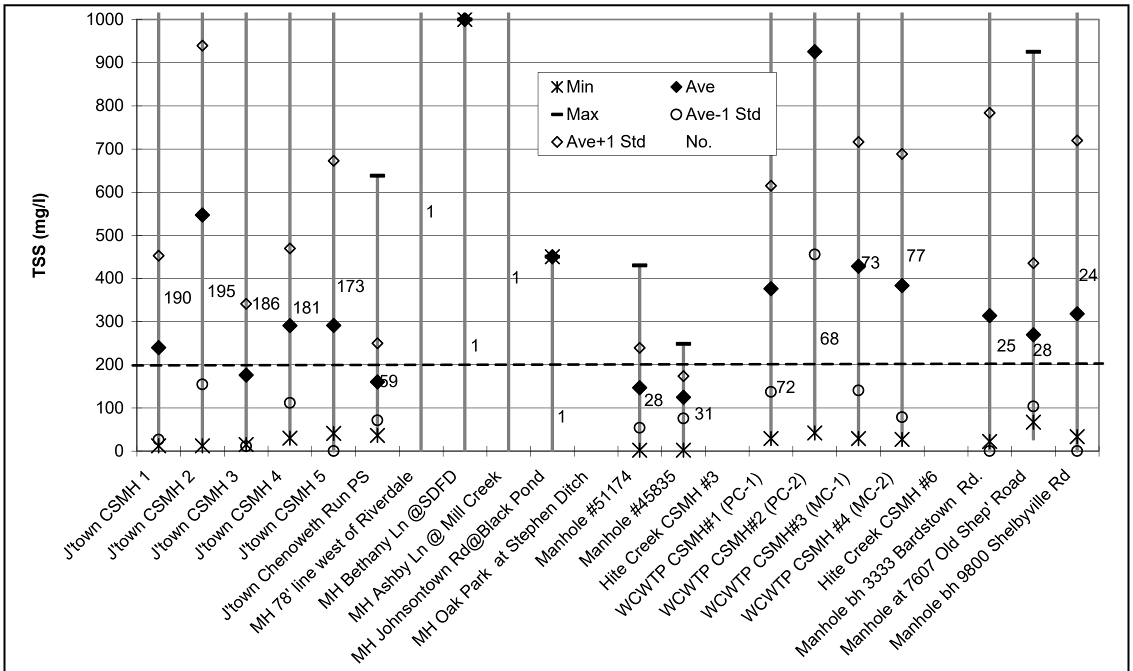


Figure A-6. Summary of Non-CSO CSS Water Quality Data for TSS (page 2 of 2)

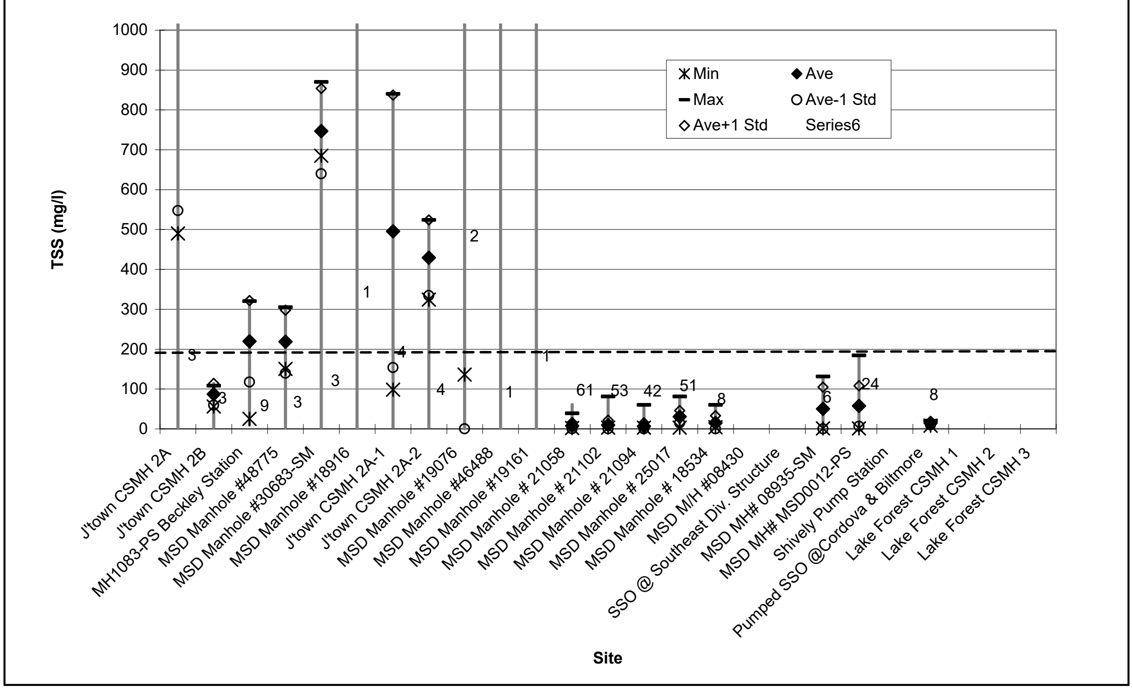


FIGURE 2.4.24 SUMMARY OF NON-CSO CSS WATER QUALITY DATA FOR BIOCHEMICAL OXYGEN DEMAND (BOD)

Figure A-7. Summary of Non-CSO CSS Water Quality Data for BOD (page 2 of 2)

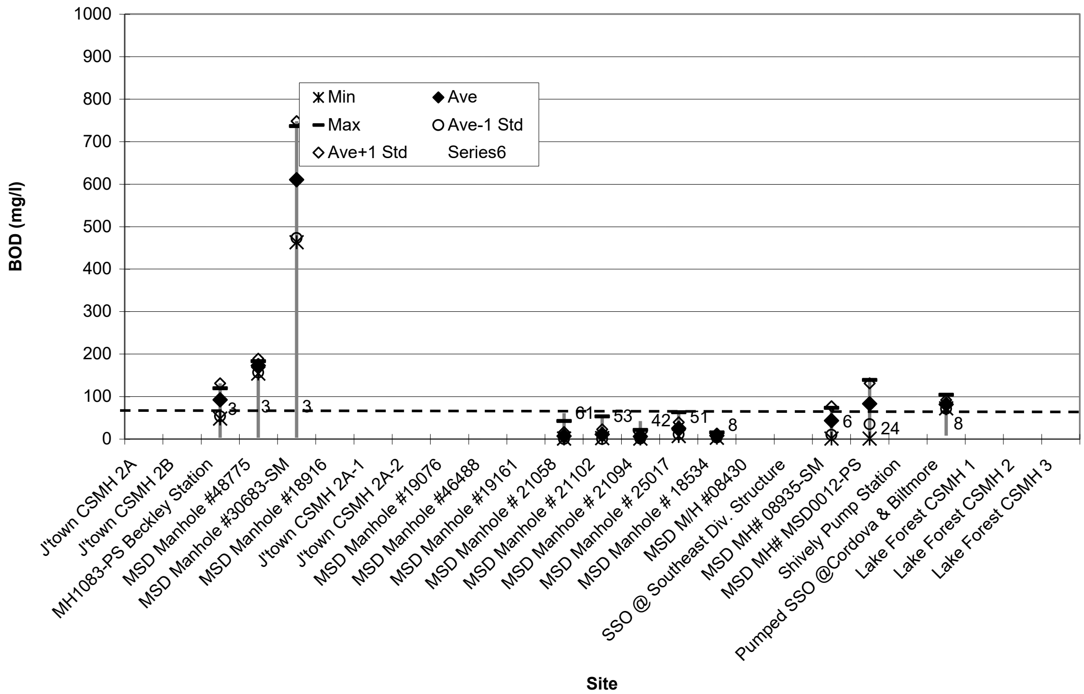


Figure A-7. Summary of Non-CSO CSS Water Quality Data for BOD (page 1 of 2)

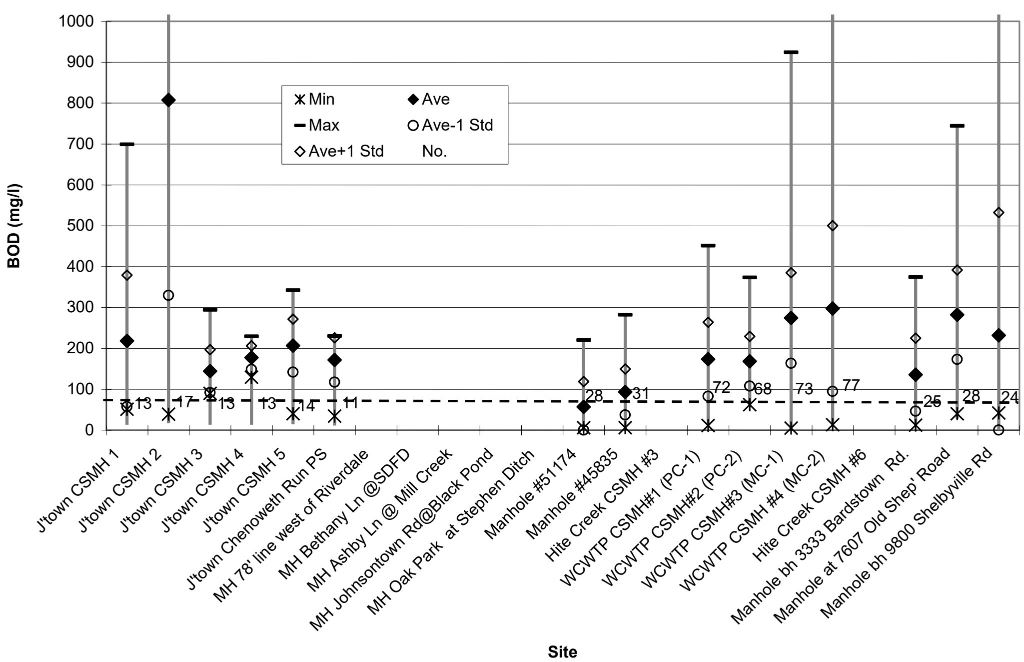


FIGURE 2.4.25 SUMMARY OF NON-CSO CSS WATER QUALITY DATA FOR FECAL COLIFORM

(page 1 of 1)

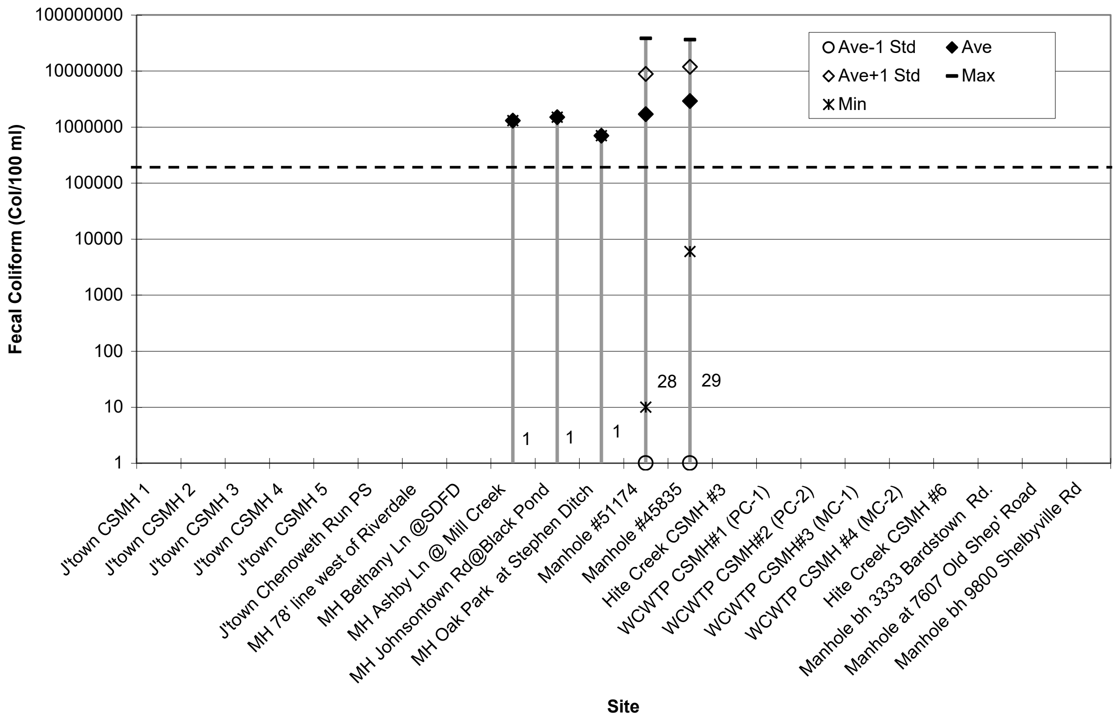
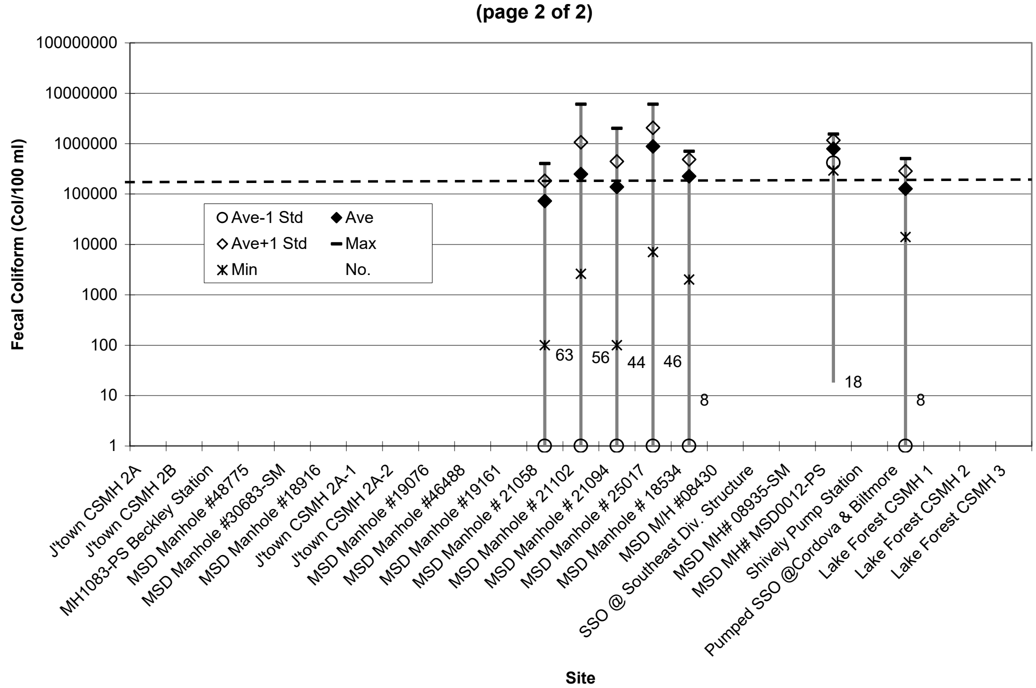


Figure A-8. Summary of Non-CSO CSS Water Quality Data for Fecal Coliform

(page 2 of 2)



2.4.6 Combined Sewer System Modeling

The CSO Control Policy describes modeling as a valuable tool for characterizing a CSS. EPA supports the proper and effective use of models. The sophistication of the model should relate to the complexity of the system to be modeled.

2.4.6.1 CSS Modeling Objectives

The development and calibration of the MSD CSS model was a part of early efforts associated with the CSO Abatement Program. The major objectives of the initial model development were to:

- Comply with CSO Policy Requirements
- Estimate CSO hydraulic and pollutant loads
- Assist in identifying the location of significant CSOs
- Assist in evaluating and prioritizing corrective actions

2.4.6.2 CSS Model Selection

The CSS model was originally developed in EPA Storm Water Management Model (SWMM) versions 4.05 and 4.3 as part of early efforts associated with the CSO Abatement Program in early 1990s. The selection of the hydraulic model for initial CSS model was based on the complexity and size of the MSD collection and conveyance system and the SWMM's ability to simulate full hydrodynamic equations. SWMM was a comprehensive water quantity and quality computer program available at the time of initial CSS model development.

In the late 1990s, the CSS model was converted from EPA's SWMM to proprietary XP-SWMM software for five primary benefits listed below:

- Useful graphical user interface
- Utilization of geographic information systems (GIS)
- Enhanced SWMM capabilities
- One simulation for entire CSO service area
- Fewer input/output boundary conditions to reconcile between simulations

The conversion of EPA-SWMM model to XP-SWMM model created one system-wide model to represent the CSS with approximately 2,000 nodes and 600 subcatchments. MSD continued to update the CSS model to reflect changing system conditions in the CSS by incorporating physical changes to various system features, and to take advantage of significant advances in computer hardware and software since the development of the model. The end product of this significant undertaking during the early 1990s and during 2004 was a working computer model of the CSS for use in predicting and analyzing the response of the system to various rain events.

MSD performed an extensive evaluation of commercially available computer models as well as the assessment of hydraulic sewer system modeling program and made a decision to convert all existing sewer models to InfoWorks Collection System (CS) format. The primary benefit of the model conversion was the decrease in run-time and ability to code in RTC rules to analyze the system benefit more accurately. The selection of InfoWorks CS model meets the criteria for selection of a CSS hydraulic model based on EPA Guidance: “Combined Sewer Overflows: Guidance for Monitoring and Modeling” (EPA 832-B-99-002). Criteria include:

- Ability to accurately represent CSSs hydraulic behavior
- Ability to accurately represent runoff in the CSS drainage basin
- Extent of monitoring
- Need for long-term simulations
- Need to assess water quality in CSS
- Need to assess water quality in receiving waters
- Ability to assess the effects of control alternatives
- Use of the presumption or demonstration approach
- Ease of use and cost

2.4.6.3 Model Description

The original CSS model was developed to include sewers larger than approximately 48 inches in diameter in general. However, in the Beargrass Creek, sewer sizes greater than 48 inches were very limited; therefore, sewer sizes as small as 12 and 24 inches were presented in the model to provide sufficient details for assessing CSO discharges. More detail information on original model development is documented in the 1993 “Combined Sewer Operational Plan,” Chapter 5.

In late 1997, the existing six EPA SWMM models were converted to XP-SWMM. Upon completion of the conversion to XP-SWMM, the six individual models were combined into one XP-SWMM to create one system-wide model. After integration of the six models into one model, CSS model consisted of approximately 2,000 manholes and 600 subcatchment areas.

As part of the NMC, MSD frequently updates the CSS model to reflect changing system conditions in the CSS. During MSD's fiscal year 2004, the CSS model was updated and calibrated to reflect the following changes:

- Reflect changing system conditions within the CSS by incorporating physical changes to various system features;
- Take advantage of significant advances in computer hardware and software since the original model construction; and
- Modify the model to be able to simulate typical year rainfall (long-term) simulations

The general overview of MSD sewer modeling history is documented in Sewer Modeling History Report (2007) and available for review in Appendix 2.4.2, Louisville/Jefferson County MSD Sewer Modeling History Report.

In 2007, MSD developed a "Hydraulic Sewer System Modeling Guideline Manual" (see Appendix 2.4.3) to standardize model development and improve the detail, quality, and functionality of sewer models. MSD contracted two modeling experts to provide independent peer review of the modeling approach and the Modeling Guideline Report, Dry Weather Flow Memorandum, and the rainfall-derived infiltration and inflow (RDI/I) Flow Memorandum. The comments provided from the peer reviewers were incorporated into the draft final version of the Modeling Guideline Manual. The Beargrass Creek Integrated Hydraulic Model Peer Review Report is available for review in Appendix 2.4.4.

2007 Model Conversion

The existing CSS model was converted to InfoWorks CS and upgraded in detail to meet the standards of modeling guideline document developed for MSD sewer system modeling. The model conversion and expansion was completed in 2007. Figure 2.4.26 at the end of this chapter is a diagram exhibiting the history of development of the CSS model. Key model inputs and sources of the data are listed in Table 2.4.6.

TABLE 2.4.6
CSS MODEL KEY INPUTS AND SOURCES

Type	Data	Sources
Hydrologic	CSO-Subcatchment area	Delineation using GIS and Field visits
	Surface Slopes	Estimated using GIS
	Roughness and percent imperviousness	Estimated using GIS
	Width	Estimated using GIS
	Rainfall Data	Hourly data from NWS gauge at Standiford Field Airport
		Ten-min radar rainfall data from 1-km pixel
		Five-min data from USGS/MSD rain gauge network
Hydraulic	Nodes and Conduits	GIS/ As built drawings/Surveying
	Diversion Structures	GIS/ As built drawings/CSO Inventory Records/Field visit
	Pump Stations	GIS/ As built drawings/Interview with operations/ Draw-down test
	Inflatable Dam /RTC operating scheme	As built drawings/ Rules developed by engineer
	Dry Weather Flow	Diurnal Pattern developed based on 2007 Flow monitoring data
	Inflow from Separate Sewer System	Flow monitoring data/ SSS model hydrographs

The expansion of the CSS model to include sewer sizes as small as 18 inches (except for the Beargrass Creek area where some pipe sizes were as small as 8 inches) was necessary to represent the CSS system more accurately. This was completed as part of conversion process. The current CSS model configuration includes approximately 12,000 nodes and 2,900 subcatchments compared to previous 2,000 nodes and 600 subcatchments in XP-SWMM model.

The newly updated CSS model includes the RTC rules of nine Phase I & II sites to model the system response accurately. Detailed descriptions of the model incorporation of RTC rules are provided for reference in Appendix 2.4.5, RTC Incorporation Technical Memorandum. See Figure 2.4.27 at the end of this chapter for the extent of CSS modeling area.

2012 Model Conversion

The InfoWorks CS model was converted into a new software platform called the InfoWorks Integrated Catchment Model, which allows for 2-dimensional modeling. This conversion is intended to improve the hydrologic accuracy of the model and more truly mimic the interaction of the surface and the combined sewer system. As MSD continues to move forward with IOAP implementation, model calibration and CSO behavioral statistics will continue to improve and be used to further verify the projected performance of the overflow abatement projects.

2.4.6.4 Model Calibration/Validation

Model calibration of the converted CSS model was completed from January through May 2007 to ensure the CSS model accurately represents the sewer system. Approximately 25 in-system locations were monitored to support hydraulic model calibration. In addition to the in-system monitors, overflow data from approximately 15 CSO sites were available for model calibration and validation. Figure 2.4.15 at the end of this chapter exhibits the location of flow monitors used for model calibration/validation purpose.

Based on review of the flow monitoring data, April 14, 2007, with a total rainfall depth of 1.3 inches was selected as the calibration event. April 12, through May 7, 2007, was selected as the validation period. It was recommended by independent peer reviewers to perform continuous calibration/validation rather than traditional independent event calibration and validation to better capture conditions during multiple rainfall events and inter-event dry weather period. The long-term calibration/validation approach was recommended because since the CSS model is used to perform annual simulations.

One of the most important input parameters in the sewer system modeling for calibration purposes is precipitation data. The precipitation data used for model calibration was 1-kilometer pixel size radar rainfall data provided by MSD. Using the radar rainfall data provided better spatial and temporal coverage of the modeling area during calibration period.

Dry Weather Flow

DWFs in the previous CSS models in XP-SWMM format were estimated from in-system flow monitoring data collected at a number of locations within the system, as well as available treatment plant and pump station flow rates. Based on an assumption that infiltration into the CSS is non-excessive, dry weather constant flow inputs (without diurnal pattern) were allocated to each subcatchment in the model based on the ratio of subdrainage area size to the total drainage area size upstream of the flow monitoring location.

Based on the modeling guideline document, the latest CSS model updated the representation of DWFs in the CSS model by distributing flows using census data and applying diurnal pattern developed based on flow monitoring data. The advantage of using this method is that the models would represent the DWF and wet weather flow capacity more accurately than previous methods used. Figures 2.4.28 and 2.4.29 present two examples of diurnal patterns used in the model to predict sanitary flows in the system.

FIGURE 2.4.28 DIURNAL FLOW PATTERN
OHIO RIVER INTERCEPTOR NEAR MAIN AND 15TH STREET

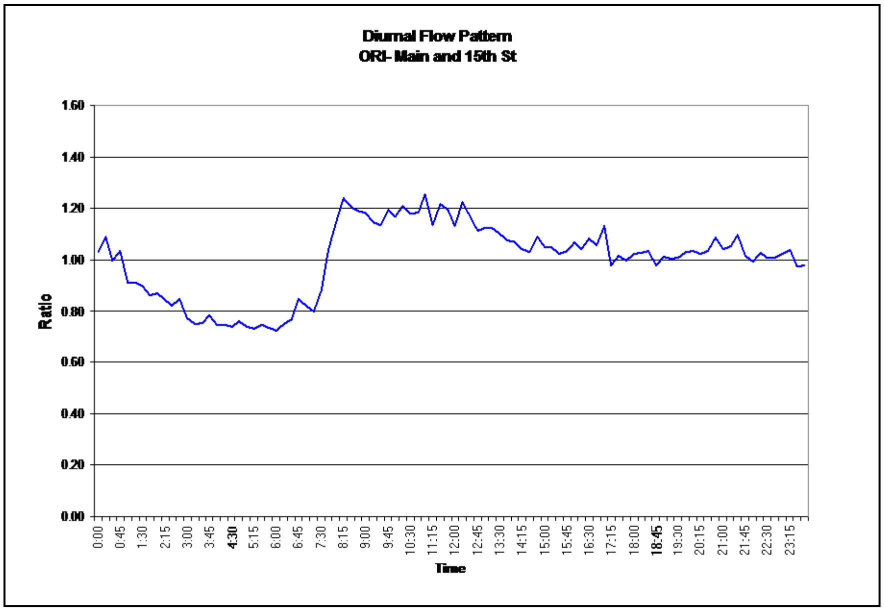
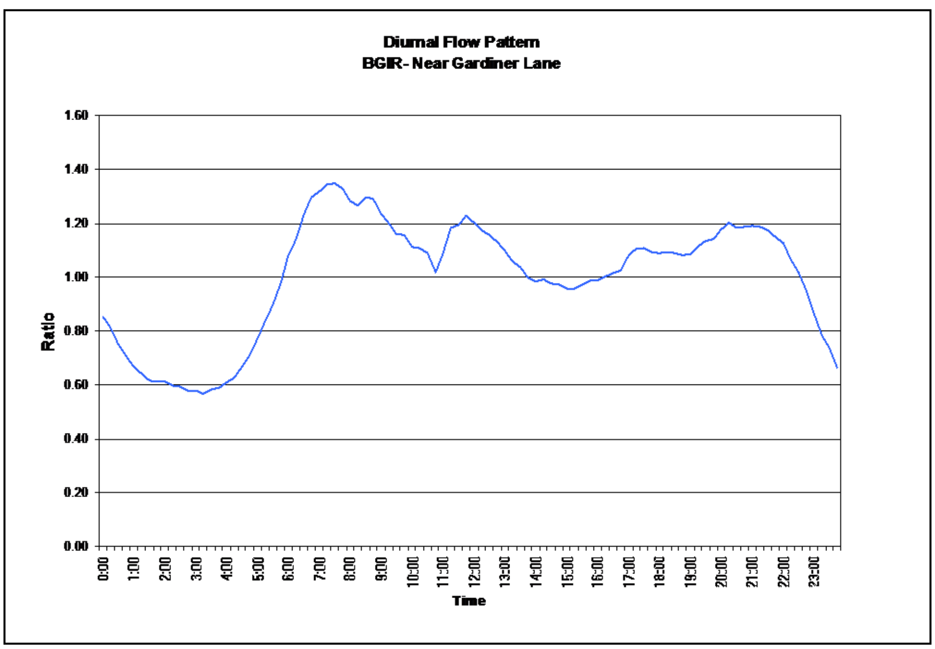


FIGURE 2.4.29 DIURNAL FLOW PATTERN
BEARGRASS INTERCEPTOR RELIEF NEAR GARDINER LANE



DWF calibration was performed to ascertain that the model appropriately calculated the DWFs at various flow monitoring locations based on new methodology. Another aspect of DWF calibration is to understand the overflow structure configuration and/or other system configuration. Once the DWF simulation is successful, the model is then ready for wet weather calibration to determine the system response to a wet weather event.

Wet Weather Flow

The objective of the wet weather flow calibration is to simulate a series of wet weather events, by use of the best available data, and compare data predicted to actual data recorded at particular locations. Realistically, it would be impossible to simulate exactly any particular storm event due to the large number of input variables, but by adjusting portions of the input data; results were obtained which reasonably approximated actual storm events.

Originally, in 1992, nine different storm events were chosen from the information obtained at the rain gauges and flow monitors during 1992 flow monitoring Phase I, and four different storm events were chosen from data recorded during 1992 flow monitoring Phase II for the wet weather calibration. The storm events were chosen because they represented a wide range of storm types. In most cases, a good correlation was achieved between two or three individual storm events at most sites, although some deviation between observed and predicted data was observed for another event. The Combined Sewer Operational Plan 1993, Chapter 5, details information from the original calibration.

The XP-SWMM version of CSS model was re-calibrated in 2004 using two different storm events: March 19 with a total of 2.9 inches of rain, and March 25 with a total of 2.8 inches of rain. The model was then executed using a two-week (March 15 to April 2, 2002) continuous simulation. The model predicted hydrographs within the system, which were compared to the monitored data, and a good correlation was found in most cases. The shapes and magnitudes of the hydrographs indicated that the original model was well calibrated for most of the service area. The updated XP-SWMM combined sewer model re-calibration, using 2002 flow meter data, was performed using the same method as outlined in the 1993 Combined Sewer Operational Plan.

The latest CSS model calibration in InfoWorks CS format was performed on April 14, 2007, and validation was performed on a continuous simulation. April 12, 2007 through May 7, 2007, was selected as a calibration and validation period to compare the model-predicted results to monitored data. In general, the plots of observed versus modeled depth and flow throughout the collection system demonstrated that the model simulated the actual collection system response reasonably well on an overall basis. Table 2.4.7 presents a summary of the model wet weather flow calibration results for the major sewers. Calibration metrics that fell outside of MSD's modeling guidelines (10 percent) are shown in **Bold Red** text.

TABLE 2.4.7
SUMMARY OF WET WEATHER FLOW CALIBRATION RESULTS

Node ID	Sewer Name	Meter Site	Monitored Flow Volume (MG)	Modeled Flow Volume (MG)	Percent Error (Volume)
Middle Fork Trunk (MFT) Sewer Area					
08769	MFT-Downstream end	Cabel St. & E. Washington St.	63.8	64.2	0.6%
24418	MFT-Lower Middle	Lexington Rd. & Bike Path	55.6	56.2	1.1%
45835	MFT-Upper Middle	Seneca Park Rd. and Alta Vista Rd.	48.0	43.8	-8.7%
24551	MFT-Upstream end	Seneca Park Rd. & Pee Wee Reese Rd.	43.5	43.2	-0.7%
Northeastern Sanitary Trunk Sewer (NSTS) Area					
08792	Mellwood	Mellwood Ave. & Delmont Ave.	3.3	3.4	1.2%
40248-X	NSTS	Louisville Metro Impound Lot	7.2	7.2	-0.6%
Beargrass Interceptor (BGI) and Beargrass Interceptor Relief (BGIR) Sewer Area					
08770	BGI	Buchanan St. & E. Washington St.	42.04	55.77	**32.8%**
08954	BGI	Near Nightingale Pump Station	40.6	31.2	**-23.1%**
27293	BGI [1]	Trevilian Way	NA	14.2	NA
16762	BGI	Downstream of SED	14.1	14.0	-0.4%
23214	BGIR	1718 Gardiner Ln.	17.2	17.4	-1.2%
50499	BGIR	Newburg Rd. & Trevilian Way	27.7	28.8	4.0%
71867	Tributary to BGI	937 S. Shelby St.	11.5	12.4	7.7%
08940	Tributary to CSO151	Castlewood Dell	2.3	2.6	**13.0%**
Southwestern Outfall Area					
10167	Cardinal Sewer	Union Ave. & Fayette Ave.	33.0	31.1	-5.7%
23167	Upper Dry Run Trunk	Lennox Ave. & S. Floyd St.	44.7	49.9	**11.5%**
50950	SW Branch	Bells Lane & S. 41st St.	198.3	175.1	**-11.7%**
Ohio River Interceptor (ORI), Western Interceptor, Southern Outfall, and Northwestern Interceptor Area					
08843	CRD [2]	S. 8th Street & Magazine St.	2.2	0.2	**-88.9%**
08726-SM	Northwestern Interceptor	Shawnee Park Rd. & W. River Park Dr.	16.0	15.2	-5.1%
08112-SM	Western Interceptor	1366 S. 45th St.	22.1	22.5	1.8%
08635	Western Interceptor	4526 W. Broadway	9.7	10.6	9.3%
04250	38th Branch	W. Market St. & S. 38th St.	8.3	7.8	-6.0%
67892	Southern Outfall	Wilson Avenue & S. 12th St.	39.9	43.0	7.7%
08116	ORI	Fordson Way & Cecil Ave.	149.7	154.3	3.1%
08761-SM	ORI	Main St. & 15th St.	103.9	147.7	**42.4%**
Morris Forman WQTC					
Plant	MFWQTC Effluent Data [3]	Plant Inflow Hydrograph from CSS model	328.0	386.5	**17.2%**

Notes:
1. This meter location experienced data loss (4/15/07 through 4/26/07) during calibration/validation period.
2. Central Relief Drain (CRD) meter data not used for dry weather flow calibration. To simulate backwater condition, daily Ohio River level data provide by the USACE was applied.
3. Morris Forman WQTC influent data was not available. Effluent flow data was compared to modeled inflow data for general comparison purposes.

The following summarizes the results of the latest CSS model calibration efforts in 2007.

Middle Fork Trunk Sewer Area

A total of four calibration locations were available in the Middle Fork Trunk Sewer service area, including one upstream boundary location. After conducting the wet weather calibration efforts, all four sites exhibited good correlations between observed data and model-predicted data in flow, depth and velocity. The total volume action level of 10 percent was met at all four of these locations.

Northeastern Sanitary Trunk Sewer Area

Two flow monitors (MH 08792 at Mellwood Avenue and MH 40248-x at the Louisville Metro Auto Impoundment Lot) were installed in the Northeastern Sanitary Trunk Sewer to characterize the inflow to the Robert J. Starkey Pump Station from the northeastern area. The hydrographs at both locations exhibited good correlation between the observed and model- predicted flows. The total volume action level of 10 percent was met at both locations.

Beargrass Interceptor and Beargrass Interceptor Relief Sewer Area

A total of eight calibration locations were available in the vicinity of the Beargrass Interceptor and Beargrass Interceptor Relief service area. For the most part, the model was able to predict the total volume of flow to meet the calibration criteria of 10 percent. Two (**MH 08770 and MH 08954**) of eight flow monitoring location calibration results will be improved by further investigation and continued analyses of operating strategy of the Nightingale Pump Station and Robert J. Starkey Pump Station. **MH 08940** calibration results were barely outside of the action level (13.0 percent or 0.2 MG). As part of continuing model maintenance activity, these sites will be closely monitored for next re-calibration task.

Southwestern Outfall Sewer Area

Three calibration locations existed in the service area of the Southwestern Outfall sewer, which is the largest pipe system in the MSD service area. The model reasonably predicted the flow rates measured and one of these calibration locations met the 10 percent action level while the other two locations (**MH 50950** and **MH23167**) were barely outside of the action level (11.7 percent and 11.5 percent). As the modeling program continues, this will be one area that will receive more focus to evaluate the calibration of the flow meters and monitor RTC responses.

Ohio River Interceptor, Western Interceptor, Southern Outfall, and Northwestern Interceptor Area

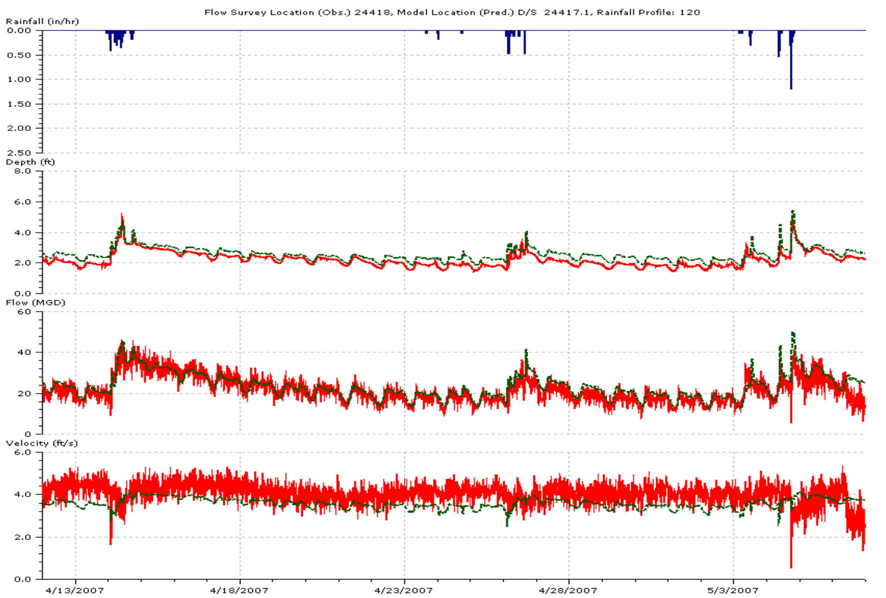
A total of seven flow monitoring locations were available for the wet weather flow calibration in the northwestern part of Louisville Metro, which includes service areas contributing to the Ohio River Interceptor, Western Interceptor, Southern Outfall and Northwestern Interceptor. As shown in Table 2.4.7, the model-predicted volumes were within the calibration action level of 10 percent, except for two locations discussed further below.

MH 08843: At this calibration/validation location flow was measured in the Central Relief Drain Sewer. This site was not considered for DWF calibration since Central Relief Drain does not carry sanitary flow. For wet weather flow calibration, this site experienced a backwater condition from the Ohio River due to an elevated river stage. Although the model-predicted volume at this location is significantly less than the observed data by percent error, the total volume measured is very small when compared to the flow at the Morris Forman WQTC (2.2 MG vs. 328.0 MG) and to other CSO locations. Further investigation of the Central Relief Drain system will result in a better understanding of the operating behavior in the service area. Furthermore, it would be beneficial to place temporary flow meters to monitor additional upstream characteristics. The investigation results will be used for re-calibration in the near future to improve calibration results of the model at this location.

MH 08761-SM: The Flow Meter at this calibration location measured the flow in the Ohio River Interceptor about midway between the Robert J. Starkey Pump Station and the Main Diversion Structure. The model-predicted volume at this location (148 MG) is about 42 percent higher than the observed volume (104 MG). This same trend was recognized during the DWF calibration. Based on other system calibration results and review of additional metering sites (downstream site shows 3.1 percent error by volume) modelers determined that additional flow monitoring and further investigation of the Robert J. Starkey Pump Station is required to improve calibration results of the model at this location.

Figures 2.4.30 and 2.4.31 are example hydrographs of the good calibration/validation results. A detailed description of the model development and calibration/validation is provided for reference in Appendix 2.4.6, CSS Model Calibration and Validation Technical Memorandum.

FIGURE 2.4.30 EXAMPLE CALIBRATION/VALIDATION HYDROGRAPH MIDDLE FORK TRUNK - LEXINGTON RD AND BIKE PATH



	Rainfall			Depth (ft)		Flow (MGD)			Velocity (ft/s)	
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Min	Max	Volume (US Mgal)	Min	Max
Rain	3.490	1.200	0.006							
Obs.				1.430	4.815	5.201	44.653	537.989	0.510	5.180
... AreaRev_Rainfall				1.757	5.417	11.927	50.110	578.243	2.443	4.100

FIGURE 2.4.31 EXAMPLE CALIBRATION/VALIDATION HYDROGRAPH
CARDINAL SEWER - UNION AND FAYETTE AVENUE

	Rainfall			Depth (ft)		Flow (MGD)			Velocity (ft/s)	
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min	Max	Min	Max	Volume (US Mgal)	Min	Max
Rain	3.690	1.260	0.006							
Obs.				0.466	2.300	0.676	28.457	230.741	1.280	5.980
... AreaRev_Rainfall				0.579	5.678	2.586	31.053	198.540	2.886	7.114

The calibrated and validated model was subject to a Quality Assurance/Quality Control (QA/QC) process. The QA/QC process involved peer review of the model, reporting discrepancies in a QA/QC checklist and a comments form. Full CSS Model QA/QC documentation is available for review in Appendix 2.4.7, CSS Model QA/QC.

2.4.6.5 Model Application

The CSS model has been used as a tool to perform numerous analyses, such as flooding analyses and development analyses. Specific applications include evaluation to determine the AAOV and percent capture impact of the initial draft 1996 LTCP elements and compliance with NMC requirements.

During 2008, the CSS model was used to generate the hydraulic statistics to determine average annual CSO characteristics and establish the "baseline" condition of the system using 2001 rainfall data. The CSS model was used to generate the baseline AAOV and post LTCP AAOV or residual AAOV after the Final CSO LTCP is completed. The summary report of CSO LTCP characteristics is available for review in Appendix 2.4.8, CSO LTCP Characteristics Summary Report. The CSS modeling program enabled MSD to determine interceptor sewer conveyance and system storage capacities, characterize overflows and pollutant loads to receiving streams and to evaluate various CSO control strategies.

2012 Model Calibration/Validation

The re-calibration of the CSS model in 2012 utilizing available monitors is described in detail in Chapter 5 along with new calibration reports in the appendices. This calibration resulted in significant proposed modifications to the 2009 LTCP project suite.

2.5 COMPILATION EXISTING DATA – BEARGRASS CREEK

This section presents a detailed description of the physical characteristics of the Beargrass Creek Region of the CSS. Presented herein is an overview of the collections system mapping, an overview of the pipe network, major interceptors, all pumping stations, and a description of the individual CSOs.

2.5.1 Beargrass Creek Region Overview and Mapping

The combined sewer collection and conveyance system in the Beargrass Creek Region consists of those sewers contributing dry and wet weather flow to the Robert J. Starkey Pumping Plant, including the interceptors along the South and Middle Forks of Beargrass Creek, the Northeastern Sanitary Trunk, and related collector sewers. See Figure 2.5.1 at the end of this chapter. Much of the interceptor network in this region has limited wet weather conveyance capacities. Although nearly all wastewater flows generated in the Beargrass Creek Region are tributary to the Robert J. Starkey Pumping Plant, two exceptions exist:

- Flows spilling into the Beargrass Interceptor Relief Sewer are subsequently pumped over to the Southwestern Outfall service area via the Nightingale Pump Station.
- Flows diverted from the Beargrass Interceptor to the Southeastern Interceptor and Northern Ditch Interceptor systems, via the Southeastern Diversion, upstream of the combined sewer area.

At this time, 53 CSOs are located in the Beargrass Creek Region, with many discharge outlets located along much of the lengths of South and Middle Fork of Beargrass Creek. The slope of the interceptors serving these areas is marginal and requires a relatively high water surface elevation to maintain flow in the sewers even under dry weather conditions.

2.5.2 Collection System Understanding

This section presents an overview of the major assets within the CSS, including major sewers, major pumps stations and the CSOs. The system components are presented in group, aligned by reaches of Beargrass Creek.

2.5.2.1 Beargrass Creek Region Major Interceptors/Relief Sewer Drains

The major interceptors included in the Beargrass Creek Region are designed to route sanitary flow and allotted quantities of diluted stormwater to the Morris Forman WQTC via either the Robert J. Starkey Pumping Plant or Nightingale Pump Station. A description of the major components of the CSS within the Beargrass Creek Region is presented below.

Beargrass Interceptor

The Beargrass Interceptor was originally constructed beginning in the early 1900s and has been reconstructed many times over the years. The line varies in size, shape and grade from a 6'-6" x 6'-1-1/2" basket-handle sewer with a 0.05 percent slope near its outlet end to a 36-inch circular sewer with a 0.073 percent slope just south of the Watterson Expressway (I-264). Estimated full flow capacities range between 74.4 million gallons per day (mgd) and 11.2 mgd, respectively.

Beargrass Interceptor Relief Sewer

The Beargrass Interceptor Relief Sewer was constructed in the 1960s and 1970s to relieve the surcharged Beargrass Interceptor. The Beargrass interceptor is located on the north side of the South Fork of Beargrass Creek, whereas the relief sewer is located on the south side of the creek between the Watterson Expressway and Nightingale Road. Most of the sewer tributaries to the Beargrass Interceptor from the south were connected to the relief sewer during its construction. The Beargrass Interceptor Relief is a 48-inch circular sewer with a varying grade. Based on a minimum slope of 0.037 percent and a maximum slope of 0.12 percent; estimated full flow capacities range from 16.5 mgd in the upstream sections to 31.1 mgd in the downstream sections.

Middle Fork Trunk Sewer

The Middle Fork Trunk Sewer serves the Middle Fork Basin of Beargrass Creek, is circular in shape and varies in size and grade throughout its length. At its outlet end, the 60-inch pipe on a slope of 0.095 percent has an estimated full flow capacity of 49.4 mgd. Typical daily DWF in the Middle Fork Trunk Sewer is about 16 mgd.

Northeastern Interceptor

The Northeastern Interceptor was originally a branch of the Beargrass Interceptor and is actually two sewers constructed in an over-under configuration. The upper Northeastern Sanitary Trunk Sewer was designed to collect sanitary flow from the northeastern portion of the city and convey it westward to the Beargrass Interceptor for discharge into the Ohio River. The lower Northeastern Storm Drain was designed to convey stormwater eastward for discharge into Beargrass Creek. After construction of these sewers, several sanitary sewers were erroneously connected to the Northeastern Storm Drain. Later, the construction of the McAlpine Locks and Dam raised the normal pool of the Ohio River from elevation 412.00 to 420.00. This submerged the Northeastern Storm Drain over most of its length and resulted in very low velocities that allowed septic conditions to develop in the sewer during dry weather periods. The Letterle Pump Station (formerly the Point Pump Station) was constructed to alleviate this condition by intercepting the Northeastern Storm Drain and discharging flow into the Northeastern Sanitary Trunk Sewer. During high flow periods, the pump station was designed to discharge the combined flow directly into Beargrass Creek. The Northeastern Sanitary Trunk Sewer is a 5-7-1/2" x 4'-0" basket-handle sewer with a 0.05 percent slope. The estimated flow capacity is 31.9 mgd. The Northeastern Storm Drain is a rectangular sewer of varying width and height. At the downstream end, the 6'-0" x 4'-9" Storm Drain is on a grade of 0.105 percent and provides an estimated full flow capacity of 78.3 mgd.

The Letterle Pump Station Elimination project eliminated the Letterle Pump Station and re-routing sewers that contributed flow. The storm drain (lower sewer) carried primarily storm flow but contained some sanitary sewage due to improperly connected property service connections. The project included removing all sanitary connections to the lower sewer and allowing it to carry stormwater only to the Beargrass Creek. The Letterle Pump Station was decommissioned and the CSO145 outfall was eliminated and converted into a stormwater outfall.

Sneads Branch Relief Drain

Beginning around 1950, the Sneads Branch Relief Drain was constructed to relieve flooding from the overloaded sewers in the area along Shelby Street near the South Fork of Beargrass Creek. This drain relieves combined sewers using side overflow weirs at 11 locations, and receives stormwater discharges from catch basins along its route. The drain discharges directly to the South Fork of Beargrass Creek and carries stormwater and the overflows of the combined sewers it relieves. An inflatable dam was constructed in 2001 at the outlet to store overflow for pumping into the Beargrass Interceptor Sewer. At the outlet end, the 11'-0" semi-elliptical drain line has a slope of 0.125 percent with an estimated full flow capacity of 473 mgd.

2.5.2.2 Beargrass Creek Region Major Pump Stations

Robert J. Starkey Pumping Plant – Sanitary and Flood

The Buchanan Street Pump Station, renamed the Robert J. Starkey Pumping Plant in 2005, located on the east corner of Buchanan and Franklin Streets, was constructed by the USACE in the 1950s as part of Louisville's flood control system. The Robert J. Starkey Pump Plant functions as a wastewater pump facility during non-flood conditions. The Beargrass Interceptor, Middle Fork Trunk, and the Northeastern Interceptor converge just outside of the pump station. A common 6' x 8' rectangular sewer conveys all flow into the pump station. The pump station was originally equipped with four pumps rated at 31 mgd each for a total of 124 mgd. Recently, the pump plant has been upgraded and is now equipped with four pumps rated at 35 mgd each for a total of 140 mgd. However, a sustainable maximum pumping rate of 108 MGD is assumed within the CSS model. Impeller wear due to heavy grit is a constant issue that degrades the pumps over time. Preventive maintenance of the pumps will keep the station at or above this operating level. Flow in excess of station capacity is discharged via gravity to the Ohio River through two overflow points. When Ohio River stage elevations prevent the discharge of overflow by gravity, the pump station switches to flood pumping and discharges to the river. A schematic of the pump station and influent sewers is shown on Figure 2.5.2 at the end of this chapter.

Nightingale Pump Station - Sanitary

The Nightingale Pump Station, which is located at the end of Nightingale Road on the west side of the South Fork of Beargrass Creek, was designed to convey flow in the Beargrass Interceptor Relief Sewer through the Manning Road-Cardinal Drive Sewer and into the Upper Dry Run Trunk and eventually to the Southwestern Outfall. A schematic of the pump station and influent sewers is shown on Figure 2.5.3 at the end of this chapter. The pump station was built in conjunction with the Beargrass Interceptor Relief sewer to prevent overflows from the Beargrass Interceptor during high flow conditions. The Nightingale Pump Station is designed with three 16" pumps rated at 8,750 gallons per minute (gpm) each for a total capacity of 26,250 gpm or about 37 mgd.

2.5.2.3 Beargrass Creek Region Combined Sewer Overflows

Table 2.5.1 on the next two pages lists CSOs located within the Beargrass Creek Region. A detailed description and discussion of each CSO structure and its discharge outfall is provided in Appendix 2.5.1, CSO Fact Sheets. A sample Summary Sheet for a CSO is shown in Figure 2.5.4 at the end of this chapter.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 2.5.1
BEARGRASS CREEK SOUTH FORK AREA CSO TABLE

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/Yr)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1,000 Gal)
CSO018	**Nightingale Pump Station**	NA	Multi	High Level Pipe W/ Side Weir	18.69	13	5.98	1,437.55
CSO082	**Beargrass Interceptor Beargrass Creek**	NA	Cyclone	High Level Pipe	1.10	24	2.98	45.70
CSO083	**Brent Street & Broadway Connect**	38.09	Baffle	Diversion Dam	0.00	0	0.00	0.00
CSO084	**Brent Street at Beargrass Creek**	125.07	Baffle	Diversion Dam	17.91	34	4.00	526.85
CSO091	**Schiller Avenue Overflow**	14.99	Screens	Orifice	1.62	34	4.38	47.67
CSO092	**St Catherine Street @ Beargrass Creek**	7.65	Screens	Leaping Weir	0.00	0	0.00	0.00
CSO097	**Cantonment Siphon Number 2**	0.00	Baffle	High Level Pipe	12.31	44	5.78	279.76
CSO106	**Royal - Neff**	11.80	Screens	Diversion Dam	0.33	17	2.40	19.49
CSO108	**Regulator Number 1 - Newburg**	485.22	Continuous Deflection Separator	Diversion Dam	10.35	9	5.17	1,149.69
CSO109	**Regulator Number 2 - Deer Park**	95.36	Screens	Orifice	0.22	3	1.98	72.20
CSO110	**Regulator Number 3 - Goss Avenue**	73.04	Basket	Orifice	27.53	44	6.18	625.60
CSO111	**Emerson Street Sewer**	99.35	Baffle	Diversion Dam	0.00	0	0.00	0.00
CSO113	**Ellison Avenue Sewer**	67.62	Screens	Diversion Dam	7.72	37	4.70	208.56
CSO117	**Regulator Number 11 - Dry Run**	74.17	Baffle	Diversion Dam W/ Regulator	92.76	39	6.27	2,378.36
CSO118	**Regulator Number 15 - East Broadway**	354.12	Baffle	Diversion Dam W/ Regulator	99.69	39	5.92	2,556.07
CSO119	**Brent Street Sewer**	7.58	Cyclone	High Level Pipe	12.38	40	5.10	309.57
CSO120	**Phoenix Hill Sewer**	16.51	Baffle	Diversion Dam	9.22	51	6.88	180.85

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

TABLE 2.5.1
BEARGRASS CREEK SOUTH FORK AREA CSO TABLE

CSO Data Outdated

Refer to Chapter 5

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/Yr)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1,000 Gal)
CSO121	**Regulator Number 18 - Green Street**	107.19	Baffle	Diversion Dam W/ Regulator	11.22	28	3.98	400.73
CSO137	**Calvary Cemetery**	26.65	Screens	Diversion Dam	3.97	37	4.48	107.22
CSO141	**Baxter Avenue at Beargrass Creek**	7.72	Screens	Orifice	5.06	27	3.82	187.34
CSO146	**Sneads Branch Diversion**	112.60	Baffle	Rack Bars	63.67	59	7.55	1,079.21
CSO148	**Eastern Parkway Diversion**	24.89	Screens	Diversion Dam	1.26	26	3.65	48.51
CSO149	**Dry Run Diversion**	226.53	Baffle	Diversion Dam	56.35	37	5.07	1,522.87
CSO151	**Regulator Number 5 - Castlewood**	219.74	Basket	Orifice	80.26	57	7.72	1,408.14
CSO152	**Regulator Number 7- Southeastern**	260.56	Basket	Orifice	75.35	51	7.25	1,477.47
CSO153	**Cooper Street**	41.65	Screens	Diversion Dam	15.59	56	7.63	278.32
CSO179	**Kentucky Street Sewer Overflow**	456.17	Baffle	Side Weir	0.00	0	0.00	0.00

Sneads Branch (11 CSOs)

As noted earlier, the Sneads Branch Relief Drain was constructed to relieve flooding from an overloaded sewer in the area along Shelby Street near the South Fork Beargrass Creek. The drain relieves combined sewers using overflow weirs at 11 locations, and receives stormwater discharges from catch basins along its route. Because the Sneads Branch Relief Drain was constructed specifically to convey the excess flows from each of the noted CSOs, the Drain itself does not function as a consolidation sewer to bring the excess flows to a common point. As a part of RTC Phase I, an inflatable gate was installed at Sneads Branch to capture flows from the 11 CSOs. Pumps send re-captured overflows back into the Beargrass Interceptor for treatment at the Morris Forman WQTC.

The storage capacity of Sneads Branch Inflatable Dam is approximately 2.5 MG and it captures approximately 86 percent of overflow volume from individual CSOs upstream during a typical simulation. During larger wet weather events, in excess of in-line storage capacity, the inflatable dam will modulate to maintain a water level to protect homes from flooding, while maximizing capture of as much CSO as possible. Table 2.5.2 summarizes the hydraulic characteristics of CSOs located within the Sneads Branch Relief area.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 2.5.2 BEARGRASS CREEK SNEADS BRANCH CSO SUMMARY TABLE								
CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO142	**Sneads Branch Relief - Logan Street and St Catherine Street**	NA	Sneads Branch Inflatable Dam	Side Weir	0.00	0	0.00	0.00
CSO174	**Sneads Branch Relief - Goss Avenue and Boyle**	157.47	Sneads Branch Inflatable Dam	Side Weir	37.31	57	7.58	654.48
CSO180	**Sneads Branch Relief - Ormsby Avenue Relief**	6.81	Sneads Branch Inflatable Dam	Side Weir	0.27	11	1.87	24.96
CSO182	**Sneads Branch Relief - Shelby Street and Burnett Avenue**	221.65	Sneads Branch Inflatable Dam	Side Weir	44.75	44	5.48	1016.93
CSO183	**Sneads Branch Relief - Alexander and Keswick**	3.62	Sneads Branch Inflatable Dam	High Level Pipe	0.00	0	0.00	0.00
CSO184	**Sneads Branch Relief - Fetter and Alexander**	104.84	Sneads Branch Inflatable Dam	Side Weir	0.43	13	1.98	33.26
CSO185	**Sneads Branch Relief - Shelby Street and Keswick**	108.19	Sneads Branch Inflatable Dam	Side Weir	0.55	7	1.98	78.08
CSO186	**Sneads Branch Relief - Logan Street and Oak Street**	4.69	Sneads Branch Inflatable Dam	Side Weir	0.00	0	0.00	0.00
CSO187	**Sneads Branch Relief - Shelby Street and Camp Street**	7.19	Sneads Branch Inflatable Dam	Side Weir	0.00	0	0.00	0.00
CSO188	**Sneads Branch Relief - Shelby Street and Clay Street**	13.11	Sneads Branch Inflatable Dam	Side Weir	0.03	8	1.65	3.31
CSO205	**Sneads Branch Relief - Morgan Street Relief**	11.52	Sneads Branch Inflatable Dam	High Level Pipe	0.00	0	0.00	0.00

Middle Fork (Eight CSOs)

CSO206 Manhole Separation and Property Service Reconnection was completed and certified March 31, 2009. Table 2.5.3 summarizes the hydraulic characteristics of CSOs located within the Beargrass Creek Middle Fork area.

CSO Data Outdated
Refer to Chapter 5

TABLE 2.5.3
BEARGRASS CREEK MIDDLE FORK AREA CSO SUMMARY TABLE

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO086	**Payne Street and Spring Street**	6.07	Screens	Leaping Weir	0.00	0	0.00	0.00
CSO140	**Locust Street**	75.54	Baffle	Diversion Dam	17.00	54	6.17	314.85
CSO144	**Vance Street Regulator**	16.40	Screens	Diversion Dam	0.00	0	0.00	0.00
CSO127	**Etley Avenue**	192.26	Screens	Diversion Dam	4.62	21	2.97	220.02
CSO126	**Regulator Number 26 - Raymond Avenue**	35.29	Cyclone	Diversion Dam	0.58	13	1.42	44.25
CSO125	**Regulator Number 24 - Grinstead Drive**	391.03	Screens	Diversion Dam	48.38	54	5.40	895.99
CSO166	**Beals Branch Sanitary Diversion**	696.65	Screens	Diversion Dam W/ Rack Bars	10.12	19	3.02	532.54
CSO130	**Webster Street**	28.41	Screens	Diversion Dam	0.84	9	2.62	93.33
CSO206	**Cherokee Park @ Spring Drive**	464.7	Sewer Separation Project In Progress					

Northeastern Area (Six CSOs)

In January 2001, the public portion of CSO088 was separated. An evaluation of the CSO closure was performed during the year 2005 to determine the effectiveness of the separation and potential influence of a proposed downspout disconnection project. Through this evaluation it was determined that CSO088 operates as a relief point for the Mellwood Interceptor, therefore a downspout disconnection program would have a minimal impact on CSO volume and frequency. CSO088 also has been identified as a CSO with potential backwater impact from the Beargrass Creek during high Ohio River elevation. Table 2.5.4 summarizes the hydraulic characteristics of CSOs located within the Northeastern Area of South Fork Beargrass Creek area.

TABLE 2.5.4
BEARGRASS CREEK NORTHEASTERN AREA CSO SUMMARY TABLE

CSO Data Outdated

Refer to Chapter 5

CSO NO.	CSO Name	Drainage Area (AC)	Static Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO088	**Mellwood Avenue Interceptor**	18.80	Screens	Leaping Weir	0.58	6	1.98	96.28
CSO093	**Spring Street**	20.79	Screens	Leaping Weir	1.81	37	4.68	48.79
CSO131	**Regulator Number 33 - Mellwood Avenue and Frankfort Avenue**	50.33	Cyclone	Orifice	0.06	2	1.88	28.66
CSO132	**Regulator Number 35 - Brownsboro**	674.01	Baffle	Diversion Dam	149.77	56	7.53	2674.53
CSO154	**Mellwood Avenue @ Schoeffle**	31.02	Screens	Diversion Dam	1.92	15	4.03	127.73
CSO167	**Brownsboro Lat Number 2**	11.00	Baffle	Diversion Dam	0.96	12	2.08	79.88

2.6 COMPILATION AND ANALYSIS OF EXISTING DATA – OHIO RIVER

This section presents a detailed description of the physical characteristics of the Ohio River Region of the CSS. Presented herein is an overview of the collections system mapping, an overview of the pipe network, major interceptors, all pumping stations and a description of the individual CSOs.

2.6.1 Ohio River Region Overview and Mapping

The Ohio River Interceptor and Central Relief Drain service areas are designated as the Ohio River North Region since they are downstream of the Robert J. Starkey Pumping Plant and overflow into the Ohio River. See Figure 2.6.1 at the end of this chapter. The collection and conveyance networks in this Region are relatively small with limitations in wet weather capacity. The Ohio River Interceptor conveys flows to the Main Diversion Structure (CSO211) near the Morris Forman WQTC from the Robert J. Starkey Pump Plant, 4th Street and 34th Street Pump Stations, as well as gravity systems generally serving the areas along the south shore of the Ohio River. Forty-nine individual overflow relief structures are widely scattered throughout the two service areas.

In the Ohio River West Region, the conveyance systems consist of much larger interceptors and trunk sewers that exist in either of the Beargrass Creek or Ohio River North Region. Major sewers and service areas in the Ohio River West Region include the Northwestern Interceptor, Western Interceptor, Western Outfall, Southern Outfall, and the Southwestern Outfall. See Figure

2.6.2 at the end of this chapter. With the exception of the Western Interceptor, the conveyance capacities of these facilities are generally much larger than the capacity required for DWF only, since they must also convey storm flows from small and large events. Taken together, the Northwestern Interceptor, Western Outfall, Southern Outfall, and Southwestern Outfall service areas can nearly contain wet weather flows from storms of 0.10 inch/hour or less in intensity. Considerable overflow can occur for storms having greater intensities. Eight CSO locations exist in this western part of the MSD service area, all of which are located near the downstream ends of the conveyance systems in each area.

2.6.2 Collection System Understanding

2.6.2.1 Ohio River North Region Major Interceptors/Relief Sewer Drains

As part of the CSO study, the major interceptors, relief sewer and drains in the Ohio River North Region were designed to route sanitary flow and allotted quantities of diluting stormwater to the Morris Forman WQTC for treatment and final discharge to the Ohio River. A description of the CSS within the Ohio River Region is presented below.

Ohio River Interceptor

In the mid-1950s, the state ordered MSD to provide primary wastewater treatment and eliminate the discharge of raw sewage into the Ohio River. As a result, the Ohio River Interceptor and three major pump stations were constructed to collect flow from eastern, central, and northwestern portions of the system and convey it to the Morris Forman WQTC. Until that time, numerous individual sewers located in the north central section of the city discharged directly into the river. The design and construction of the Ohio River Interceptor enabled these lines to be intercepted and the sewage to flow by gravity to the treatment plant. In addition, the Robert J. Starkey, 4th Street, and 34th Street Pump Stations, which were constructed by the USACE as part of the city's flood control system, were also designed to be utilized as sanitary pumping facilities during non-flood periods. The Ohio River Interceptor, Western Interceptor, and Southern Outfall join south of 45th Street and Winnrose Way at the Main Diversion Structure located on the Whayne Supply Company property.

The Ohio River Interceptor enters the diversion structure as an 8'-0" circular sewer and exits as an 11'-0" semi-elliptical sewer flowing to the Morris Forman WQTC. The Ohio River Interceptor passes under the Southern Outfall in a siphon type arrangement but is open on the top, on each side of the Southern Outfall, within the diversion structure. The Southern Outfall is also open on the top within the structure. The Ohio River Interceptor is routinely backfilled by the Southern Outfall during wet weather. Because the Ohio River Interceptor is lower, water surface elevations equalize in both sewers resulting in some storage being provided before an overflow occurs.

Between the Morris Forman WQTC and the Main Diversion Structure, the Ohio River Interceptor is an 11'-0" semi-elliptical sewer with a slope of 0.03 percent. The estimated full capacity of the line in this reach is about 250 mgd. Upstream of the Main Diversion Structure, the interceptor varies in size, shape, and grade throughout its length. At its outlet end, the 8'-0" circular pipe on a slope of 0.08 percent has an estimated full flow capacity of 155 mgd. Typical daily flow is about 45 mgd.

38th Street Branch Interceptor

The 34th Street Pump Station serves the northwestern portion of the city from about 12th Street westward to the Ohio River. The flow from the station discharges into the 38th Street Branch Interceptor at 35th Street and Northwestern Parkway. The 38th Street Branch Interceptor in turn conveys the flow southward in 38th Street to the Ohio River Interceptor at 38th and Herman Streets. The 38th Street Sewer parallels the branch interceptor along 38th Street but continues one block further south before discharging into the Northwestern Interceptor.

The 38th Street Branch Interceptor is circular in shape and varies in size and grade from a 36-inch sewer with a 0.15 percent slope at its outlet end to a 30-inch sewer with a 0.39 percent slope at its upstream terminus. Estimated full flow capacity range is between 16.6 mgd and 17.2 mgd, respectively.

Central Relief Drain

In the mid to late 1930s, in response to flooding in the central business district from overtaxed combined sewers, the Central Relief Drain was constructed. This drain was designed to only receive flow during wet weather and relieves the combined sewers in the central part of the city at 14 locations. At each location, a side overflow weir was constructed on the sewer being relieved. When flow in the combined sewer reaches the level of the weir, a portion of the flow is relieved into the Central Relief Drain and transported to the Ohio River. The remaining flow continues through the combined sewer to its destination. Around 1950, the Central Relief Drain was extended south and relief was provided at 13 additional locations. Any flow that enters the Central Relief Drain must be discharged to the Ohio River.

A flood control gate is closed when the upper pool of the Ohio River reaches elevation 439.0 that protects the Central Relief Drain. When this gate is closed, all flow in the Central Relief Drain is diverted to the 5th Street Flood Pump Station and discharged to the Ohio River. Near its outlet end, the 6'-5" x 9'-7-1/2" inverted egg-shaped drain line with a slope of 0.335 percent has an estimated full flow capacity of 305 mgd.

4th Street Relief Sewer

The 4th Street Relief Sewer was designed and constructed to relieve sewers in the central business district that were being surcharged during periods of dry weather. For this reason, at each relief point, all flow in the combined sewers was diverted into the relief sewer. The relief sewer originally discharged flow into the Ohio River at the northern end of 4th Street. The 4th

Street Pump Station was built in conjunction with the Ohio River Interceptor when the treatment facilities were built. A dam was constructed across the relief sewer to divert DWF into the pump station. The pump station discharges into the Ohio River Interceptor. Excess flow during wet weather tops the dam and continues through the relief sewer to the river. The majority of the 4th Street Relief Sewer was constructed in a tunnel and is of such depth that the crown of the sewer is below the basement level of most of the adjacent buildings. Just upstream of the pump station, the 7'-6" semi-elliptical relief sewer with a slope of 0.20 percent has an estimated full flow capacity of 215 mgd.

2.6.2.2 Ohio River North Region Major Pump Stations

The northern region of the Ohio River sewershed contains many larger pump stations, many of which are facilities that are part of the CSS and operate during Ohio River flood and non-flood modes. The pump stations within this region include: 4th Street Pump Station, 34th Street Pump Station, 5th Street Pump Station, 10th Street Pump Station, 17th Street Pump Station, and 27th Street Pump Station.

4th Street Pump Station - Sanitary and Flood

The 4th Street Pump Station, located on the southeast corner of 4th and Main Streets, was constructed by the USACE in the 1950s as part of Louisville's flood control system and functions as a wastewater pumping facility. During non-flood conditions, the flow in the 4th Street Relief Sewer is diverted into the pump station and discharged to the Ohio River Interceptor. Per the USACE operational manual, during flood periods the pump station can discharge into the Ohio River Interceptor or the Ohio River, depending on flow.

The 4th Street Relief Sewer was built in the late 1920s to relieve overloaded sewers along 4th Street, Muhammad Ali Boulevard, Chestnut Street and Broadway. The relief sewer was designed to relieve all flows in the overloaded sewers, not just excess flows. Therefore, sanitary flow is present in the relief sewer continuously. A plan view of the pump station, sewers, diversions and gates is presented in Figure 2.6.3 at the end of this chapter.

The 4th Street Pump Station contains a sanitary wet well, a flood wet well and six pumps (three sanitary pumps and three flood pumps). The sanitary pumps can also be used as flood pumps. There are two 35 horsepower sanitary pumps rated at 4,000 gpm at 25 feet of head and one 60 horsepower sanitary pump rated at 5,900 gpm at 35.7 feet of head. The sanitary pumps discharge into a common header, which leads to either the Ohio River Interceptor or the flood pump discharge chamber. Fourth Street has three 350 horsepower stormwater pumps with a total station capacity of 95,400 gpm.

The 4th Street Pump Station is the ninth flood pump station to be placed into service should flooding occur on the Ohio River. This facility is not placed in flood operation mode until the river elevation exceeds elevation 436.3. This facility is expected to operate as a flood pump facility about once every five years on average.

34th Street Pump Station - Sanitary and Flood

The 34th Street Pump Station, which is located just south of the levee on 34th Street, was constructed by the USACE in the 1950s as part of Louisville's flood control system and functions as a wastewater pump facility. The station conveys flow from the northern portion of Louisville Metro to the Ohio River Interceptor or to the lower pool of the Ohio River, depending on flow and river elevation. A plan of the pump station, sewers, diversions and gates is presented in Figure 2.6.4 at the end of this chapter.

A diversion dam on the sewer flowing north on 34th Street diverts low flows through a 24-inch sewer into the pump station. The pump station discharges to the 38th Street Branch Interceptor that conveys the flow to the Ohio River Interceptor at 38th Street and Herman Street. The diversion dam is designated as CSO 019. Excess flow tops the dam and is discharged through the sewer to the lower pool of the Ohio River. When the river stage exceeds elevation 421.00, the pump station is shut down and backwater and sewage is allowed to pond in the sewer system.

The pump station contains two sanitary pumps rated at 4,250 gpm each at 31.5 feet of head and four storm pumps rated at 15,600 gpm each at 34 feet of head. The sanitary pumps can also be used for flood pumping.

The 34th Street Pump station is the thirteenth station to be placed into service should flooding occurs on the Ohio River. This facility is not placed in flood operation mode until river elevation exceeds 434.6. This facility is expected to operate as a flood pump facility about once every five years on average.

5th Street Pump Station - Flood

The 5th Street Pump station, which is located at 100 Place Montpelier, north of Main Street adjacent to the floodwall, was constructed by the USACE in the 1950s as part of Louisville's flood control system. This facility is equipped with three 50 horsepower pumps and one 25 horsepower pump providing a total capacity of approximately 37,000 gpm at minimum design head. The minimum water level elevation in the wet well is 426.75 based on the smaller pump and 437.00 for the larger pumps. The maximum design pumping elevation is 440.00.

The 5th Street Pump Station is the seventh station to be placed into service should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 434.3. Above this level, the facility is used to pump excess combined flows from the sewers in 5th, 6th, and 7th Streets and storm flows accumulated between Main Street and the floodwall to the river. Normal flows in these sewers, up to the capacities of their appropriate diversion structures, are conveyed to the Ohio River Interceptor. This facility is placed in operation about once every five year on average.

10th Street Pump Station - Flood

The 10th Street Pump Station, which is located on the southwest corner of 10th and Rowan Streets, was constructed by the USACE in the 1950s as part of Louisville's flood control system. This facility utilizes three 200 horsepower pumps and one 25 horsepower unit to achieve a total capacity of approximately 90,000 gpm at minimum design head. The minimum water level elevation in the wet well is 420.50 based on the smaller pump and 427.70 for the larger pumps. The maximum design pumping elevation is 432.10.

The 10th Street Pump Station is the eighth station to go on-line should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 434.6. At various stages above this level, the facility is used to pump excess combined flows from the sewer in 8th, 9th, 10th, 11th, 12th, and 13th Streets and storm flows accumulated between Main Street and the floodwall to the river. At upper gauge elevation 439.00, flow in the Central Relief Drain is diverted to the pump station. Normal flows in the numerous tributary sewers in 8th through 13th Streets, up to the capacities of their appropriate diversion structures, are conveyed to the Ohio River Interceptor. This facility is placed in operation about once every five years on average.

17th Street Pump Station - Flood

The USACE constructed the 17th Street Pump Station, which is located at the beginning of 17th Street north of Northwestern Parkway and adjacent to the floodwall, constructed by the USACE in the 1950s as part of Louisville's flood control system. The facility is equipped with three 75 horsepower pumps and one 15 horsepower pump providing a total capacity of approximately 496.0 gpm at minimum design head. The minimum water level elevation in the wet well is 427.25 based on the smaller pump and 433.00 for the larger pumps. The maximum design pumping elevation is 438.20.

The 17th Street Pump Station is the eleventh station to be placed into service should flooding occur on the Ohio River. This facility is not placed in operation until the river elevation exceeds 437.5. Below this level, normal flow in the sewer in 17th Street is conveyed to the 34th Street Pump Station and discharged into the Ohio River Interceptor. High flows top the diversion dam in Northwestern Parkway just upstream of the 17th Street station and are discharged by gravity directly into the river. Above river elevation 437.5 on the upper gauge, combined flows in the sewer in 17th Street are routed to the 17th Street facility and pumped into the river. This facility is placed in operation about once every five to ten years on average.

27th Street Pump Station - Flood

The 27th Street Pump Station, which is located at 27th Street and the floodwall, was constructed by the USACE in the 1950s as part of Louisville's flood control system. The facility utilizes four 350 horsepower pumps and one 60 horsepower unit to achieve a total capacity of approximately 198,150 gpm at minimum design head. The minimum water level elevation in the wet well is 419.25 based on the smaller pump and 428.20 for the larger pumps. The maximum design pumping elevation is 433.20.

The 27th Street Pump Station is the tenth station to be placed into service should flooding occur on the Ohio River. The 27th Street Pump Station is not placed in operation until the river elevation exceeds 436.8. Below Ohio River elevation 427.5, normal flows in the sewer in 22nd and 27th Streets are conveyed around the 27th Street facility to the 34th Street Pump Station and discharged into the Ohio River Interceptor. High flows overflow the diversion dam just upstream of the 34th Street station and are discharged by gravity directly into the river. Between upper gauge elevations 427.5 and 436.8, normal flows are handled in the same manner prescribed above, but a portion of the high flows is diverted by gravity directly into the Portland Canal instead of traveling all the way to 34th Street. Above river elevation 436.8 on the upper gauge, combined flows in the sewers in 22nd and 27th Streets are routed to the 27th Street Pump Station and pumped into the river. This facility is placed in operation about once every five to ten years on average.

2.6.2.3 Ohio River North Region Combined Sewer Overflows

The following is a list of CSOs located within the Ohio River North Region. Table 2.6.1 summarizes the hydraulic characteristics of CSOs located within the Ohio River North Region.

Note that CSO023 is one of three CSOs within the entire CSS that does not have solids and floatables control. A concerted effort was made in August of 2006 to design and install devices but because of physical limitations of the diversion structure, it was not feasible to install solids and floatables device without extensive engineering or construction. Therefore, solids and floatables will be addressed as part of the Final CSO LTCP at these locations.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 2.6.1
OHIO RIVER NORTH CSO SUMMARY TABLE

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO019	**34th Street Pump Station**	1,094.02	Baffle	Diversion Dam	297.91	60	8.10	4965.23
CSO022	**4th Street Pump Station**	100.89	Baffle	Diversion Dam	0.95	4	2.23	238.69
CSO023	**Ohio River Interceptor @ 4th Street Pump Station**	[illegible]0.0	None	Side Weir	74.00	28	5.32	2642.72
CSO050	**12th Street**	36.32	CDS	Diversion Dam	38.87	41	8.15	948.08
CSO051	**11th Street**	6.34	Baffle	Diversion Dam	3.84	28	4.93	137.24
CSO052	**10th Street**	8.70	Baffle	Diversion Dam	8.43	27	8.00	312.27
CSO054	**7th Street**	7.06	Cyclone	Diversion Dam	0.11	23	2.25	4.75
CSO053	**8th Street**	34.12	Baffle	Diversion Dam	4.52	23	3.57	196.41
CSO055	**6th Street**	18.03	Baffle	Diversion Dam	18.44	28	8.40	658.74
CSO056	**5th Street**	22.03	Baffle	Diversion Dam	2.74	18	3.83	152.29
CSO057	**1st Street Overflow Weir**	-	Screens	High Pipe	0.00	0	0.00	0.00
CSO058	**Preston Street Overflow Weir**	105.41	Baffle	Side Weir	116.64	50	8.65	2332.90
CSO150	**8th Street @ Common Place**	1.79	Baffle	Diversion Dam	7.81	31	7.97	251.88
CSO155	**Rowan Street and 12th Street**	11.93	Screens	Diversion Dam	2.05	39	4.80	52.57
CSO156	**6th Street & Washington Sanitary Diversion**	0.0	Screens	Diversion Dam	0.09	10	2.65	9.27
CSO160	**Sewer in Alley Sanitary Diversion**	1.98	Baffle	Diversion Dam	0.28	28	3.53	9.96
CSO161	**Market Street Sanitary Diversion**	2.54	Screens	Diversion Dam	0.01	1	1.92	10.05
CSO190	**17th Street Sanitary Diversion**	145.41	Baffle	Diversion Dam	36.19	49	5.32	738.54
CSO207	**2nd Street and Jefferson Street**	2.5	Screens	Diversion Dam	0.05	2	1.93	25.08
CSO208	**12th Street and Jefferson Street**	11.19	Screens	Diversion Dam	0.33	11	1.95	29.81
CSO172	**Adams Street**	13.67	Screens	Side Weir	1.28	31	4.05	41.14
CSO062	**Logan Company**	-	Screens	Diversion Dam	0.00	0	0.00	0.00
CSO020	**Buchanan Pump Station**	86.59	Screens	Diversion Dam	6.29	11	3.43	571.61

Central Relief Drain (22 CSOs)

The following is a list of active CSOs located within Central Relief Drain area. Table 2.6.2 summarizes the hydraulic characteristics of CSOs located within the Central Relief Drain of the Ohio River North area.

TABLE 2.6.2
OHIO RIVER NORTH CENTRAL RELIEF DRAIN CSO SUMMARY TABLE

CSO Data Outdated

Refer to Chapter 5

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO026	Central Relief Drain - 6th Street and Broadway	[illegible]	Baffle	Side Weir	0.00	0	0.00	0.00
CSO027	Central Relief Drain - 7th Street and Broadway	10.08	Baffle	Side Weir	0.00	0	0.00	0.00
CSO028	Central Relief Drain - 6th Street and York Street	6.11	Cyclone	Side Weir	0.00	0	0.00	0.00
CSO029	Central Relief Drain - 8th Street and York Street	34.78	Baffle	Side Weir	4.53	33	4.12	137.38
CSO031	Central Relief Drain - 6th Street and Breckinridge Street	3.75	Baffle	Side Weir	0.00	0	0.00	0.00
CSO034	Central Relief Drain - 4th Street and York Street	5.09	Cyclone	Side Weir	0.00	0	0.00	0.00
CSO035	Central Relief Drain - 2nd Street and Broadway Number 1	14.26	Baffle	Side Weir	0.21	11	1.95	18.86
CSO036	Central Relief Drain - 3rd Street and Broadway	23.08	Baffle	Side Weir	0.02	4	1.42	4.55
CSO038	Central Relief Drain - 5th Street and Broadway	9.49	Baffle	Side Weir	0.00	0	0.00	0.00
CSO178	Central Relief Drain - 9th Street and York Street "B"	58.02	Baffle	Side Weir	0.60	11	1.82	54.84
CSO181	Central Relief Drain - 2nd Street and Broadway Number 2	22.63	Baffle	Side Weir	0.01	3	1.43	3.61

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

TABLE 2.6.2
OHIO RIVER NORTH CENTRAL RELIEF DRAIN CSO SUMMARY TABLE

CSO NO.	CSO Name	Drainage Area (Ac)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO192	**Central Relief Drain - South 6th Street and Garland Street**	9.00	Screens	Side Weir	0.00	0	0.00	0.00
CSO193	**Central Relief Drain - South 6th Street and Kentucky Street**	22.69	Baffle	Side Weir	0.04	5	1.85	7.22
CSO195	**Central Relief Drain - South 4th Street and Oak Street**	7.28	Baffle	Side Weir	2.19	55	5.75	39.90
CSO196	**Central Relief Drain - South 3rd Street and Oak Street**	2.18	Baffle	Side Weir	0.13	11	1.83	12.13
CSO197	**Central Relief Drain - South 3rd Street, South of Oak Street**	4.54	Screens	Side Weir	3.02	47	5.10	64.21
CSO198	**Central Relief Drain - South 3rd Street and Ormsby Avenue**	4.40	Baffle	Side Weir	0.00	2	1.08	1.24
CSO199	**Central Relief Drain - South 3rd Street, North of Magnolia Street**	8.64	Screens	Side Weir	0.46	45	4.67	10.26
CSO200	**Central Relief Drain - South 3rd Street and Magnolia Street**	10.28	Screens	Side Weir	4.91	65	7.43	75.56
CSO201	**Central Relief Drain - S 5th Street and Kentucky Street**	8.33	Screens	Side Weir	0.00	0	0.00	0.00
CSO202	**Central Relief Drain – South Ormsby Avenue, West of 3rd Street**	5.3	Screen	Side Weir	0.00	0	0.00	0.00
CSO203	**Central Relief Drain - South 4th Street and Ormsby Avenue**	14.24	Baffle	Side Weir	0.00	0	0.00	0.00

2.6.2.4 Ohio River West Region Major Interceptors/Relief Sewer Drains

Northwestern Interceptor and Western Interceptor

The Northwestern Interceptor and Western Outfall were constructed around 1911 and 1870, respectively, and both at one time discharged directly into the lower pool of the Ohio River around Shawnee Park. In the early part of the 1900s, park visitors and patrons of a nearby amusement park extensively used this area. The direct discharges from the Western Outfall produced some offensive conditions during periods of low water. Thus, the Western Interceptor was constructed in conjunction with the Northwestern Interceptor. The Western Interceptor was designed to intercept the DWF in both the Northwestern Interceptor and the Western Outfall and convey it to the Southern Outfall, which then were discharged downstream of Shawnee Park and the amusement park.

When the treatment facilities at Morris Forman WQTC were constructed, the Western Interceptor was redirected into the Ohio River Interceptor just upstream of the CSO211. Today, a CSO remains on the Western Interceptor at that point of redirection. Excess flow continues through the Western Interceptor to the Southern Outfall downstream of the CSO211.

Between its outlet end and Broadway, the Western Interceptor is a 5'-0" circular sewer with a slope of .055 percent and provides an estimated full flow capacity of 36.8 mgd. At Broadway, the interceptor becomes a 3'-6" circular sewer on the same grade and remains as such until it terminates at its junction with the Northwestern Interceptor. The estimated full flow capacity of the smaller section is reduced to approximately 14.4 mgd. Peak wet weather flow in the Western Interceptor has been measured at up to 20 mgd.

Western Outfall

The Western Outfall drains the area along Broadway from the Ohio River east to about 12th Street, encompassing about 1,800 acres. DWF from the Western Outfall is directed into the Western Interceptor just south of Shawnee Park in Broadway. Excess flows top an overflow diversion dam and continue through the Western Outfall to the river. When the lower gauge reaches elevation 435.0, a flood control gate on the Western Outfall is closed and any excess flow is directed into the Shawnee Park Flood Pump Station, which is then pumped to river.

The eastern portion of the Western Outfall service area, notably that area located along Maple Street, has surcharged several times in recent years, flooding vehicles and yards with combined sewage. This low-lying area is especially susceptible to flooding from sewer surcharges. Although the Western Outfall is relatively large in diameter, its flat slope results in insufficient capacity to convey all flows during high intensity storm events. The result is basement backups, sewer surcharging, and/or surface flooding during heavy rains. Surface flooding has occurred all along this sewer since as far back as 1910.

The segment of the Western Outfall in Broadway between Southwestern Parkway and 28th Street is a 10'-6" diameter circular brick sewer that was constructed circa 1873. Just west of the Southwestern Parkway, the sewer becomes 11'-9" in diameter. Based on plans developed during the underground sewer investigations of 1937, the outfall line has an estimated grade of 0.052 percent providing a full flow capacity of approximately 355 mgd upstream of the diversion dam. Peak wet weather flow in the Western Outfall has been measured at over 220 mgd at about two-thirds full. Typical daily flow is 3 or 4 mgd.

Southern Outfall

The Southern Outfall serves a combined sewer area of about 3,500 acres and has an unsurcharged full flow capacity of about 765 mgd at its lower end. The Southern Outfall was constructed around 1912 and discharges to the lower pool of the Ohio River, just upstream of the treatment plant. Continued growth and development in the service area of the Southern Outfall has increased runoff to the extent that basement backups and surface flooding occur during intense storms.

When the diversion structure was built, a dam was constructed across the Southern Outfall to divert DWF through a drop connection into the Ohio River Interceptor to the Morris Forman WQTC. High flows top the dam in the diversion structure and continue through the Southern Outfall to the river. The Western Parkway Flood Pump Station provides flood protection for the Southern Outfall. When the lower gauge of the river exceeds elevation 416.4, the flood control gates are closed and the pump station begins operation. Overflow from the diversion structure is then pumped to the river.

Southwestern Outfall

The Southwestern Outfall serves the southwestern section of Louisville Metro and through its branches also serves the south central portion. Flows collected in the south central area north of the Watterson Expressway are routed via the Manning Road - Cardinal Drive Sewer and Upper Dry Run Trunk Sewer to a junction with the Southwestern Outfall at Taylor Boulevard and Oleanda Avenue. In a similar fashion, flows collected in south central Louisville, south of the Watterson Expressway, are conveyed through the Northern Ditch Trunk Interceptor and Mill Creek Trunk Sewer to the same junction point with the Southwestern Outfall at Taylor and Oleanda.

Flow in the Beargrass Interceptor Relief Sewer is discharged by the Nightingale Pump Station into the upstream end of the Manning Road - Cardinal Drive Sewer and thus enters the Southwestern system. In addition, other sewers, normally a tributary to the Beargrass Interceptor, can be diverted behind the Bashford Manor Mall through the Southeastern Interceptor, Northern Ditch Trunk Interceptor, and Mill Creek Trunk Sewer to the Southwestern Outfall. This diversion can be accomplished manually and is limited by the capacity of the Northern Ditch Pump Station. The Southwestern Outfall is diverted near Bells Lane and Watterson Expressway to the Southwestern Pump Station where the flow is pumped through the Southwestern Branch Interceptor to the Morris Forman WQTC.

The Southwestern Outfall, constructed in the 1930s, drains a combined sewer area of about 7,700 acres. The expanse of the service area of the Southwestern Outfall dictated its large size, 18'-4" x 27'-6" at one point. This sewer is considered the outstanding accomplishment of the Commissioners of Sewerage. In both length and size, it was one of the largest sewers built in the United States during that era. The Southwestern Outfall is an inverted egg-shaped sewer with varying width, height, and grade throughout its length. At the Southwestern Pump Station, the 18'-4" x 27'-6" line was constructed on a slope of 0.087 percent and provides an estimated capacity of 2,556 mgd flowing full.

DWF in the Southwestern Outfall is diverted by a 6-foot high dam into the Southwestern Pump Station and discharged through the Southwestern Branch Interceptor to Morris Forman WQTC. For a majority of its length, the 6'-0" circular Southwestern Branch Interceptor was laid on a slope of 0.07 percent and provided an estimated full flow capacity of 74 mgd. The 104 mgd capacity of the pump station exceeds the maximum unsurcharged capacity of the Branch Interceptor.

Normal lower pool elevation on the Ohio River is 383.00. Because of the presence of the McAlpine Locks and Dam at Louisville, the lower pool elevations fluctuate much more than the upper pool elevations. Lower pool elevations exceed 400.00 quite regularly. In consideration, the Southwestern Outfall is protected by three large electrically operated sluice gates just below the Southwestern Pump Station.

Southwestern Branch Interceptor

The Southwestern Branch Interceptor conveys flow discharged from the Southwestern Pump Station to the Morris Forman WQTC. For a majority of its length, the 6'-0" circular sewer was laid on a slope of 0.07 percent and provided an estimated full flow capacity of 72 mgd. It should be noted that the 104 mgd capacity of the pump station exceeds the maximum unsurcharged capacity of the Southwestern Branch Sewer.

2.6.2.5 Ohio River West Region Major Pump Stations

Northern Ditch Pump Station - Sanitary

The Northern Ditch Pump Station is located on the Northern Ditch Trunk Interceptor on New Way southeast of Strawberry Lane. The facility differs from other stations discussed herein in that it functions solely as a sanitary lift station (LS). Flow in the 72-inch interceptor is lifted approximately 24 feet and discharged into a 60-inch downstream continuation of the interceptor that ultimately flows to the Mill Creek Trunk Sewer and Southwestern Outfall. See Figure 2.6.5 at the end of this chapter. The Northern Ditch Pump Station utilizes four submersible propeller pumps each rated at 14,400 gpm for a total constructed capacity of 57,600 gpm. Due to limited capacity in the discharge chamber and downstream sewer, only three pumps are operated simultaneously. The fourth pump is used as a stand-by. Therefore, the maximum discharge from the pump station is 43,200 gpm or 62 mgd. The full flow capacity of the Northern Ditch Interceptor, upstream of the pump station is about 52 mgd.

Southwestern Pump Station

The Southwestern Pump Station is located just south of Bells Lane on the west side of the Watterson Expressway. The facility was designed to intercept flow in the Southwestern Outfall and convey it via the Southwestern Branch Interceptor to the Morris Forman WQTC. Excessive high flows in the Southwestern Outfall overflow a diversion dam and continue through the outfall line to the Ohio River. See Figure 2.6.6 at the end of this chapter.

The pump station has an east and west wet well, each fed by a 60" sewer. Mechanical screening is provided on both of the wet well inlets. Two 30-inch centrifugal pumps draw from the west wet well and two 20-inch centrifugal pumps draw from the east wet well. The bottom elevation of the wet wells is 382.25. An opening in the dividing wall at elevation 393.34 connects the wet wells. The four pumps are rated at 24,000 gpm each. The fourth pump is used as a standby. Therefore, maximum discharge from the pump station is 104 mgd.

Shawnee Park Pump Station - Flood

The Shawnee Park Pumping Station is located at 612 Southwestern Parkway in the middle of Shawnee Park. The facility has five 800 horse power pumps and one 75 horse power pump providing a total capacity of approximately 526,500 gpm at minimum design head. The minimum water level elevation in the wet well is 412.50 based on the smaller pump and 420.00 for the larger pumps. The maximum design pumping elevation is 426.50.

The Shawnee Park Pumping Station is not placed in operation until the river level reaches elevation 435.00 on the lower gauge. Below this level, normal flows in the Northwestern Interceptor and Western Outfall enter the Western Interceptor and are eventually conveyed to the Morris Forman WQTC. Excessive high flows in the Northwestern Interceptor are diverted at its junction with the Western Interceptor to the Ohio River. In a similar fashion, excessive high flows in the Western outfall overflow the diversion dam in Broadway and discharge to the river. Above river elevation 435.00 on the lower gauge, combined flows from both the Northwestern Interceptor and Western outfall are routed to the Shawnee facility and pumped into the river. Shawnee is the fourteenth station to be placed into service should flooding occur on the Ohio River. This pump station operates about once every five to ten years on average.

Western Parkway Pump Station - Flood

The Western Parkway Pumping Station is located on the Southern Outfall west of Southwestern Parkway at 1300 Southwestern Parkway. The facility is equipped with four 1,250 horse power and three 450 horse power pumps capable of discharging a total flow of approximately 810,000 gpm at minimum design head. The minimum water level elevation in the wet well is 412.60 based on the smaller pumps and 417.00 for the larger pumps.

The Western Parkway Pumping Station is not placed in operation until the river elevation exceeds 416.4 on the lower gauge. Below this level, normal flows in the Ohio River Interceptor, Southern Outfall, Western Interceptor, and 45th Street-Greenwood Avenue Sewer converge at the CSO211 and continue to the Morris Forman WQTC. Excessive high flows overflow the dam in the main diversion structure and are conveyed by gravity through the Southern Outfall to the Ohio River. Above river elevation 416.4 on the lower gauge, the Western Parkway facility is used to pump the combined flow in the Southern Outfall downstream of the CSO211 into the river. Western Parkway facility is the first station to be placed in service should flooding occur on the Ohio River. This facility can be expected to operate about once or twice a year on average and one of the pumps may run for a short period of time.

Paddy's Run Pump Station - Flood

The Paddy's Run Pumping Station, which is located at 4200 Campground Road, is equipped with four 1,250 horse power pumps and two 700 horse power units providing a total capacity of approximately 607,500 gpm at minimum design head. The minimum water level elevation in the wet well is 402.25 based on the smaller pumps and 427.60 for the larger pumps. The maximum design ponding elevation is 434.00.

The Paddy's Run Pumping Station is not placed in operation until the river elevation exceeds 435.3 on the lower gauge. Above this level, the facility is used to pump the surface water in Paddy's Run and excess combined flow in the Southwestern Outfall that overflows the diversion dam at the Southwestern Pump Station to the river. Paddy's Run is the twelfth station to go on line should flooding occur on the Ohio River. This facility can be expected to operate about once every five to ten years on average.

2.6.2.6 Ohio River West Region Combined Sewer Overflows

The following is a list of CSOs located within the Ohio River West Region. Table 2.6.3 summarizes the hydraulic characteristics of CSOs located within the Ohio River North Region.

Note that CSO015, the operating procedures for the outfall gate are being modified to operate as a baffle. The procedures will be revised and implemented by March 31, 2010.

CSO015 and CSO211 are two of three CSOs within the entire CSS that do not have solids and floatables control. A concerted effort was made in August of 2006 to design and install devices but because of physical limitations of the diversion structures, it was not feasible to install solids and floatables device without extensive engineering or construction at these locations. Therefore, solids and floatables will be addressed as part of the Final CSO LTCP projects for these CSO locations.

TABLE 2.6.3
OHIO RIVER WEST REGION CSO SUMMARY TABLE

CSO Data Outdated

Refer to Chapter 5

CSO NO.	CSO Name	Drainage Area (AC)	S&F Device	Overflow Type	Baseline AAOV (MG/YR)	Overflow Incidents (# of/Yr)	Average Duration of Overflows (Hrs)	Average Volume Per Incident (1000 Gal)
CSO015	**Southwestern Pump Station**	7,496.70	Baffle	Diversion Dam	494.56	61	7.23	8,108
CSO016	**Miles Park Bypass**	-	Screens	Side Weir	29.65	29	6.22	1,023
CSO104	**Southwest Parkway Sewer @ Broadway**	62.04	Screens	Diversion Dam	0.20	5	2.12	41
CSO105	**Western Outfall @ Broadway**	1,881.20	None	Diversion Dam	21.43	19	3.75	1,128
CSO189	**Northwestern Sanitary Diversion**	1,148.65	Baffle	Side Weir	175.79	37	6.03	4,751
CSO191	**Algonquin Parkway Sanitary Diversion**	339.75	Baffle	Diversion Dam	32.42	19	6.65	1,706
CSO210	**45th Street - Greenwood**	166.67	Baffle	Diversion Dam	195.57	51	8.12	3,835
CSO211	**Main Diversion Structure**	3,554.89	None	Inflatable Dam	373.17	29	4.23	12,868

2.7 RECREATIONAL USE SURVEY

The process to evaluate and select CSO control approaches considers several community values identified by the Wet Weather Team (WWT) Stakeholder Group. These values include the protection of the environment, compliance with regulatory requirements, and protection of public health. The performance measures established to quantify protection of public health consider the potential public contact with sewer overflows.

To assist in identifying the locations with the greatest potential for public contact with sewer overflows, MSD conducted a Recreational Use Survey within the Beargrass Creek and Ohio River Watersheds. The result of this survey is summarized in a technical memorandum and was used in the evaluation of overflow control measures, and the prioritization of project implementation schedules. The results may also be useful in the water quality standards review suggested by the CSO Policy and LTCP guidance documents prepared by EPA.

2.7.1 Study Area

The Recreational Use Survey study area consists of the Beargrass Creek and Ohio River watersheds. The Beargrass Creek watershed is further subdivided into three forks (Muddy, Middle, and South) as show below.

- Ohio River Region
- Beargrass Creek Muddy Fork
- Beargrass Creek Middle Fork
- Beargrass Creek South Fork

2.7.2 Survey Locations

Thirteen sites were identified for the Recreational Use Survey, which included four locations within the Ohio River Region watershed, one location within the Beargrass Creek Muddy Fork watershed, six locations within the Beargrass Creek Middle Fork watershed, and two locations within the Beargrass Creek South Fork watershed. During the kickoff meeting on May 14, 2007, two sites (11 – Brown Park and 13 - Louisville Junior Academy) were removed from the survey, because they were located upstream of the CSO area.

Two sites (14 - Eva Bandman Park and 15 - Eva Bandman Park) were added on May 18, 2007, as a follow-up to the kickoff meeting. The Eva Bandman Park was split into two sites because the park is located in both the Ohio River watershed and the Beargrass Creek confluence. On September 1, 2007, two sites (16 - Beargrass Creek at Irish Hill and 17 - Butchertown Trail) were added to the list of survey sites to provide additional data within Beargrass Creek Middle Fork and Beargrass Creek confluence, respectively.

The final list of Recreational Use Survey Sites and associated watersheds are listed in Table 2.7.1 below. Figure 2.7.1 at the end of this chapter indicates the survey site locations, watershed boundaries, and identified CSO locations. Of the 17 survey sites identified in Table 2.7.1, 10 were located downstream of the CSO area in Table 2.7.2.

Survey site fact sheets containing locations, descriptions and site photos are located in Appendix 2.7.1, Recreational Use Survey Technical Memorandum.

TABLE 2.7.1
LIST OF RECREATIONAL USE SURVEY SITES

Site Number	Site Name	Watershed	Comments
1	Riverside, Farnsley Moremen Landing	Ohio River	-
2	Riverview Park	Ohio River	-
3	Waterfront Park	Ohio River	-
4	Cox Park (Public Boat Ramp)	Ohio River	-
5	Louisville Soccer Park	Muddy Fork BGC	-
6	Cherokee Golf Course	Middle Fork BGC	-
7	Cherokee Park	Middle Fork BGC	-
8	Seneca Park (Scenic Loop & Maple)	Middle Fork BGC	-
9	Seneca Park (Big Rock)	Middle Fork BGC	-
10	Seneca Golf Course (1 Mile Stretch)	Middle Fork BGC	-
11	Brown Park		Removed May 14, 2007
12	Joe Creason Park	South Fork BGC	-
13	Louisville Junior Academy		Removed May 14, 2007
14	Eva Bandman Park	Ohio River	Added May 18, 2007
15	Eva Bandman Park	Beargrass Creek Confluence	Added May 18, 2007
16	Beargrass Creek At Irish Hill	Middle Fork BGC	Added September 1, 2007
17	Butchertown Trail	Beargrass Creek Confluence	Added September 1, 2007

TABLE 2.7.2
RECREATIONAL USE SURVEY SITES LOCATED WITHIN/DOWNSTREAM OF THE CSS

Site Number	Site Name	Watershed
1	Riverside, Farnsley Moremen Landing	Ohio River
2	Riverview Park	Ohio River
3	Waterfront Park	Ohio River
6	Cherokee Golf Course	Beargrass Creek Middle Fork
7	Cherokee Park	Beargrass Creek Middle Fork
8	Seneca Park (Scenic Loop & Maple)	Beargrass Creek Middle Fork
14	Eva Bandman Park	Ohio River
15	Eva Bandman Park	Beargrass Creek Confluence
16	Beargrass Creek at Irish Hill	Beargrass Creek Middle Fork
17	Butchertown Trail	Beargrass Creek Confluence

2.7.3 Study Design

The Recreational Use Survey was conducted from May 1 through November 29, 2007, to coincide with the Kentucky recreational season. During the months of May through August, the sites were visited twice on the weekends and twice during the week. During September, October, and November, the sites were visited twice on the weekends and once during the week. Table 2.7.3 summarizes the number of site visits conducted at each survey site during the study. Appendix 2.7.1 provides a detailed list of survey site visits conducted throughout the duration of the study.

TABLE 2.7.3
SURVEY SITE VISITS

Site Number	Site Name	# of Site Visits
1	Riverside, Farnsley Moremen Landing	104
2	Riverview Park	104
3	Waterfront Park	104
4	Cox Park (Public Boat Ramp)	104
5	Louisville Soccer Park	104
6	Cherokee Golf Course	104
7	Cherokee Park	104
8	Seneca Park (Scenic Loop & Maple)	104
9	Seneca Park (Big Rock)	104
10	Seneca Golf Course (1 mile stretch)	104
11	Brown Park	8
12	Joe Creason Park	104
13	Louisville Junior Academy	8
14	Eva Bandman Park	94
15	Eva Bandman Park	94
16	Beargrass Creek at Irish Hill	32
17	Butchertown Trail	32

Survey locations 11 and 13 were visited only eight times, because they were removed from the survey on May 14, 2007. Survey locations 14 and 15 were added on May 18, 2007, and survey locations 16 and 17 were added on September 1, 2007, and therefore have a reduced number of site visits.

During the daily site visits, field data at each site was reported on a form entitled Field Data Sheet for Recreational Use Stream Survey. In addition, a minimum of three photos were taken per site (upstream, downstream, and observed recreational activity). Field data reported on the form included:

- Site Information: Name, Location Description, GPS Coordinates
- Photo Log ID Number
- Date & Time
- Personnel
- Current Weather Conditions
- Weather Conditions for Past 7 Days
- Number of People Observed
- Recreational Activities Observed
- Type of Water Contact

SURVEY CATEGORIES

Contact activities:

Boating	Fishing
Wading	Swimming
Jet Ski	Water Ski
Kayak	Study

Non-contact activities:

Dog Walking	Party/Picnic
Playground	Lounging
Walking/Jogging	Sport
Working	Bike Riding
Sunbathing	

Type or magnitude of the contact:

Incidental	Below Ankle
Below Waist	Below Neck
Full	Non Contact
Non Recreational	

Recreational activities were split into two subcategories: contact activities and non-contact activities. In addition, the number of people was further subdivided into adults and children, because children are at greater risk of ingestion and present a higher degree of health impact. For purposes of this study, children represented ages 12 and younger.

A summary sheet was created to analyze the field data for all the survey sites. Field data included on the summary sheets include the site description, number of people observed, recreational activities observed and magnitude of water contact. See Appendix 2.7.1, Recreational Use Survey Technical Memorandum, for more details on the survey information.

The survey results are divided into the following categories:

- Adults observed at the site
- Children observed at the site
- Adults observed participating in non-contact activities
- Children observed participating in non-contact activities
- Adults observed participating in contact activities
- Children observed participating in contact activities
- Contact observed

In order to provide assistance in evaluating and selecting overflow control approaches that protect public health, the recreational use survey site locations with the greatest potential contact with overflows need to be identified and prioritized.

The following four parameters were selected to rank and prioritize the survey site locations:

- Average number of people observed per site visit;
- Percent contact observed;
- Potential for water contact; and
- Percent children observed.

An overall summary of the survey results from these seventeen locations throughout the duration of the study are presented in Table 2.7.4 at the end of this chapter. Potential contact is defined as the number of adults and children participating in contact activities but where no contact was observed; therefore, having the potential for water contact.

Each survey site was scored on a twenty-point scale (1 = Low and 20 = High) for each parameter with the exception of the percent contact observed parameter, where a weighting factor was applied. A weighting factor (doubling the parameter score) was applied to this parameter, because it represents direct water contact and was therefore considered of greater relative importance. Once the parameters were scored for each survey site, a priority rating was applied to each survey site. The priority rating is based on the sum of the parameter scores following applications of weighting factors.

The priority rating categories range from High (greatest potential for public contact with) to Low (least potential for public contact). The resultant priority scale has a potential maximum of 100 and minimum of zero as shown below:

- High: 51-100
- Medium: 21-50
- Low: 0-20

2.7.4 Conclusions

Of the seventeen survey sites observed, Seneca Park at Big Rock scored the highest rating equal to 56 and was the only site identified as high priority. Four sites were identified with medium priority and the remaining twelve sites were categorized as low priority. The priority rating scores for all survey sites are listed on Table 2.7.5.

Of the 10 survey sites located within/downstream of the CSS, no sites were identified as high priority. Riverview Park and Cherokee Golf Course ranked the highest of the 10 sites with a rating equal to 26 and 25, respectively. These two sites were the only sites identified as medium priority and the remaining eight sites were categorized as low priority. The priority rating scores for the survey sites within the CSS are listed on Table 2.7.6.

TABLE 2.7.5
SURVEY SITE PRIORITY RATING SCORES

Park ID	Park Name	Watershed	Average People	% Children	% Potential	% Contact	Total	Rating
9	**Seneca Park - Big Rock**	Middle Fork BGC	9	6	6	40	52	High
2	**Riverview Park**	Ohio River	12	5	12	9	26	Medium
6	**Cherokee Golf Course - Lexington Rd**	Middle Fork BGC	4	1	20	4	25	Medium
4	**Cox Park**	Ohio River	20	3	16	5	24	Medium
5	**Louisville Soccer Park**	Muddy Fork BGC	4	20	1	1	22	Medium
3	**Waterfront Park**	Ohio River	18	7	8	4	19	Low
12	**Joe Creason Park**	South Fork BGC	5	10	0	0	10	Low
17	**Butchertown Greenway**	BGC Confluence	2	1	8	0	9	Low
1	**Farnsley Moremen Landing**	Ohio River	5	5	1	1	7	Low
7	**Cherokee Park - Shelter**	Middle Fork BGC	10	6	0	0	6	Low
14	**Eva Bandman Park - Ohio River**	Ohio River	11	2	3	1	6	Low
15	**Eva Bandman Park - Beargrass Creek**	BGC Confluence	3	0	6	0	6	Low
16	**Beargrass Creek at Irish Hill**	Middle Fork BGC	3	4	0	0	4	Low
10	**Seneca Golf Course**	Middle Fork BGC	8	1	1	1	3	Low
8	**Seneca Park - Scenic Loop**	Middle Fork BGC	6	1	1	0	2	Low
11	**Brown Park**	-	8	0	0	0	0	Low
13	**Louisville Junior Academy**	-	4	0	0	0	0	Low

TABLE 2.7.6
SURVEY SITES WITHIN/DOWNSTREAM OF THE CSS PRIORITY RATING SCORES

Park ID	Park Name	Watershed	Average People	% Children	% Potential	% Contact	Total	Rating
2	**Riverview Park**	Ohio River	12	5	12	9	26	Medium
6	**Cherokee Golf Course - Lexington Rd**	Middle Fork BGC	4	1	20	4	25	Medium
3	**Waterfront Park**	Ohio River	18	7	8	4	19	Low
17	**Butchertown Greenway**	BGC Confluence	2	1	8	0	9	Low
1	**Farnsley - Moremen Landing**	Ohio River	5	5	1	1	7	Low
7	**Cherokee Park - Shelter**	Middle Fork BGC	10	6	0	0	6	Low
14	**Eva Bandman Park - Ohio River**	Ohio River	11	2	3	1	6	Low
15	**Eva Bandman Park - BGC**	BGC Confluence	3	0	6	0	6	Low
16	**Beargrass Creek at Irish Hill**	Middle Fork BGC	3	4	0	0	4	Low
8	**Seneca Park - Scenic Loop**	Middle Fork BGC	6	1	1	0	2	Low

2.8 ECOLOGICAL CHARACTERIZATION (SENSITIVE AREA STUDY)

The CSO Control Policy requires consideration and priority ranking of CSO discharges to areas meeting the criteria of sensitive area classification. Using CSO Policy criteria, all forks of Beargrass Creek are classified as sensitive, so no prioritization is possible using these criteria.

To allow prioritization of CSO discharges, MSD developed a process to rate the ecological condition of each stream reach (defined as length between CSO outfalls). Further assessment was necessary to prioritize implementation of the various CSO controls. Beargrass Creek is an urbanized stream, which has resulted in severe stresses to its aquatic environment. These stresses have been caused by the large extent of paved surfaces (Figure 2.8.1 at the end of this chapter) as well as inputs from both non-point and point sources of pollution. Existing stream conditions range from somewhat natural channels with typical biotic components (Figure 2.8.2) to channelized, concrete-lined channels with little to no natural aquatic habitat (Figure 2.8.3).

FIGURE 2.8.2 TYPICAL GOOD QUALITY PORTION OF BEARGRASS CREEK

FIGURE 2.8.3 TYPICAL POOR QUALITY PORTION OF BEARGRASS CREEK

The overall goal of this ecological reach characterization was to construct a framework for prioritizing proposed CSO controls based on the degree of benefit anticipated to be gained by the ecological components of Beargrass Creek from implementation of CSO control measures. Specific study objectives include:

- Provide an ecological component to the decision-making process regarding phasing of CSO controls;
- Provide a measure for distinguishing stream reaches and CSO control projects based on aquatic ecology; and
- Rate and rank stream reaches based on ecologically-related parameters, with high scores indicating those reaches that will benefit most from water quality improvements.

The study is presented here in terms of methodology, results, and conclusion.

2.8.1 Methodology

The ecological characterization study uses an approach that incorporates the biological integrity of existing aquatic communities, as well as the associated physiographic and geomorphologic characteristics of the stream, its riparian corridor, and societal values. The study was undertaken based on identification of discrete stream reaches, selection of appropriate assessment parameters, and the assessment/scoring of each reach under each parameter.

2.8.1.1 Reach Identification

Stream reaches were delineated based on CSO discharge locations, with each reach beginning at a CSO outfall location and continuing downstream to the next CSO outfall location. Some stream reaches may consist of multiple CSOs when the outfalls were located at the same general geographic location and were all considered a component of the same reach. Each stream reach is numbered based on a fork identifier (MU = Muddy Fork; MI = Middle Fork; S = South Fork) and the CSOs that discharges to it. A total of 37 stream reaches were identified: one in Muddy Fork Beargrass Creek; eight in Middle Fork Beargrass Creek; and 28 in South Fork Beargrass Creek.

2.8.1.2 Parameter Selection

Because the effects of CSO discharges are a concern to a diverse group of constituents (residents, communities, businesses, environmental groups, and MSD), prioritization of CSO control measures must consider numerous factors. These include environmental, economic feasibility, asset protection, public health, and regulatory compliance performance. Parameters for each reach were scored using either in situ field observations or from GIS data obtained from federal, state, and local sources. All of the data used for the rating system were organized and used for analysis, display, and query in a GIS using ArcGIS 9.2 software.

Stream reach rating parameters were chosen for this project to reflect the complex dynamics of ecological conditions of streams and the surrounding landuses. A multi-parameter approach was necessary to accurately characterize existing/potential condition of stream reaches, especially in this highly urbanized environment. The 10 parameters selected for this characterization include:

- Accessibility – A measure of the potential for human contact with the creek. Data were obtained through field observations. Reaches where access was encouraged (trails to creek, gradual stream bank angles, lack of fencing, or public ownership) scored high whereas areas where access was discouraged (thick vegetation, fences, steep bank angles, or private ownership) scored low. High scores for this parameter indicate more accessible reaches that would most benefit from water quality improvements.
- Threatened/Endangered Species – A defined component of sensitive areas. Protected species occurrence information in the Beargrass Creek Watershed was obtained through a formal data request to the Kentucky State Nature Preserves Commission.

Potential threatened/endangered species within the project area include 14 mussels, two crustaceans, one insect, and two fish species. The presence of potential habitat for these species was determined based on qualitative observations of stream substrate and overall aquatic habitat in the field by qualified ecologists. High scores for this parameter indicate a greater potential for the presence of one of these species or their habitats, and reaches that would most benefit from water quality improvements.

- Stream Rapid Bioassessment Protocol – A method for assessing stream habitat quality and its ability to harbor a healthy ecological community. Data were obtained at each reach using the EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999). High scores indicate a reach with habitat characteristics that would potentially contain a healthier biological community, and would most benefit from water quality improvements.
- Bank Erosion Hazard Index – A measure of the potential for streambank erosion. Bank Erosion Hazard Index is a quantitative prediction tool to assess erosion potential using a multi-parameter scoring system based on field measurements of bank heights, angles, materials, layers, rooting depth and density, and amount of bank protection (Rosgen 2001). The Bank Erosion Hazard Index data were obtained from the Stream Assessment Report for the Beargrass Creek Watershed. High scores for this parameter reflect a reach with low erosion potential; an indicator of stable habitat for aquatic communities that would most benefit from water quality improvements. Although stream reaches located within the concrete-lined portion of South Fork Beargrass Creek would rate high because of their stability and limited potential to contribute to downstream sedimentation, these reaches are rated low based on their overall inability to harbor the important biological/organic components of natural streambanks or provide basic aquatic habitat.
- Index of Biotic Integrity – An index developed for rating fish community assemblages as an indicator of the degree of impact from pollutants. Data were obtained from MSD's 2005 Long-Term Monitoring Network program. The Index of Biotic Integrity is a multi-metric fish index, which measures stream health using fish community data (Karr et al. 1986). High scores for this parameter indicate a stream reach with favorable ecological integrity that warrants stream protection, and that would most benefit from water quality improvements.
- CSO AAOV – Overflow volume for each CSO was obtained from O'Brien & Gere; a typical rainfall year data was applied to CSS model to predict AAOV. High scores for this parameter represent CSO discharge locations with lower discharge and imply less severe impacts to the reach, healthier aquatic communities, a reduced risk to public health, and a reach that would most benefit from water quality improvements.
- Landuse – A classification system describing the types of human activities (e.g. parks, residences, industrial, etc.) for a given area. Data were created by Louisville Metro Planning and Design Services in 1992 and were obtained through MSD. For this analysis, landuse data were clipped within a 200-foot buffer around each reach and the percentage of each landuse type was determined. High scores represent reaches with a

high probability of community activity near the creek (e.g. parks and public areas), that would benefit the most from water quality improvements. See Figure 2.8.4.

- Landcover – Types of vegetative or manmade features covering a landscape. Data were obtained from the USGS National Landcover Database. The National Landcover Database is derived from 2001 satellite (Landsat) imagery and uses the Anderson Level II classification system (Anderson et al. 1976). Landcover raster data were extracted from a 200-foot buffer around each reach using ESRI ArcGIS Spatial Analyst software and the percentage of each type of landcover type was calculated. High scores represent reaches with landcover types that provide shading (tree cover) and reduced stormwater runoff to the creek (pervious surfaces), and would thus benefit most from in-stream water quality improvement.
- Restoration Potential – A qualitative assessment of benefits a stream reach may realize considering the level of effort required to restore aquatic/riparian habitat functions. Reaches were scored based on qualitative field observations by qualified ecologists at each reach in terms of the feasibility and need for stream restoration activities. Feasibility is defined in terms of the scale of construction (for example, costs and effort associated with planting trees, bank shaping, and removal of concrete lining) and accessibility (e.g. equipment access, property ownership, terrain) necessary to perform the work. High scores indicate reaches where lower-cost restoration efforts would provide immediate stream habitat benefits, and benefit the most from water quality improvements.
- Reach Length – The physical measurement of each reach. Length was measured in the GIS as the length from the CSO discharge point along the centerline of the channel to the beginning of the next reach. High scores correspond to longer stream reaches suggesting that water quality improvements and protection measures would provide more benefit to the overall aquatic system by improving a larger portion of the creek per CSO control measure.

2.8.1.3 Scoring

Parameter scores and subsequent reach priority ratings were graded relative to the distribution of results across all reaches within the CSS. The results provide a means for comparing stream reaches located only within the CSS and do not reflect conditions comparative to reaches outside of the CSS or reference conditions. The rating scale reflects the ecological condition of each stream reach and the degree of ecological benefit to be gained by water quality improvements. “Ecological condition” for these purposes was considered to be the existing, or realistic potential of, stream-related communities in terms of biological integrity, ecological function, and aesthetic/public health value. Based on this approach, reaches with high ratings would realize greater benefit from water quality improvements and, therefore, should be given higher priority during the CSO control and implementation decision process.

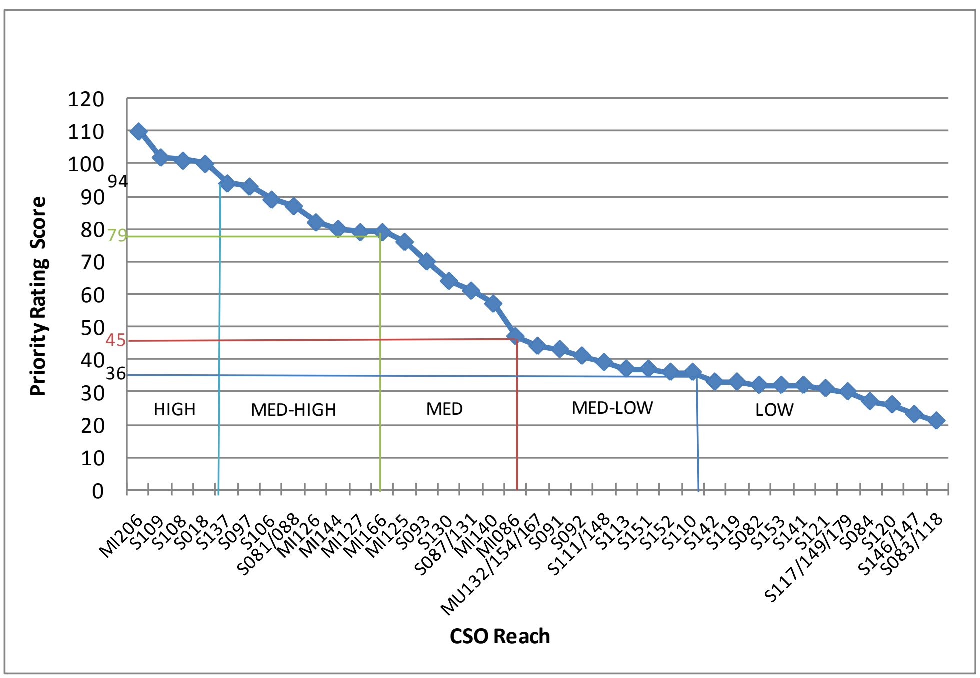
Each reach was assessed under each of the 10 parameters and scored on a 10-point scale, with one being the lowest and 10 the highest. The raw scores for each reach were then adjusted based on a weighting factor for individual parameters to obtain an overall priority rating.

The weighting factor involved doubling the score for three parameters:

1. Threatened/endangered species
2. Stream Rapid Bioassessment Protocol
3. Index of Biotic Integrity

These parameters represent direct measures of existing ecological condition and were therefore, considered of greater relative importance in scoring. The final priority rating is based on the sum of the parameter scores following application of the parameter weighting factor. Potential scores could range from 13 (lowest ecological integrity) to 130 (highest ecological integrity). The scores were then broken into five distinct priority categories for data summary purposes: highest priority; high/medium; medium priority; medium/low; and lowest priority. Breaks between priority rating categories were defined based on the distribution of results using only unique values. An attempt was made to evenly distribute reaches across the priority rating categories; however, final break points were chosen at distinct gaps between reach priority scores. Refer to Figure to 2.8.5 below.

FIGURE 2.8.5 BEARGRASS CREEK ECOLOGICAL REACH CHARACTERIZATION



2.8.2 Results

The final scores of all reaches ranged from 21 to 110 and are provided in Tables 2.8.1 and 2.8.2. The distribution of priority rating scores across the five priority categories is depicted in Figure 2.8.6 at the end of this Chapter.

TABLE 2.8.1
DISTRIBUTION OF PRIORITY RATING SCORES

Score	Priority Category	Number of Reaches
95-130	Highest Priority	4
80-94	High/Medium	6
46-79	Medium Priority	8
37-45	Medium/Low	6
13-36	Lowest Priority	13

Overall, existing ecological condition tends to decrease as the creek moves downstream through the watershed. This suggests that water quality improvements within the upper portions of the watershed may produce greater beneficial effects to the aquatic system as a whole than similar water quality improvements to downstream reaches.

Examples of characterization results are outlined in Table 2.8.2 for high, medium, and low priority reaches.

TABLE 2.8.2
REACH SCORE DISTRIBUTION

Priority Score	Reach Number	Priority Score	Reach Number
110	MI-206	44	MU-132/154/167
102	S-109	43	S-091
101	S-108	41	S-092
100	S-018	39	S-111/148
94	S-137	37	S-113
93	S-097	37	S-151
89	S-106	36	S-110
89	S-081/088	36	S-152
84	MI-126	33	S-119
80	MI-144	33	S-142
79	MI-127	32	S-082
79	MI-166	32	S-141
76	MI-125	32	S-153
70	S-093	31	S-121
64	S-130	30	S-117/149/179
61	S-087/131	27	S-084
57	MI-140	26	S-120
47	MI-086	23	S-146/147
		21	S-083/118
PRIORITY SCORES **95-130 Highest Priority** **80-94 High/Medium**		**46-79 Medium** **37-45 Medium/Low** **13-36 Lowest Priority**	

2.8.2.1 High Priority

The upper portions of Middle and South Forks of Beargrass Creek rated higher. These reaches are characterized by wooded riparian corridors and have received fewer human-made disturbances. The highest priority stream reach score is the most upstream reach in Middle Fork at Cherokee Park, Reach MI-206. See Figure 2.8.7. This reach rated as high priority due to its higher quality of aquatic habitat, potential for threatened/endangered species and Index of Biotic Integrity scores. It also exhibits moderately stable banks, is located within a more vegetated watershed, has a relatively low AAOV, good restoration potential, and high accessibility. It scored 110.

FIGURE 2.8.7 HIGH PRIORITY REACH MIDDLE FORK BEARGRASS CREEK CSO206)

2.8.2.2 Medium Priority

An example of a medium-rated priority reach is Reach MI-086 (Figure 2.8.8). It has poor accessibility, low quality habitat, and low potential for threatened/endangered species. It also exhibits high discharge volumes (low AAOV score), is located within a developed watershed, and is a relatively short reach. It scored 47.

FIGURE 2.8.8 MEDIUM PRIORITY REACH (MIDDLE FORK BEARGRASS CREEK CSO086)

2.8.2.3 Low Priority

The concrete-lined portion of South Fork Beargrass Creek rated lowest of all reaches and would benefit least from water quality improvements. Reach S-081/118 (Figure 2.8.9) scored low for most parameters. It has poor accessibility and little to no viable aquatic habitat, although it did exhibit a moderate fish population (Index of Biotic Integrity). It also has a large AAOV, urban/developed landuse and landcover, little restoration potential, and short reach length. It scored 21.

FIGURE 2.8.9 LOW PRIORITY REACH (SOUTH FORK BEARGRASS CREEK CSO081 AND CSO118)

2.8.3 Conclusion

In order to provide cost-effective CSO control implementation, it is important that a phased approach be used that will target the most problematic areas while protecting existing sensitive features. Because CSOs impact a diverse set of constituents, numerous factors must be considered when prioritizing and evaluating CSO control alternatives.

The Beargrass Creek Ecological Reach Characterization Report (Appendix 2.8.1) presents one component of a multifaceted decision process framework that is being used in development of a LTCP for the Louisville Metro CSS. This tool was developed to provide a means for comparing individual stream reaches within the CSS in terms of ecological condition. High scores/ratings indicate more favorable ecological conditions that would most benefit from water quality improvements. The results do not imply that stream reaches with high priority ratings should be the sole target for CSO control activities since all portions of Beargrass Creek must meet water quality standards. The parameters used for this rating system were chosen in an attempt to reflect the complex and dynamic interaction between ecological condition of streams, diverse constituencies, and varied landuse practices in urban environments. Results of this prioritization process and ecological reach ranking are one of numerous components integrated into the Final CSO LTCP selection process and implementation schedule, to be established by the community Stakeholder Group in compliance with the value-based risk management process.

2.9 RECEIVING WATER CHARACTERIZATION

System characterization, monitoring, and modeling are one of the nine elements of a long-term CSO control plan. Receiving water characterization, monitoring, and modeling "establishes the existing baseline conditions and provides the basis for determining receiving water goals and priorities and identifying specific CSO controls in the LTCP" (EPA, 1995). MSD has conducted receiving water monitoring and reviewed water quality data for Beargrass Creek and the Ohio River near Louisville (river mile 594 to 620) since the start of the CSO program in 1991 (MSD, 2006a; MSD, 2006b). The most recent assessments are documented in *Water Quality Status Report: Beargrass Creek and Ohio River at Louisville* (LimnoTech, 2007).

This section presents the water quality standards and summarizes the findings of the 2007 assessment, and provides a review of data obtained after the status report was completed.

The review of the available receiving water quality data show that the following:

- All three tributary branches of Beargrass Creek and the Ohio River (river mile 593 to 621) are listed as being impaired by pathogens. E. Coli and fecal coliform bacteria concentrations are significantly higher during wet weather conditions. CSOs are contributing to these impairments.
- The lower portions of Beargrass Creek, Middle Fork, and Muddy Fork are listed as being impaired by organic enrichment (causing low dissolved oxygen levels). pH violations

may also be indicative of organic impairment. CSOs may be contributing to these impairments.

- Biological conditions are generally poor to fair at most of the monitored locations, which is not uncommon for urbanized watersheds.

The receiving water data were used to calibrate and confirm the receiving water quality models. The models were then applied to establish current (baseline) conditions, establish how CSOs and other sources are impacting water quality, and to assess the effectiveness of controls in attaining water quality standards.

2.9.1 Water Quality Standards

Water quality standards are established for MSD's receiving waters by the Kentucky Natural Resources and Environmental Protection Cabinet Department for Environmental Protection and the Ohio River Valley Water Sanitation Commission (ORSANCO). Kentucky's Water Quality Regulations establish surface water use classifications for all waters of the Commonwealth. Kentucky has designated stream uses for the surface water bodies within the Ohio River near Louisville and the Beargrass Creek Basin is summarized in Table 2.9.1.

ORSANCO has designated the Ohio River as "public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life."

TABLE 2.9.1
STREAM USE DESIGNATION

Stream	Use Designation
Ohio River - Main Stem	Warm Water Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation, Domestic Water Supply
South Fork Beargrass Creek and Tributaries	Warm Water Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation
Middle Fork Beargrass Creek and Tributaries	Warm Water Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation
Muddy Fork Beargrass Creek and Tributaries	Warm Water Aquatic Habitat, Primary Contact Recreation, Secondary Contact Recreation

To protect warm water aquatic life uses, Kentucky's standards require that:

- Dissolved oxygen is to be maintained at a minimum concentration of 5.0 mg/l daily average; the instantaneous minimum shall not be less than 4.0 mg/l.
- Total dissolved solids and TSS are not to be changed to the extent that the indigenous aquatic community is adversely affected.
- pH to be no greater than nine, and no less than six at any time.
- The addition of settleable solids that may alter the stream bottom to affect productive aquatic communities adversely is prohibited.
- The concentration of un-ionized ammonia shall not be greater than 0.05 mg/l at any time in-stream after mixing.

ORSANCO's standards also require that the dissolved oxygen in the main stem of the Ohio River not be less than 5.1 mg/l during the August 15 to June 15 spawning season. Kentucky and ORSANCO have bacteria criteria for protection of primary contact recreational uses (for example, swimming), as shown in Table 2.9.2. These criteria apply during the recreation season of May 1 to October 31. Kentucky's standards apply during any 30-day period whereas ORSANCO's standards are applied on a monthly basis.

For the non-recreational period from November 1 to April 30, Kentucky's fecal coliform criteria are the same as the criteria for secondary contact recreation (that is, "waters that are suitable for partial body contact recreation, with minimal threat to public health due to water quality"). Kentucky's standards state:

"Fecal coliform content shall not exceed 1,000 colonies per 100 ml as a thirty (30) day geometric mean based on not less than five (5) samples; nor exceed 2,000 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period."

ORSANCO has also established criteria for the Ohio River main stem for protection of public water supply uses at all times as follows:

"Fecal coliform bacteria content shall not exceed 2,000/100 ml as a monthly geometric mean based on not less than five samples per month."

TABLE 2.9.2
INDICATOR BACTERIA CRITERIA FOR PROTECTION OF PRIMARY CONTACT RECREATION

Indicator Bacteria	Standard	Geometric Mean[1] (per 100 ml)	Instantaneous Maximum[2] (per 100ml)	Period For Measuring Compliance
Fecal Coliform bacteria	Kentucky	200	400 (no more than 20%)	Any 30-day period
	ORSANCO	200	400 (no more than 10%)	Monthly
E. Coli bacteria	Kentucky	130	240	Any 30-day period
	ORSANCO	130	240	Monthly

[1] The geometric mean for both Kentucky and ORSANCO are to be calculated using no less than 5 samples.
[2] Kentucky and ORSANCO allow 20% of the samples during a period to exceed the instantaneous maximum criterion. ORSANCO's standards specify that E. Coli shall not exceed 240 per 100 ml in any sample.

A key principle of the 1994 CSO Control Policy is "[r]eview and revision, as appropriate, of water quality standards and their implementation procedures when developing CSO control plans to reflect site-specific wet weather impacts of CSOs" (59 FR 18688). Review and revision of standards is accomplished through a Use Attainability Analysis (UAA). A UAA is a structured scientific assessment of the factors affecting the attainment of uses specified in Section 101(a)(2) of the CWA. In response to directives from Congress, EPA developed guidance in 2001 for coordinating water quality standards reviews for water bodies where long-term CSO

control plans will be implemented because "implementation of this principle has not progressed as quickly as expected" (US EPA, 2001). Several states such as Maine (MDEP, 2003), Massachusetts (MassDEP, 2007), and Indiana (IDEM, 2008) have adopted provisions in their water quality standards to recognize the challenges associated with attaining recreational uses even after CSO controls have been fully implemented. ORSANCO has provisions in its water quality standards for the Ohio River allowing for development and application of alternative criteria if CSO communities have submitted a long-term CSO control plan and a UAA.

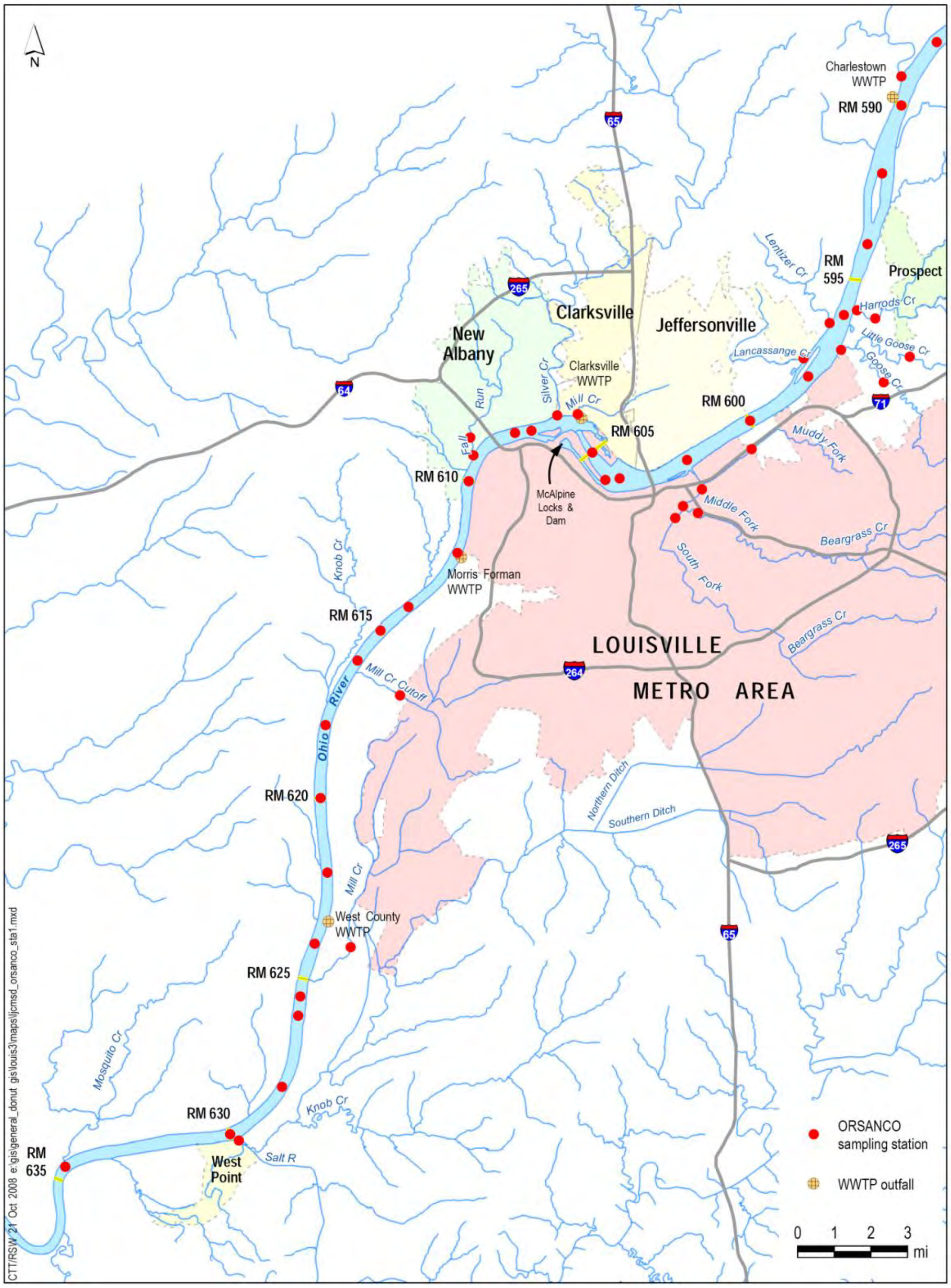
2.9.2 Receiving Water Quality Monitoring Analysis – Ohio River

Receiving water quality data are available for the Ohio River from ORSANCO for 2000 to 2007. ORSANCO's monitoring stations (and Ohio River miles) are shown on Figure 2.9.1. A total of 596 fecal coliform measurements and 596 E. Coli measurements were taken as part of ORSANCO's routine monitoring on the Ohio River in the Louisville Metro area during the period 2000-2007. E. Coli data (1,008 measurements) were obtained from ORSANCO's five-week longitudinal, "snapshot" and tributary only surveys of the Ohio River for the period October 2003 to October 2007. Both data sets were analyzed in terms of average concentrations during wet and dry weather periods as well as percentage of individual samples exceeding specific target levels. Samples were characterized as "wet" using hourly rainfall from the Louisville International Airport (Standiford Field) and the following criteria:

- Precipitation greater than or equal to 0.1 inch within 24 hours of sample collection;
- Precipitation greater than or equal to 0.25 inch within 25-48 hours of sample collection; and
- Precipitation greater than or equal to 0.5 inch within 49-72 hours of sample collection.

A separate analysis was conducted on the bacteria data collected by ORSANCO as part of their Wet Weather Demonstration Project during 2001. Water quality data for other parameters from ORSANCO's routine sampling of the Ohio River main stem are summarized as well.

FIGURE 2.9.1 ORSANCO OHIO RIVER MONITORING STATIONS



2.9.2.1 Average Bacterial Concentrations from Routine Monitoring

Figure 2.9.2 shows a summary display of average fecal coliform concentrations for each of the routine ORSANCO monitoring stations, stratified by climatic condition. Concentrations at River Mile 594.0 (upstream of the CSOs) are similar to concentrations at River Mile 608.7 (downtown, downstream of the CSOs). The highest concentrations are observed at River Mile 619.3, which is downstream of the Mill Creek Cutoff. Concentrations at this location are also noticeably higher during wet weather periods. Results are displayed in similar format in Figure 2.9.3 for E. Coli, with similar results.

FIGURE 2.9.2 AVERAGE FECAL COLIFORM LEVELS DURING WET AND DRY PERIODS AT THREE STATIONS ON THE OHIO RIVER NEAR LOUISVILLE, KY USING DATA FROM 2000 TO 2007

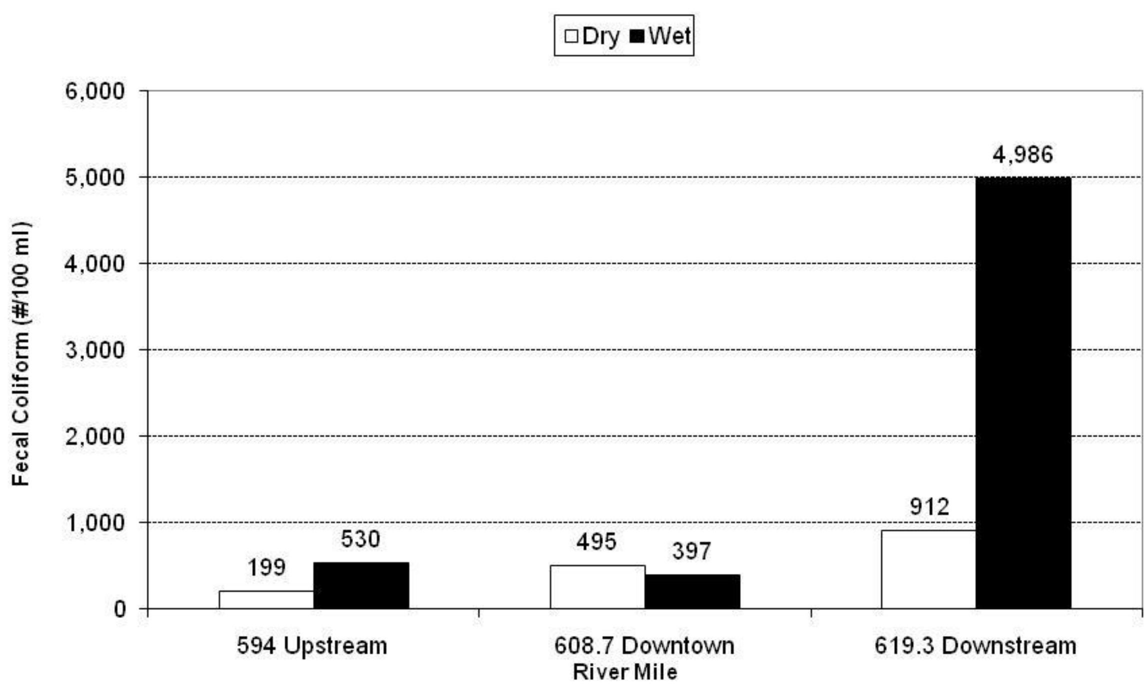
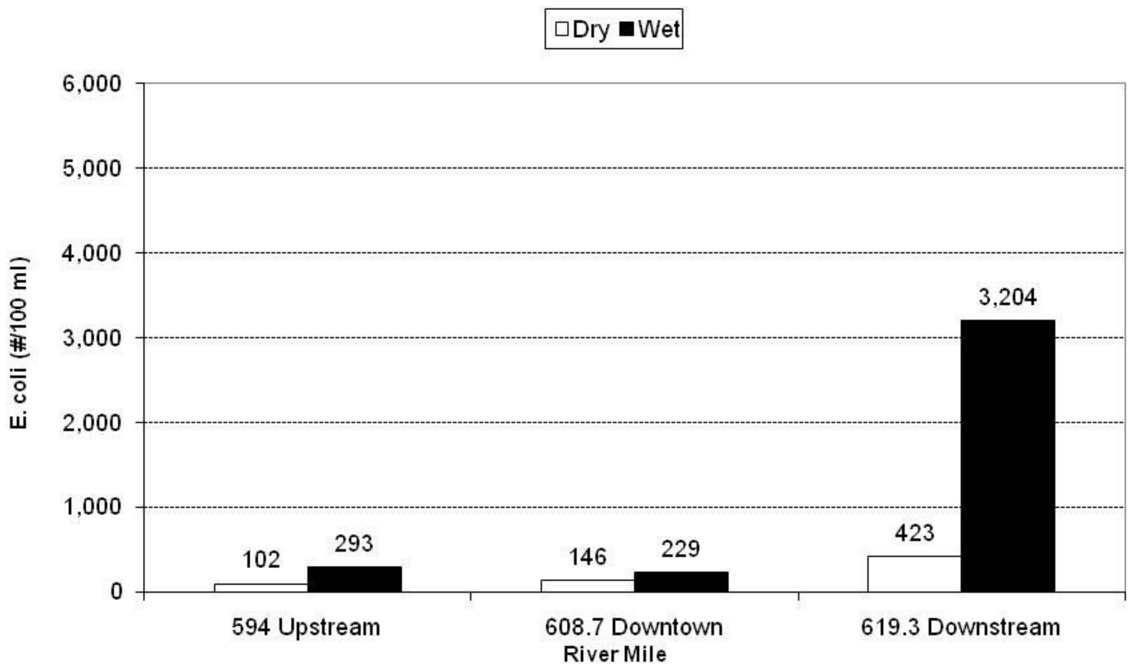


FIGURE 2.9.3 AVERAGE E. COLI LEVELS DURING WET AND DRY PERIODS AT THREE STATIONS ON THE OHIO RIVER NEAR LOUISVILLE, KY USING DATA FROM 2000 TO 2007



Figures 2.9.4 and 2.9.5 show temporal variability in average (geometric mean) dry and wet weather concentrations at the location upstream of the CSOs (River Mile 594) for fecal coliform and E. Coli, respectively. Figures 2.9.6 and 2.9.7 provide similar results for River Mile 608.7 (downtown, downstream of the CSOs), while Figures 2.9.8 and 2.9.9 represent 619.3 (downstream of the Mill Creek Cutoff). No long-term trend is consistently observed across all three stations.

FIGURE 2.9.4 AVERAGE FECAL COLIFORM LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 594 ON THE OHIO RIVER

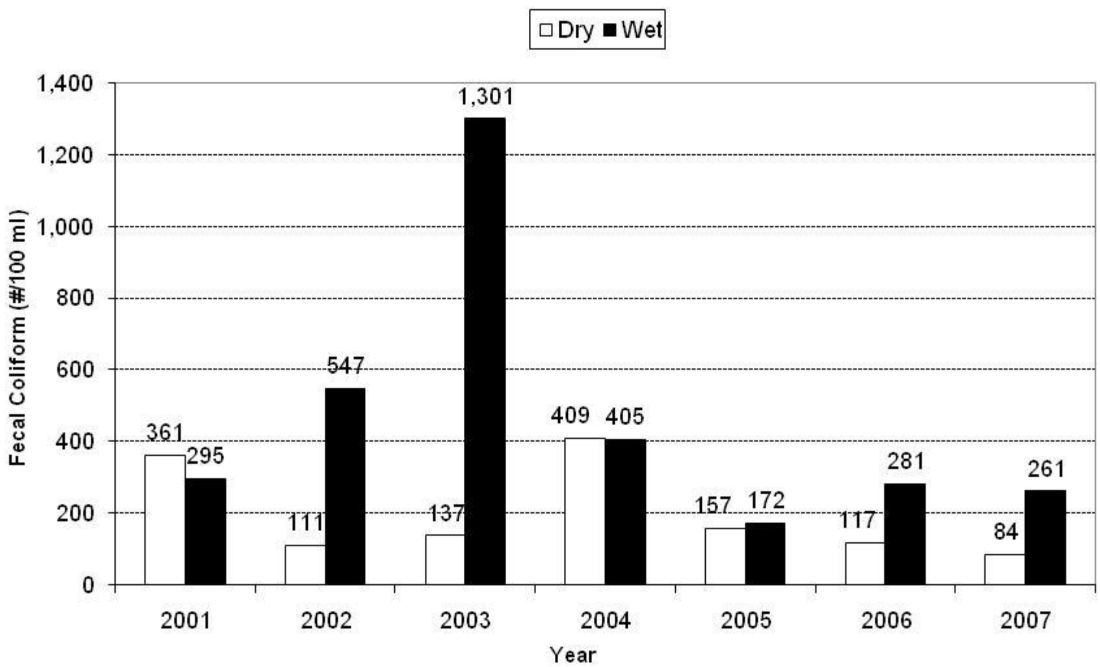
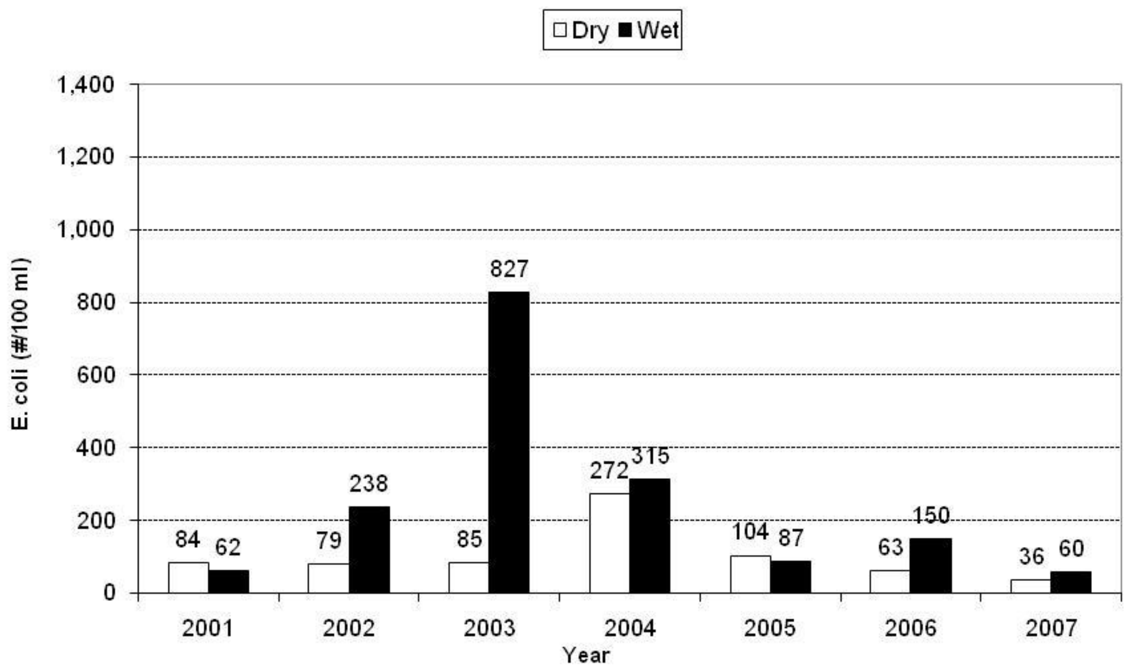


FIGURE 2.9.5 AVERAGE E. COLI LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 594 ON THE OHIO RIVER



Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 2.9.6 AVERAGE FECAL COLIFORM LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 608.7 ON THE OHIO RIVER

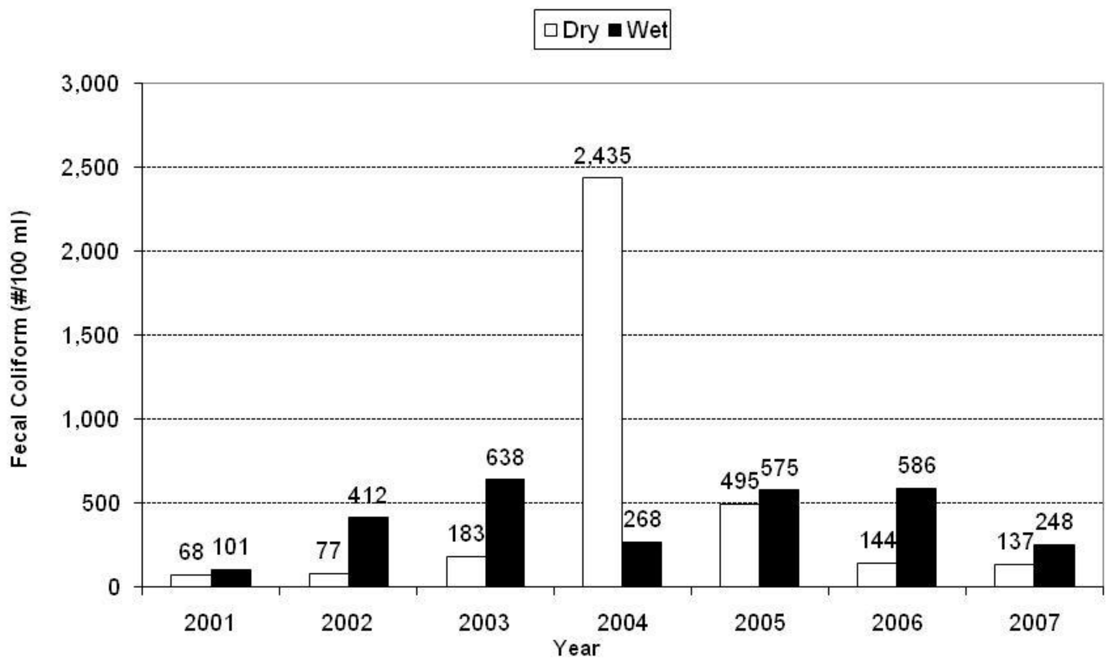


FIGURE 2.9.7 AVERAGE E. COLI LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 608.7 ON THE OHIO RIVER

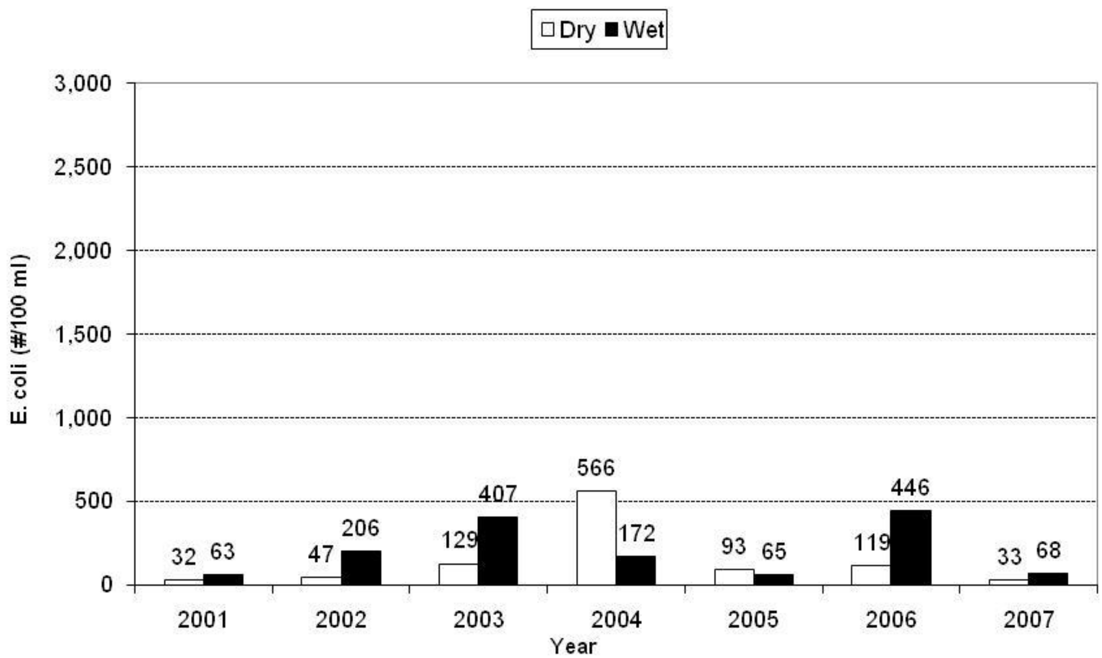


FIGURE 2.9.8 AVERAGE FECAL COLIFORM LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 619.3 ON THE OHIO RIVER

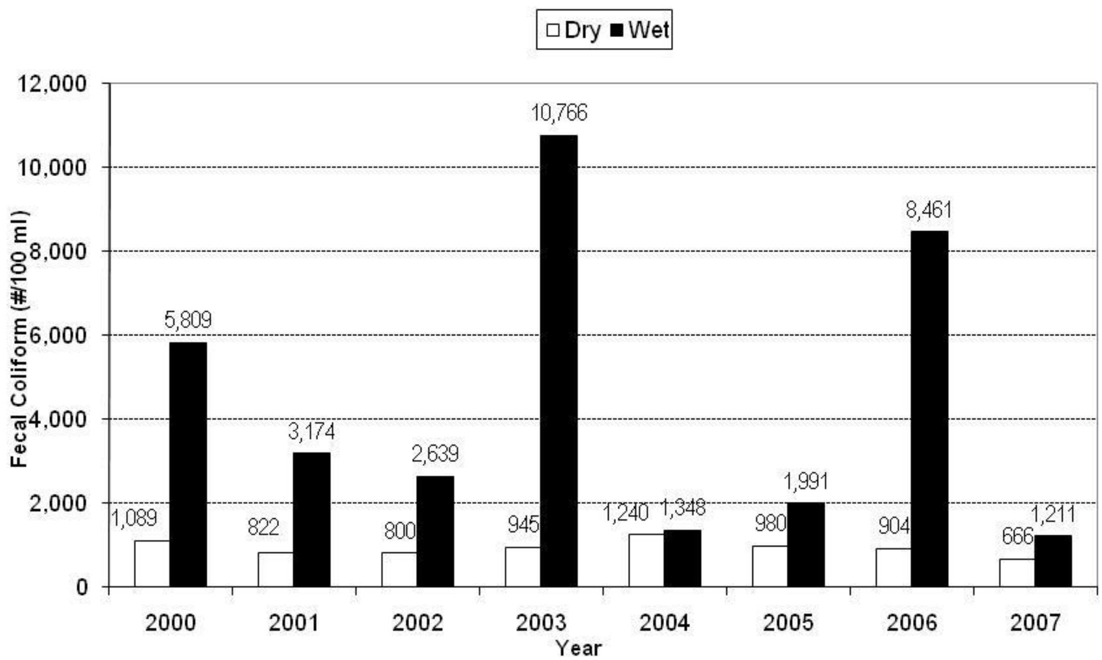
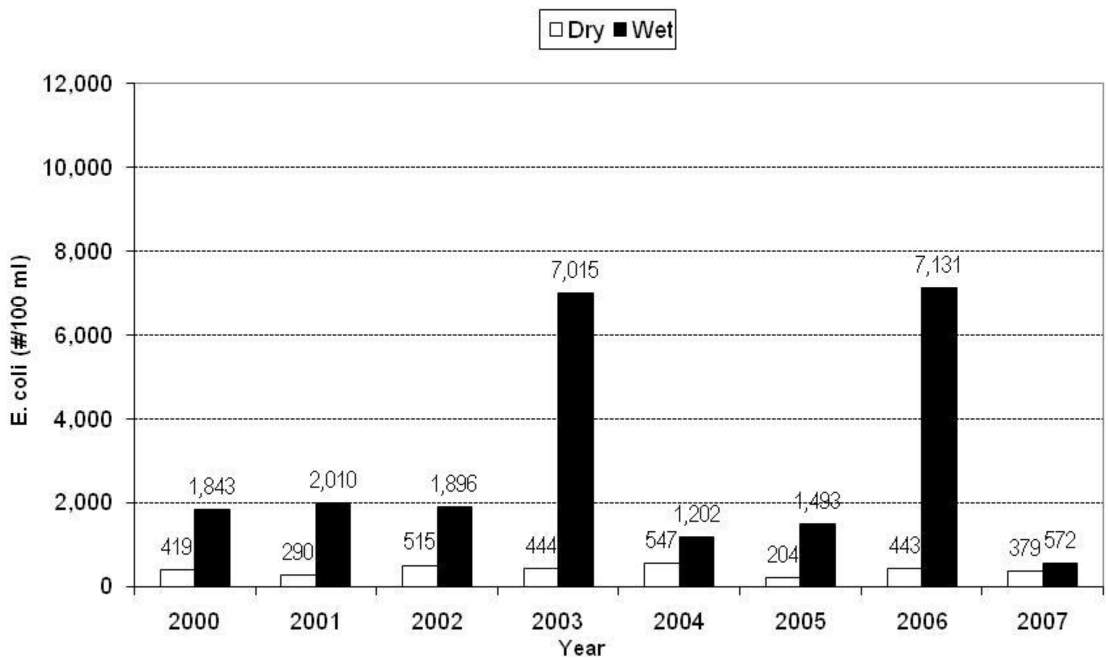


FIGURE 2.9.9 AVERAGE E. COLI LEVELS DURING WET AND DRY PERIODS AT RIVER MILE 619.3 ON THE OHIO RIVER



2.9.2.2 Frequency of Exceedance of Bacterial Targets from Routine Monitoring

This section examines the frequency of exceedances of the monthly geometric mean criteria and the instantaneous maximum in the Ohio River exceeded the fecal coliform and E. Coli criteria. Available routine monitoring data from each station was used to calculate the number of exceedances of the geometric mean criterion for each monthly period. Available data was used to calculate the percent of samples that were greater than the instantaneous maximum criterion for dry and wet weather samples. Note that this is not a direct comparison to water quality standards for fecal coliform, since the criteria allow for 10 percent of the samples to exceed the criterion during a month. A comparison to the instantaneous maximum criterion for fecal coliform was conducted based on the percentage of samples exceeding the criterion each month.

The comparison of the geometric mean criterion for E. Coli is shown in Table 2.9.3. In most instances, there were five samples collected during each month (a few of the months had only four samples). Exceedances are relatively infrequent (17-50 percent) at the upstream and downtown stations, but are prevalent (67-100 percent) at the downstream station.

TABLE 2.9.3
NUMBER OF EXCEEDANCES OF THE E. COLI 30-DAY GEOMETRIC MEAN OF 130 PER 100 ML

Year	RM 594.0 (Upstream)			RM 608.7 (Downtown)			RM 619.3 (Downstream)		
	No. Months GM > 130	Total No. Months	% Months GM > 130	No. Months GM > 130	Total No. Months	% Months GM > 130	No. Months GM > 130	Total No. Months	% Months GM > 130
2000							5	6	83%
2001	0	6	0%	0	6	0%	6	6	100%
2002	2	6	33%	1	6	17%	4	6	67%
2003	3	6	50%	3	6	50%	6	6	100%
2004	3	6	50%	2	6	33%	6	6	100%
2005	0	2	0%	0	2	0%	2	2	100%
2006	0	6	0%	1	6	17%	6	6	100%
2007	0	6	0%	0	6	0%	1	6	17%

Table 2.9.4 shows that exceedances of the fecal coliform geometric mean criterion are similar to those of the E. Coli criterion. Exceedances are relatively infrequent (17-67 percent) at the upstream and downtown stations, but are prevalent (50-100 percent) at the downstream station.

TABLE 2.9.4
NUMBER OF EXCEEDANCES OF THE FECAL COLIFORM 30-DAY GEOMETRIC MEAN OF 200 PER 100 ML.

Year	RM 594.0 (Upstream)			RM 608.7 (Downtown)			RM 619.3 (Downstream)		
	No. Months GM > 200	Total No. Months	% Months GM > 200	No. Months GM > 200	Total No. Months	% Months GM > 200	No. Months GM > 200	Total No. Months	% Months GM > 200
2000							6	6	100%
2001	1	6	17%	0	6	0%	6	6	100%
2002	2	6	33%	1	6	17%	6	6	100%
2003	3	6	50%	4	6	67%	6	6	100%
2004	2	6	33%	2	6	33%	5	6	83%
2005	0	2	0%	1	2	50%	2	2	100%
2006	0	6	0%	1	6	17%	6	6	100%
2007	0	6	0%	1	6	17%	3	6	50%

Table 2.9.5 shows the percent of samples where the E. Coli concentrations were greater than the instantaneous maximum criterion of 240 per 100 ml. Table 2.9.6 shows a similar comparison for fecal coliform. Again, the percentage of samples that were greater than the criteria levels was similar at the location upstream of the CSOs (River Mile 594) and downstream of the CSOs (River Mile 608.7). The percentage of samples with concentrations that were greater than the instantaneous maximum criterion were higher downstream of the Mill Creek Cutoff (River Mile 619.3).

TABLE 2.9.5
NUMBER OF E. COLI SAMPLES THAT WERE GREATER THAN THE INSTANTANEOUS MAXIMUM OF 240 PER 100 ML

River Mile (RM)	No. of Dry Weather Samples		% Dry	No. of Wet Weather Samples		%Wet	%All Samples
	Greater Than	Total		Greater Than	Total		
RM 594.0	11	104	11%	19	85	22%	16%
RM 608.7	11	103	11%	20	86	23%	16%
RM 619.3	38	116	33%	66	102	65%	48%

TABLE 2.9.6
NUMBER OF FECAL COLIFORM SAMPLES THAT WERE GREATER THAN THE INSTANTANEOUS MAXIMUM OF 400 PER 100 ML

River Mile	No. of Dry Weather Samples		% Dry	No. of Wet Weather Samples		%Wet	%All Samples
	Greater Than	Total		Greater Than	Total		
RM 594.0	8	104	8%	21	85	25%	15%
RM 608.7	10	103	10%	23	86	27%	17%
RM 619.3	51	116	44%	75	102	74%	58%

2.9.2.3 Longitudinal and "Snapshot" Data for the Ohio River

E. Coli data (1,008 measurements) were obtained from ORSANCO's five-week longitudinal, "snapshot" and tributary surveys of the Ohio River and tributary mouths for the period October 2003 to October 2007. For the Ohio River main stem, data were collected on the Kentucky side (left-descending bank), the middle of the river, and the Indiana side (right-descending bank). Louisville Metro CSO study area. Results for these surveys are presented in Figures 2.9.10 through 2.9.14.

Surveys were generally conducted on a weekly basis during the longitudinal surveys. Some of the data therefore reflect dry weather conditions, and some of the data reflect wet weather conditions. Table 2.9.7 provides a summary of the number of surveys that were reflective of dry and wet weather conditions and the total amount of rain falling during that period or preceding the survey. The May 25 to June 22, 2006, survey (Figure 2.9.10) is reflective of more wet weather conditions whereas the October 4 – 8, 2007, (Figure 2.9.11) is reflective of dry weather conditions. Under wet weather conditions, E. Coli concentrations increase in the CSO-impacted area but are highest well downstream of the CSO-impacted area.

TABLE 2.9.7
NUMBER OF DRY AND WET WEATHER SURVEY DAYS FOR THE ORSANCO LONGITUDINAL AND TRIBUTARY SURVEYS

Survey Period	No. of Survey Days		Total Rain (in)
	Dry	Wet	
October 2 - 30, 2003	3	2	2.15
May 12 - June 7, 2005	4	1	5.53
May 25 to June 22, 2006	4	1	6.24
July 24 to August 21, 2006	3	2	4.63
July 30 - 31, 2007	1	1	0.58
September 4 - 5, 2007	2	0	0
October 4 - 8, 2007	2	0	0

FIGURE 2.9.10 E. COLI CONCENTRATIONS FOR THE OCTOBER 2-30, 2002 LONGITUDINAL SURVEY OF THE OHIO RIVER

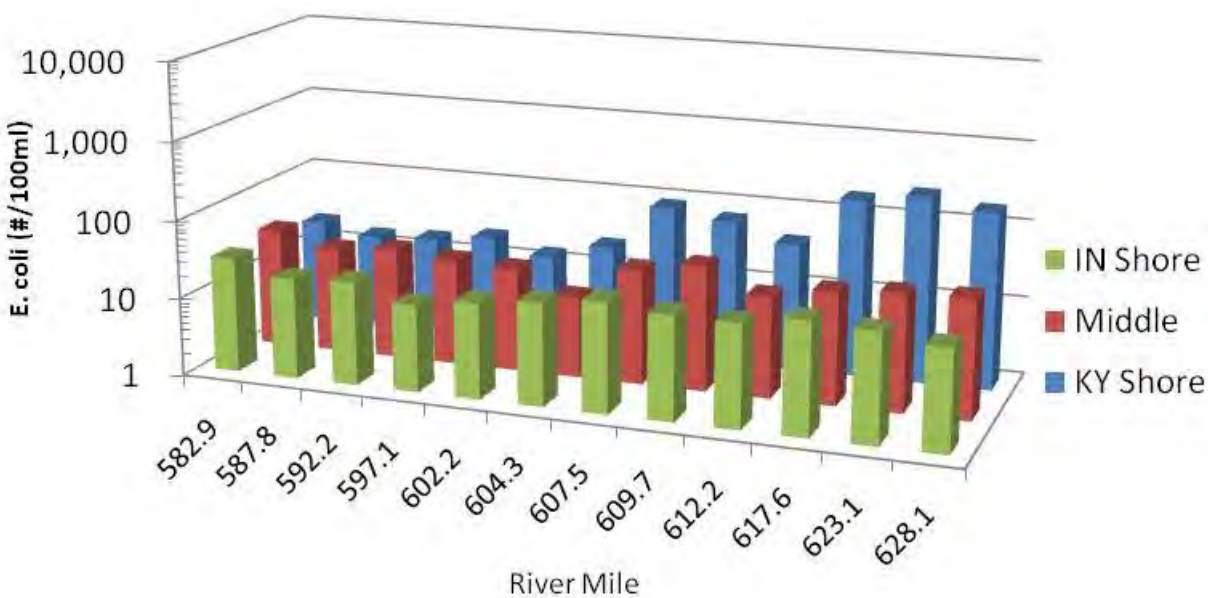


FIGURE 2.9.11 E. COLI CONCENTRATIONS FOR THE MAY 12 TO JUNE 9, 2005 LONGITUDINAL SURVEY OF THE OHIO RIVER

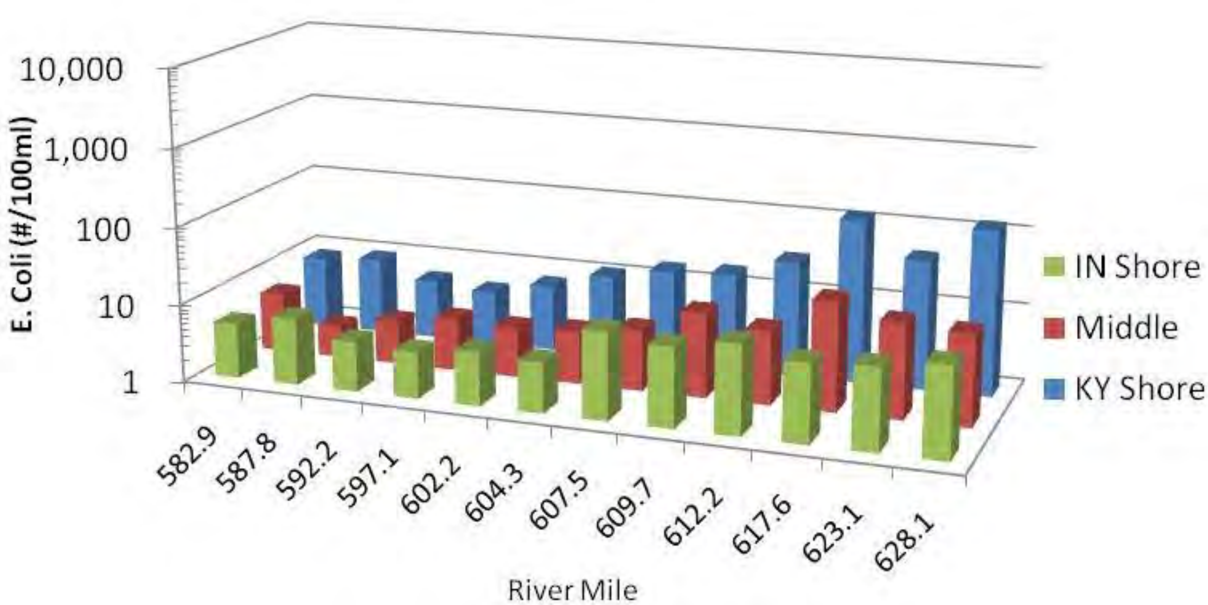


FIGURE 2.9.12 E. COLI CONCENTRATIONS FOR THE MAY 25 TO JUNE 22, 2006 LONGITUDINAL SURVEY OF THE OHIO RIVER

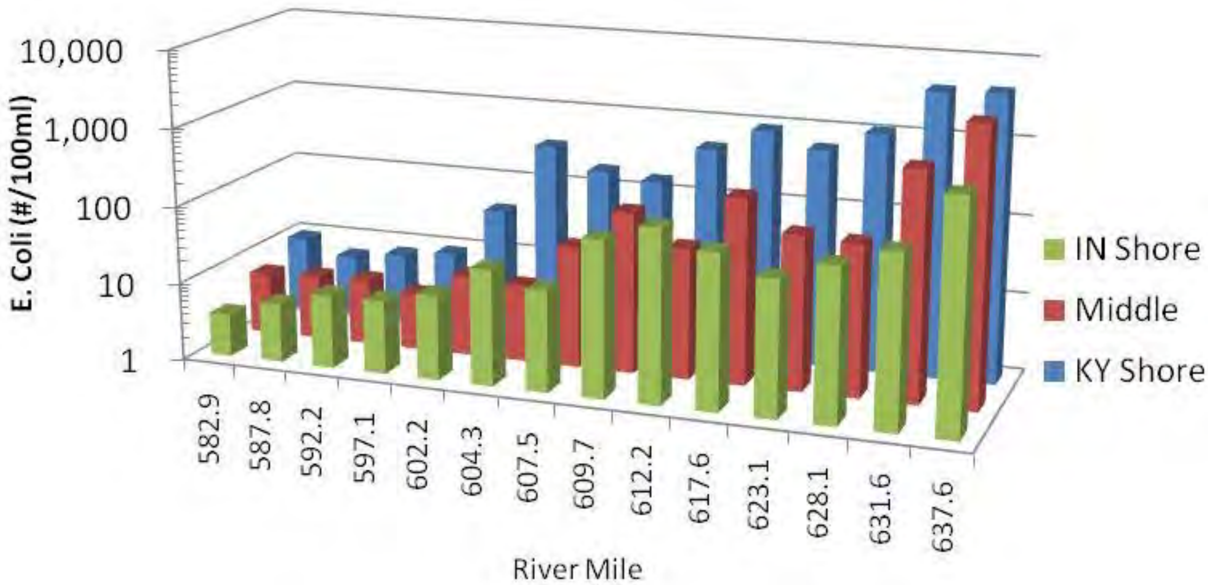


FIGURE 2.9.13 E. COLI CONCENTRATIONS FOR THE JULY 24 TO AUGUST 21, 2006 LONGITUDINAL SURVEY OF THE OHIO RIVER

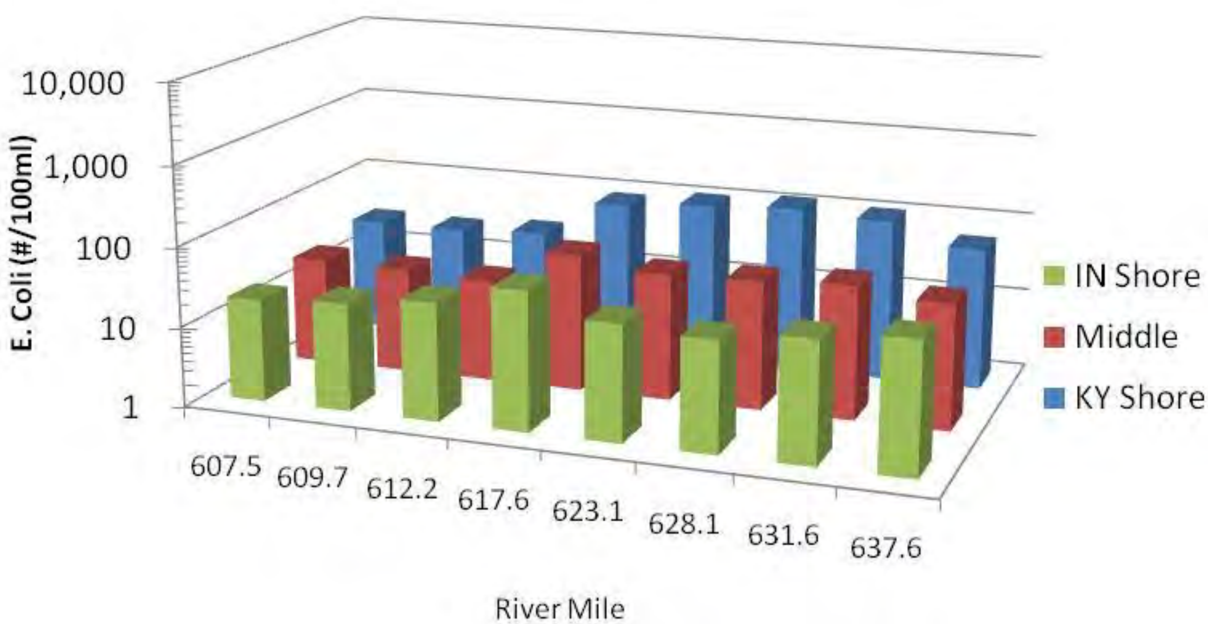


FIGURE 2.9.14 E. COLI CONCENTRATIONS FOR THE OCTOBER 4 -8, 2007 LONGITUDINAL SURVEY OF THE OHIO RIVER

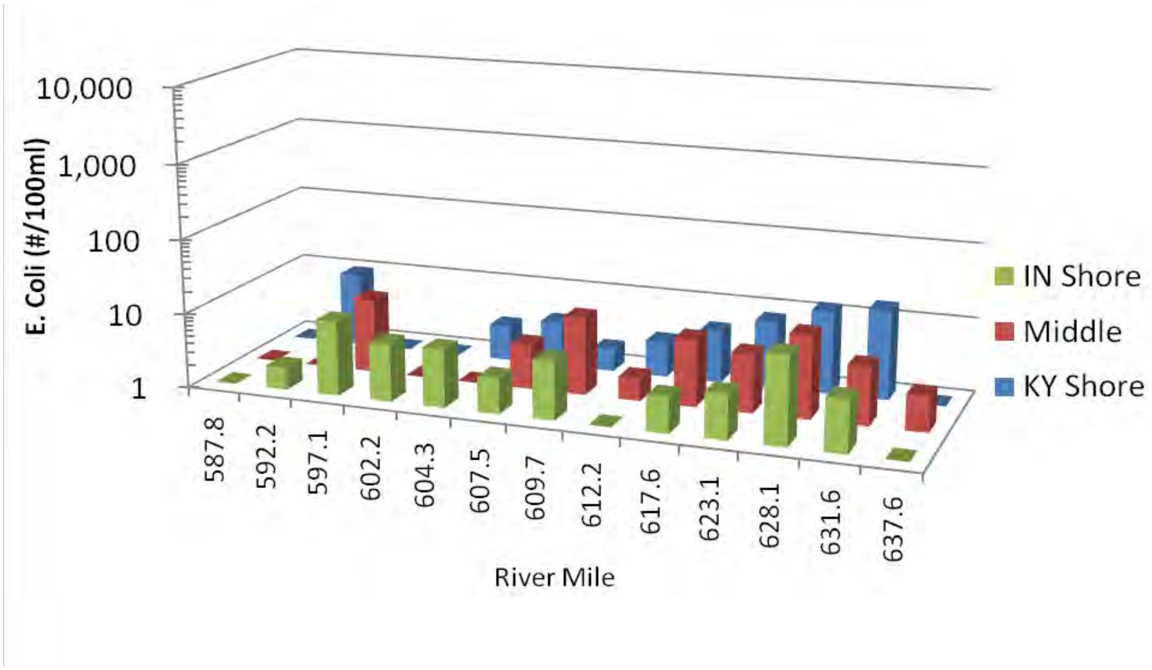


Table 2.9.8 presents a summary of the total number of E. Coli longitudinal survey samples available from 2003 to 2007 for the Ohio River main stem along the Kentucky shore that exceeded the instantaneous maximum criterion of 240 per 100 ml. Although there is an increase (6 to 19 percent) within the CSO-impacted area, the largest increase is downstream of the Mill Creek Cutoff.

The tributary sampling data are presented in Table 2.9.9 for periods when data were collected on Beargrass Creek. In general, concentrations in Beargrass Creek are significantly higher than the other tributaries. E. Coli concentrations at some of the other tributaries exceed the instantaneous maximum criterion of 240 per 100 ml. The percent of samples at the tributary mouths that exceeded the instantaneous maximum (shown in Table 2.9.10) was greater than 10 percent for all tributaries and was highest for Beargrass Creek (100 percent).

TABLE 2.9.8
PERCENT OF LONGITUDINAL E. COLI SAMPLES ON THE OHIO RIVER THAT EXCEEDED THE INSTANTANEOUS MAXIMUM OF 240 PER 100ML (2003-2007)

Station	No. >240	Total No.	Percent > 240
RM_582.9	0	15	0%
RM_587.8	0	16	0%
RM_592.2	0	16	0%
RM_597.1	0	16	0%
RM_602.2	1	16	6%
RM_604.3	3	16	19%
RM_607.5	4	21	19%
RM_609.7	4	21	19%
RM_612.2	3	21	14%
RM_617.6	8	21	38%
RM_623.1	8	21	38%
RM_628.1	8	21	38%
RM_630	5	10	50%
RM_631.6	11	20	55%
RM_637.6	9	20	45%
Total	**64**	**271**	**24%**
RM = River Mile			

TABLE 2.9.9
E. COLI CONCENTRATIONS FOR THE MOUTHS OF THE OHIO RIVER TRIBUTARIES

Tributary Station	May 25 to June 9, 2005 (#/100 ml)	July 30 to 31, 2007 (#/100 ml)	September 4 to 5, 2007 (#/100 ml)	October 4 to 8, 2007 (#/100 ml)
RM_595.9-Harrods_Ck	268	990	629	327
RM_597-Goose_Ck	759	113	8	71
RM_602.1-a_Muddy_Fk_BGC	5,438	353	216	399
RM_602.1-b_Middle_Fk_BGC	12,597	10,200	12,700	14,100
RM_602.1-c_South_Fk_BGC	7,278	680	194	634
RM_605.2-Cane_Run	3,400	1,210	5,400	361
RM_606.2-Mill_Ck (IN)	2,370	133	130	228
RM_606.5-Silver_Ck	3,670	290	25	435
RM_609.3-Falling_Run	4,214	469	55	1,150
RM_616.4-Mill_Ck_Cutoff	1,566	104	10	5
RM_625-Mill_Ck(KY)	976	47	11	57
RM_629.9-b_Salt_Ck	132			7
RM = River Mile				

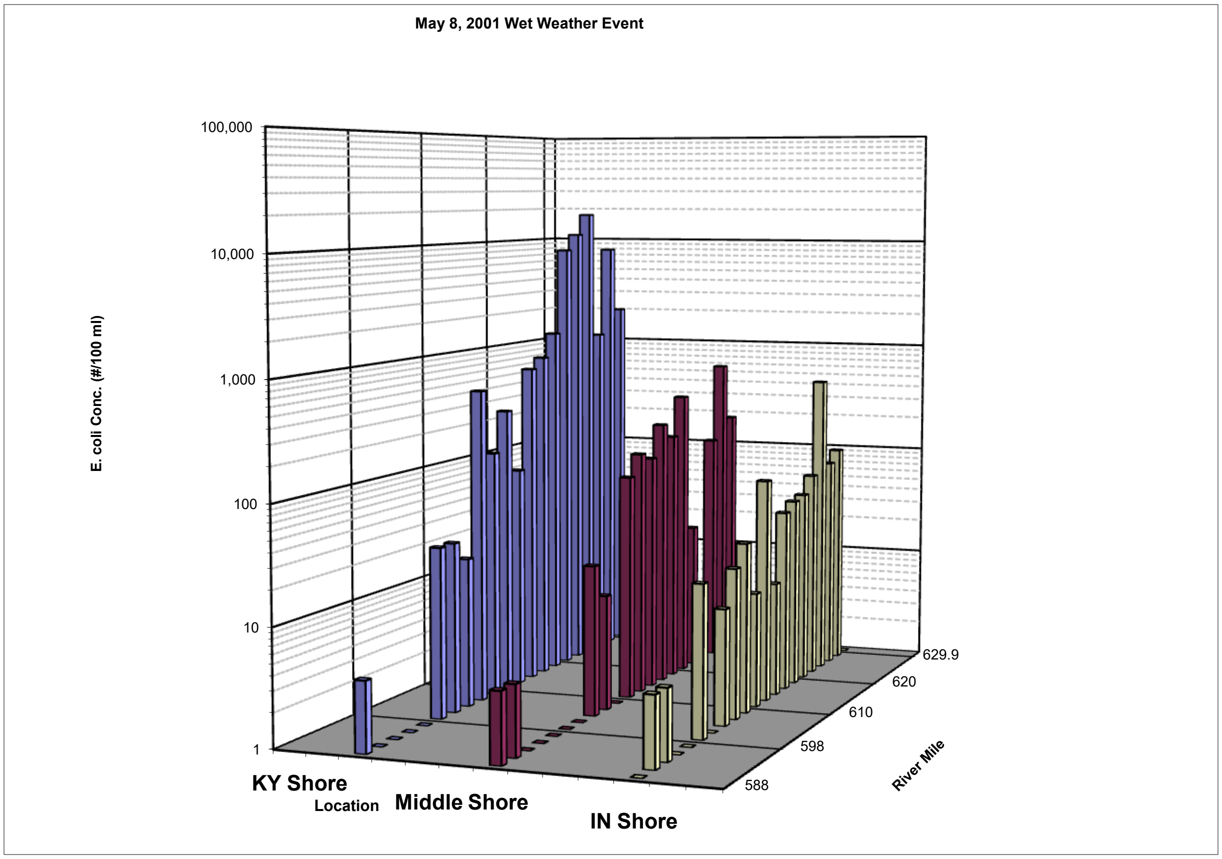
TABLE 2.9.10
PERCENT OF E. COLI SAMPLES ON THE OHIO RIVER TRIBUTARY MOUTHS THAT EXCEEDED THE INSTANTANEOUS MAXIMUM OF 240 PER 100 ML (2003-2007)

Station	No. > 240	Total No.	Percent > 240
RM_595.9-Harrods_Ck	6	8	75%
RM_597-Goose_Ck	4	8	50%
RM_602.1-a_Muddy_Fk_BGC	7	8	88%
RM_602.1-b_Middle_Fk_BGC	8	8	100%
RM_602.1-c_South_Fk_BGC	7	8	88%
RM_605.2-Cane_Run	13	13	100%
RM_606.2-Mill_Ck (IN)	6	13	46%
RM_606.5-Silver_Ck	9	13	69%
RM_609.3-Falling_Run	9	13	69%
RM_616.4-Mill_Ck_Cutoff	4	13	31%
RM_625-Mill_Ck (KY)	2	13	15%
RM_629.9-b_Salt_Ck	3	21	14%
Total	**78**	**139**	**56%**
RM = River Mile			

2.9.2.4 ORSANCO Wet Weather Demonstration Project

The data collected during the ORSANCO Wet Weather Demonstration Project in 2000-2002 provide much more spatial resolution on bacterial concentrations. Results for the only wet weather event that was monitored after the year 2000 near Louisville are shown in Figure 2.9.15, which shows longitudinal and lateral variation in concentrations. Concentrations are observed to increase as the river moves downstream through the Louisville metropolitan area. Concentrations are also observed to be consistently higher along the Kentucky shoreline than they are in the middle of the river channel.

FIGURE 2.9.15 E. COLI CONCENTRATIONS OBSERVED DURING MAY, 2001 ORSANCO WET WEATHER EVENT



2.9.2.5 Other Parameters

ORSANCO collects other parameters beyond bacteria as part of its routine monitoring. Results for these parameters are shown in Table 2.9.11. As discussed previously, the known impairments associated with the CSOs are limited to bacteria.

TABLE 2.9.11
SUMMARY OF ORSANCO ROUTINE MONITORING DATA FROM 2000-2007 FOR OTHER PARAMETERS

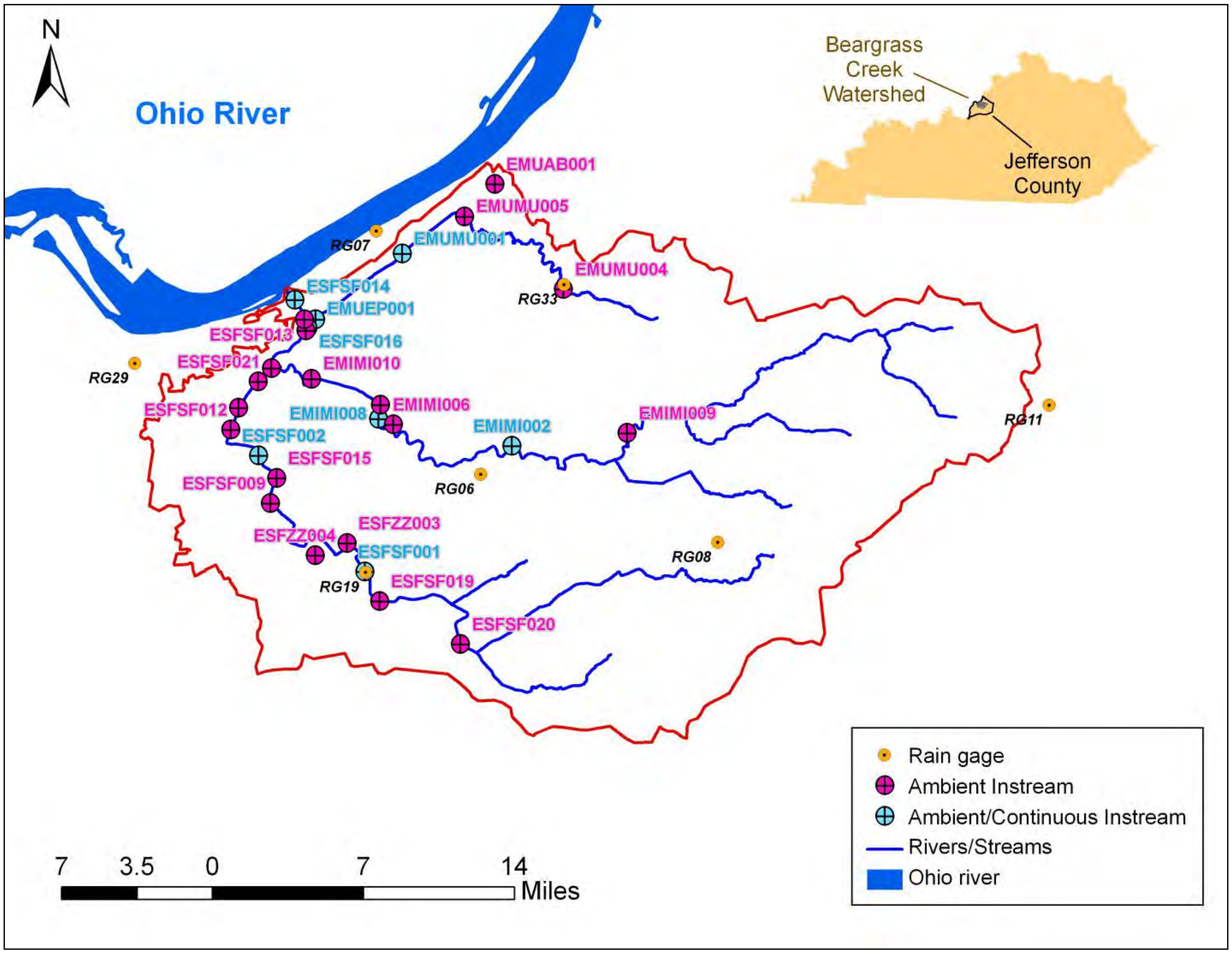
Parameter	Number of Samples	Average	Minimum	Maximum
Ammonia as Nitrogen (MG/l)	147	0.06	0.03	0.27
Nitrate-Nitrite as N (MG/l)	155	1.17	0.06	2.41
Total Kjeldahl Nitrogen (MG/l)	152	0.62	0.10	2.95
Total Phosphorus (MG/l)	152	0.16	0.01	1.94
Chlorophyll (ug/l)	196	6.6	0	36.67
Turbidity (ntu)	196	46.46	0	347
pH	196	7.9	7.4	8.5
Copper (ug/l)	34	3.2	0.9	9.3
Hardness (MG/l)	34	143.6	111.5	205.7
Nickel (ug/l)	34	3.9	1.1	13.1
Lead (ug/l)	34	1.8	0.3	9.3
Zinc (ug/l)	34	10	1.8	46.2

2.9.3 Receiving Water Quality Monitoring Analysis – Beargrass Creek

Data available for Beargrass Creek included fecal coliform and continuous monitoring data from MSD’s long-term monitoring network (LTMN); other parameters from the LTMN; biological data from the LTMN; and other studies that were conducted to support development of the Beargrass Creek Water Quality Tool (Tetra Tech, 2008). Figure 2.9.16 shows the three forks of Beargrass Creek and the location of the LTMN network and rainfall gages.

For the fecal coliform and other parameters from the LTMN ambient stations, rainfall data were used to assign each sample as a “wet” or “dry” sample with the criteria discussed in Section 2.9.3. For data preceding May 2003, hourly rainfall from the Louisville International Airport was used. In May 2003, MSD installed a high frequency (5 minute) rain gage network. MSD selected the nearest rainfall gages to each Beargrass Creek ambient station to make the assignment of “wet” or “dry” samples for the data collected after April 2003.

FIGURE 2.9.16 LOCATION OF MSD'S BEARGRASS CREEK MONITORING STATIONS

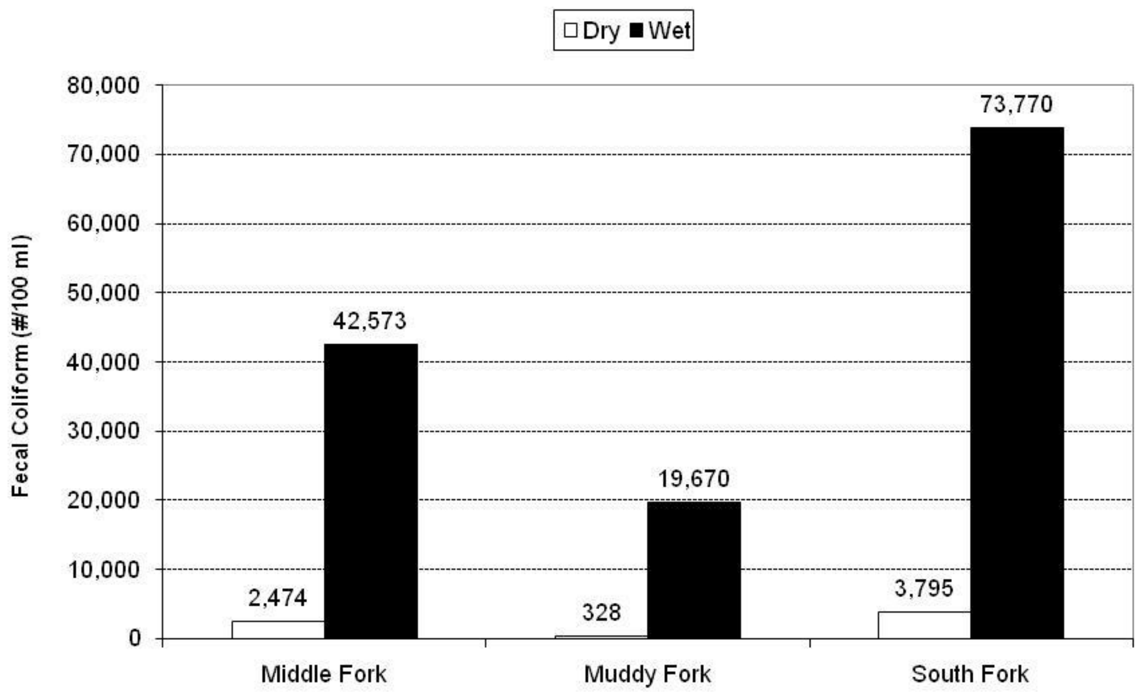


2.9.3.1 Average Fecal Coliform Concentrations

A total of 1,840 fecal coliform measurements were collected by MSD throughout the Beargrass Creek watershed during the period 2000-2007. These data were analyzed in both terms of average concentrations during wet and dry weather periods as well as percentage of individual samples exceeding specific target levels associated with the water quality standards.

A summary display of average concentrations is provided in Figure 2.9.17, which stratifies results by tributary branch and climatic condition. Average concentrations are higher in the Middle and South Forks than in Muddy Fork during both dry and wet weather. Concentrations in all three tributaries are also noticeably higher during wet weather periods.

FIGURE 2.9.17 AVERAGE FECAL COLIFORM IN BEARGRASS CREEK 2000-2007



Figures 2.9.18 through 2.9.21 show annual variation in fecal coliform concentrations in the Middle, Muddy, and South Forks, respectively. Concentrations are higher in the years 2000, 2001, and 2007 for all three forks. Concentrations are higher in years when additional sampling was performed for special wet weather monitoring studies.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 2.9.18 AVERAGE FECAL COLIFORM ON THE MIDDLE FORK OF BEARGRASS CREEK

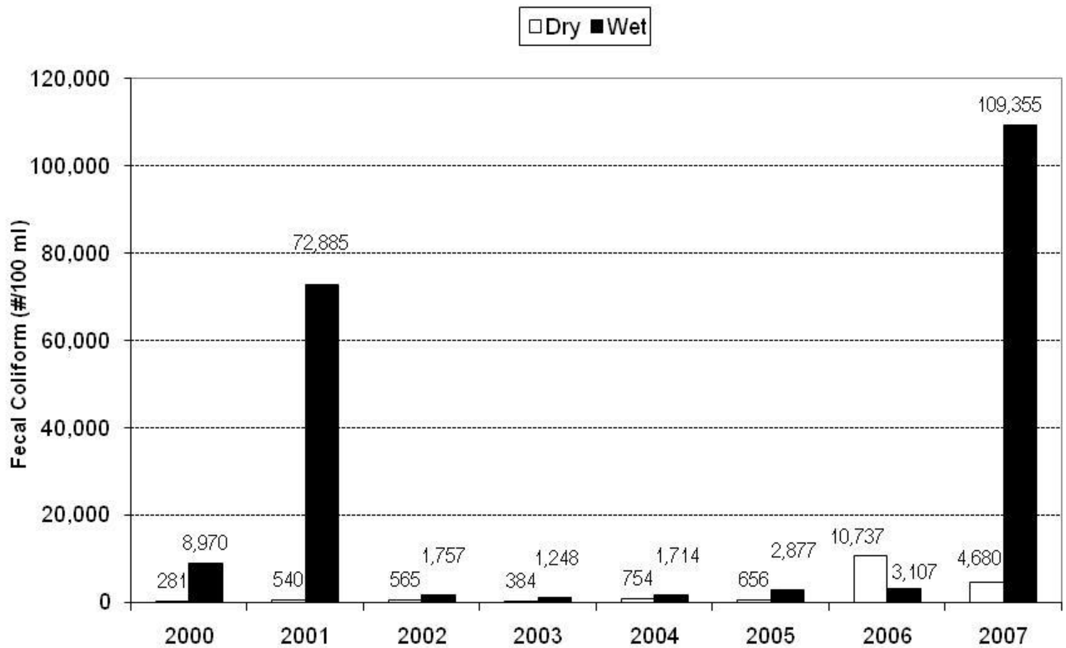


FIGURE 2.9.19 AVERAGE FECAL COLIFORM ON THE MUDDY FORK OF BEARGRASS CREEK

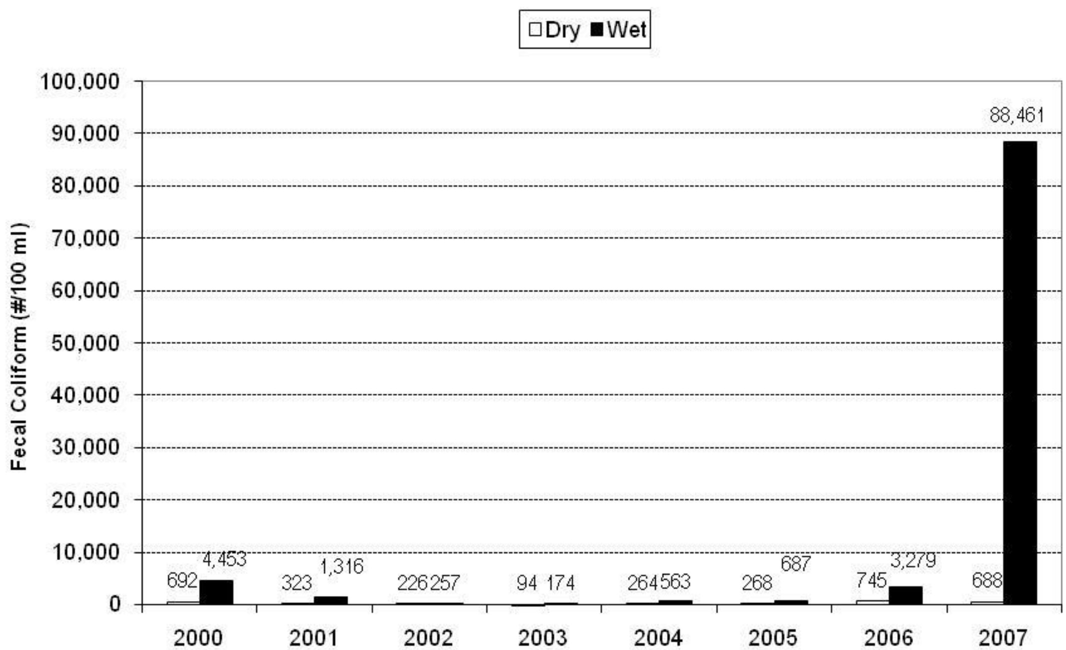


FIGURE 2.9.20 AVERAGE FECAL COLIFORM ON THE SOUTH FORK OF BEARGRASS CREEK

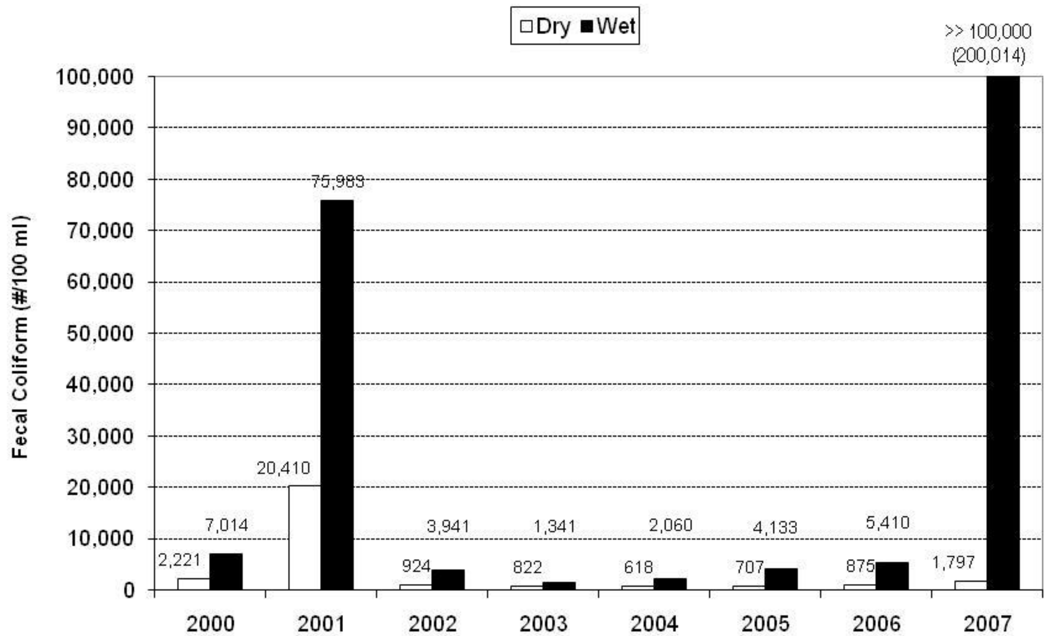
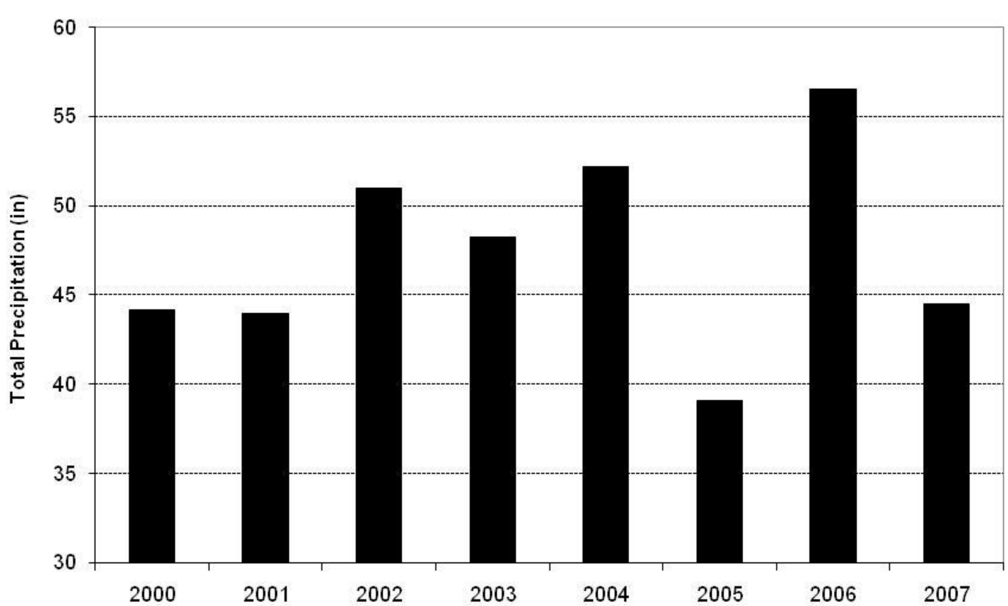


FIGURE 2.9.21 ANNUAL RAINFALL TOTAL AS MEASURED AT THE LOUISVILLE STANDIFORD FIELD



2.9.3.2 Frequency of Exceeding Target Levels

As discussed in Section 2.9.2, water quality standards for indicator bacteria in waters designated for primary contact recreation consist of two parts. During the recreation season (May-October), the fecal coliform concentrations shall not exceed 200 per 100 ml as a geometric mean based on not less than five samples taken during a 30-day period. Further, the fecal coliform concentration shall not exceed 400 colonies 100 ml in 20 percent or more of all samples taken during a 30-day period.

This section examines the frequency of time that these target values are exceeded. It should be noted that this analysis does not represent a direct comparison to water quality standards, as individual measurements are being compared to targets representing a geometric mean or 80 percentile. Data were not necessarily collected of sufficient frequency to allow for a direct comparison.

Available data from each branch were used to calculate the number of exceedances of the geometric mean criterion (Table 2.9.12). Exceedances are prevalent for all six years on all three branches, with the average exceedance percentage across the three branches ranging from 69-79 percent.

TABLE 2.9.12
EXCEEDANCES OF THE 30-DAY GEOMETRIC MEAN (200 PER 100 ML) FECAL COLIFORM TARGET IN EACH BRANCH OF BEARGRASS CREEK FROM MAY – OCTOBER

Year	Middle Fork			Muddy Fork			South Fork		
	Exceed	Total	Percent	Exceed	Total	Percent	Exceed	Total	Percent
2000	5	6	83%	5	6	83%	4	6	67%
2001	4	6	67%	5	6	83%	3	6	50%
2002	3	6	50%	2	6	33%	4	6	67%
2003	3	6	50%	1	6	17%	3	6	50%
2004	5	6	83%	3	6	50%	5	6	83%
2005	6	6	100%	5	6	83%	6	6	100%
2006	6	6	100%	6	6	100%	6	6	100%
2007	6	6	100%	6	6	100%	6	6	100%
Total	**38**	**48**	**79%**	**33**	**48**	**69%**	**37**	**48**	**77%**

Table 2.9.13 presents a similar exceedance analysis; using the 80th percentile fecal coliform standard (400 per 100 ml). The percent of time that the target is exceeded is less than for the geometric mean criteria, which is expected because the target value is higher. Nonetheless, these percentages indicate that water quality standards are likely not being met over large periods of time. The nature of the target is that no more than 20 percent of the samples should exceed it, and the observed percentage exceedance ranges from 42-61 percent.

TABLE 2.9.13
NUMBER OF EXCEEDANCES OF THE 80TH PERCENTILE FECAL COLIFORM STANDARD (400 PER 100 ML) IN EACH BRANCH OF BEARGRASS CREEK FROM MAY-OCTOBER, 2000-2007

	Middle	Muddy	South
Exceed	385	151	455
Total	634	358	805
%	61%	42%	57%

2.9.3.3 Continuous Monitoring Data

As shown in Figure 2.9.22, MSD has operated seven continuous water quality monitors in the Beargrass Creek watershed. Data from these monitors are summarized in the report entitled *Water Quality in Jefferson County, Kentucky: A watershed synthesis report, 2000-2005* (Jin, 2007). Figures 2.9.22 to 2.9.27 present a summary of the percent of days where the daily average dissolved oxygen criterion of 5.0 mg/l was violated. Stations are presented in upstream to downstream order for each of the three forks. Both the raw and the USGS corrected data is presented because the sondes (continuous monitors) were subject to fouling and many of the raw data were considered unreliable. MSD has since replaced these sondes with sensors that are less prone to fouling. Corrected data were not provided for 2005. In general, there are less violations at the locations upstream of the sanitary sewer overflows (SSOs) and the CSOs.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 2.9.22 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2000

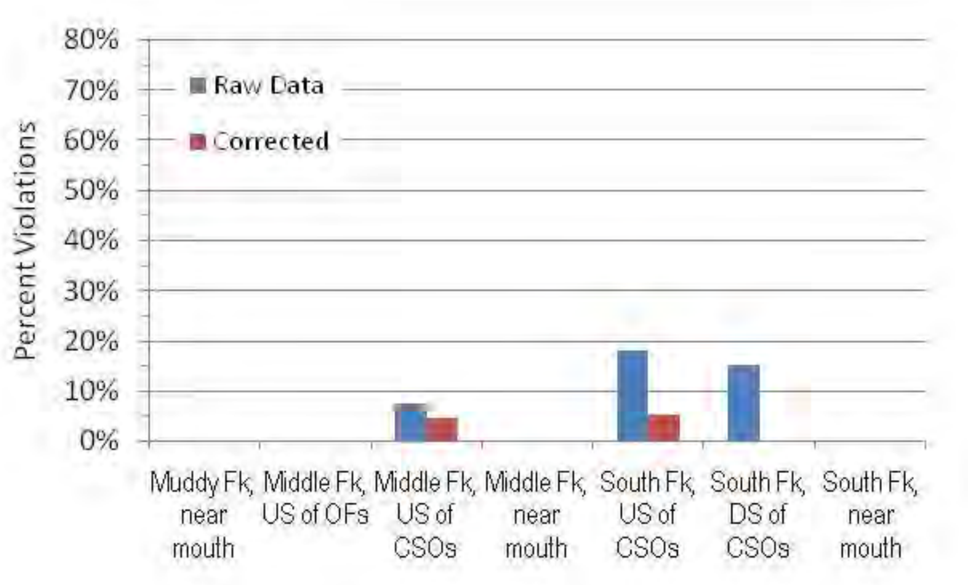


FIGURE 2.9.23 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2001

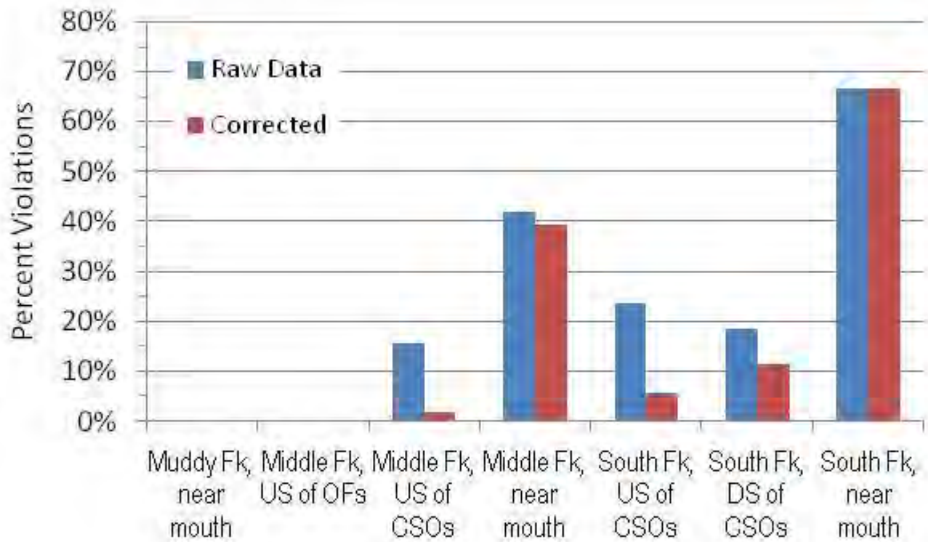


FIGURE 2.9.24 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2002

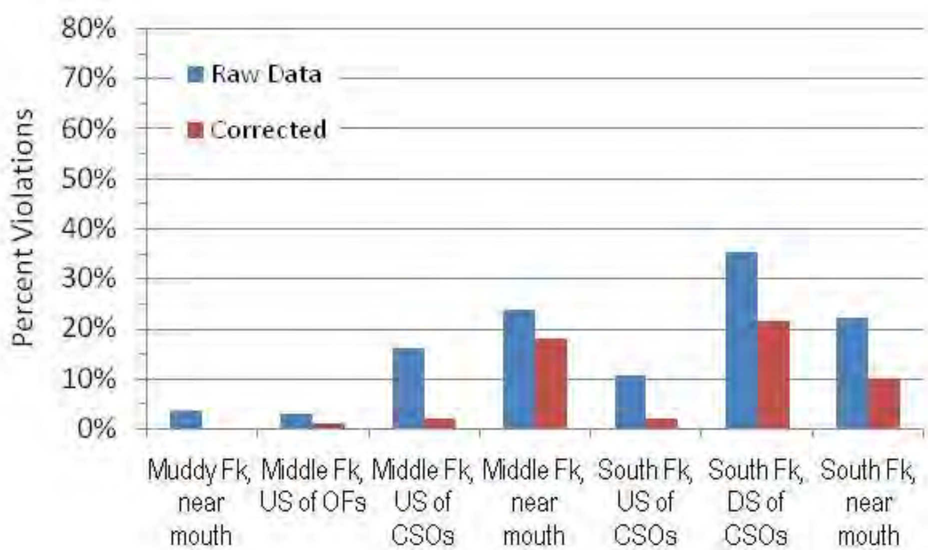


FIGURE 2.9.25 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2003

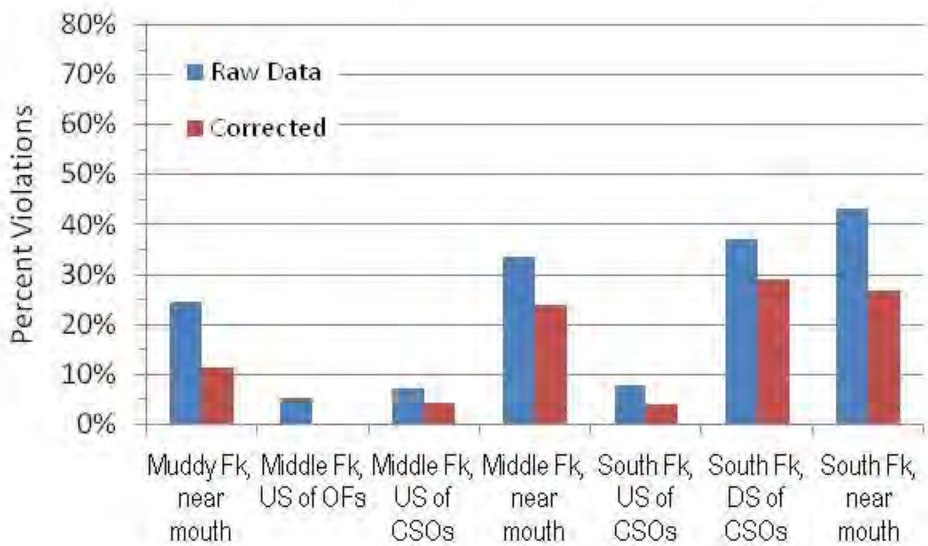


FIGURE 2.9.26 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2004

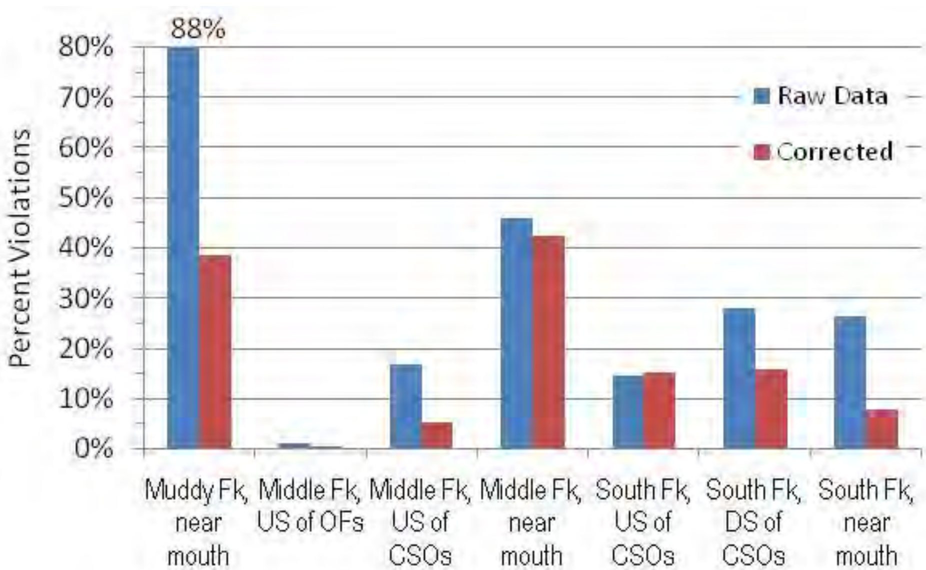
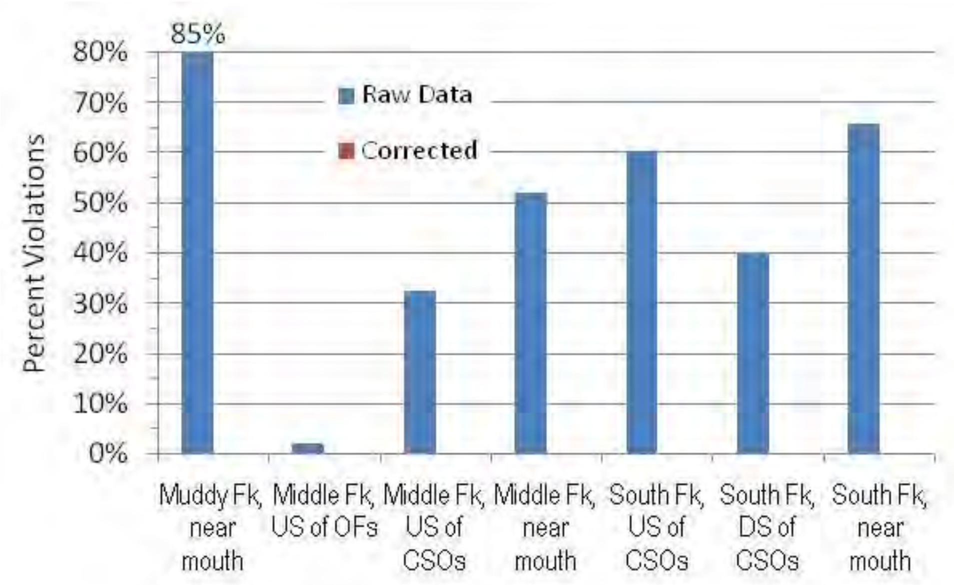


FIGURE 2.9.27 PERCENT DAILY AVERAGE DISSOLVED OXYGEN VIOLATIONS IN BEARGRASS CREEK, 2005



The evaluation of the daily average pH reported in the Synthesis Report indicated that there were occasional violations of the minimum and maximum pH criteria. This occurred at all locations with the exception of EMIMI002 on the Middle Fork, upstream of the CSOs.

2.9.3.4 Biological Data

MSD conducts biological (fish and macroinvertebrate), habitat and bioassessment data at the long-term monitoring network stations. Data are summarized in the Synthesis Report for 2000 to 2005 (Jin, 2007). Macroinvertebrate biotic integrity scores ranged from vary poor to fair at all locations, depending on the year. The fish index of biotic integrity, which is often highly variable particularly for urbanized streams, ranged from poor to excellent. The diatom bioassessment index ranged from fair to excellent.

2.9.3.5 Other Parameters

MSD collects other parameters beyond bacteria as part of its routine monitoring. Results for these parameters for 2000-2006 are shown in Tables 2.9.14 through 2.9.16.

TABLE 2.9.14
SUMMARY OF WATER QUALITY DATA FOR MIDDLE FORK (2000-2007)

Parameter	Number of Samples	Average	Minimum	Maximum
Ammonia as Nitrogen (MG/l)*	141	0.32	0.05	10.00
Nitrate (MG/l)	9	0.74	0.05	1.10
Nitrite (MG/l)	9	0.02	0.01	0.04
Total Kjeldahl Nitrogen (MG/l)	155	16.2	0.2	832.0
Total Phosphorus (MG/l)	153	0.23	0.02	2.28
TSS (MG/l)**	508	71	0	5,916
pH	30	6.68	4.21	8.76
Copper (ug/l)	120	0.092	0.002	2.62
Hardness (MG/l)	82	203	7	337
Nickel (ug/l)	106	0.071	0.001	1.960
Lead (ug/l)	148	0.011	0.0005	0.239
Zinc (ug/l)	116	0.341	0.008	9.150

*Does not include suspect ammonia data from 9/13/01 and 10/30/01, which were > 50 MG/l. These data are undergoing further investigation.
**TSS data are from 2000-2006.

TABLE 2.9.15
SUMMARY OF WATER QUALITY DATA FOR MUDDY FORK (2000-2007)

Parameter	Number of Samples	Average	Minimum	Maximum
Ammonia as Nitrogen (MG/l)	394	0.15	0.05	1.46
Nitrate (MG/l)	3	1.04	0.67	1.23
Nitrite (MG/l)	3	0.02	0.01	0.03
Total Kjeldahl Nitrogen (MG/l)	205	0.7	0.04	2.6
Total Phosphorus (MG/l)	361	0.112	0.006	7.17
TSS(MG/l)*	396	14	1	246
pH	375	7.27	5.05	10.43
Copper (ug/l)	214	0.010	0.002	0.028
Hardness (MG/l)	253	285	3	469
Nickel (ug/l)	200	0.003	0.001	0.124
Lead (ug/l)	284	0.002	0.001	0.040
Zinc (ug/l)	204	0.021	0.003	0.430

*TSS data are from 2000-2006.

TABLE 2.9.16
SUMMARY OF WATER QUALITY DATA FOR SOUTH FORK (2000-2007)

Parameter	Number of Samples	Average	Minimum	Maximum
Ammonia as Nitrogen (MG/l)	192	0.68	0.05	34.0
Nitrate (MG/l)	9	0.74	0.48	0.90
Nitrite (MG/l)	9	0.04	0.01	0.08
Total Kjeldahl Nitrogen (MG/l)	241	9.45	0.40	801
Total Phosphorus (MG/l)	210	0.454	0.013	14.700
TSS (MG/l)*	565	96	0	1,470
pH	52	6.95	5.13	8.00
Copper (ug/l)	162	0.148	0.003	6.290
Hardness (MG/l)	107	198.1	7.0	379.0
Nickel (ug/l)	170	0.067	0.001	2.050
Lead (ug/l)	204	0.040	0.001	2.100
Zinc (ug/l)	177	0.482	0.008	23.000

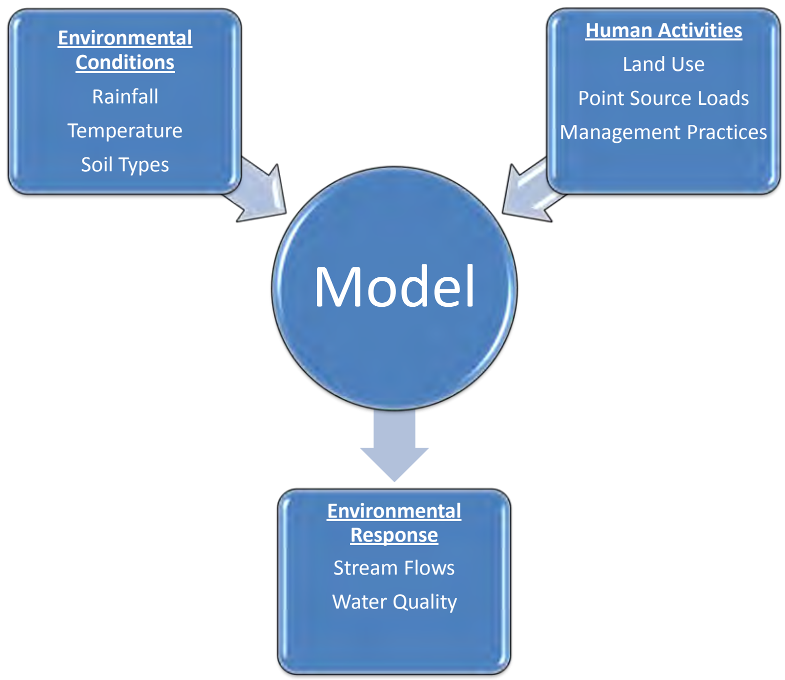
*Does not include suspect ammonia data from 9/13/01, 10/30/01, 11/8/01, and 11/14/01, which were > 50 MG/l. These data are undergoing further investigation.

**TSS data are from 2000-2006.

2.9.4 Receiving Water Quality Modeling Overview

A water quality model is a series of mathematical equations describing real world processes. The mathematical equations contained in the model are based upon scientific principles describing known relationships that affect water quality. As a depicted in Figure 2.9.28, water quality models are designed to convert inputs on environmental conditions and human activities into outputs of water quality.

FIGURE 2.9.28 SIMPLE DEPICTION OF A WATER QUALITY MODEL



Mathematical models, such as water quality models, are commonly used to predict the consequences of future actions for complicated analyses when it is unfeasible to gain the necessary information via trial and error. In the context of the CSO LTCP, water quality model answers will be used to define the water quality benefit to be obtained by various levels of CSO control, allowing MSD to define optimal controls prior to spending millions of dollars on implementation.

The water quality models developed for the Final CSO LTCP describe water quality throughout MSD's service area. The Beargrass Creek WQT predicts water quality throughout all branches of Beargrass Creek, while the Ohio River Water Quality Model predicts water quality in the Ohio River. Both models predict how concentrations change over distance in a downstream direction, and the Ohio River Water Quality Model also considers lateral variation in water quality, i.e. the difference in concentration between the Kentucky shoreline, mid-channel areas, and the Indiana shoreline. Both models also consider how concentrations change over time, on an hour-by-hour basis over the course of a year.

2.9.5 Beargrass Creek Water Quality Model

The CWA has the goal of making our nation's waters suitable for the uses of drinking water, aquatic habitat, and recreation through the establishment of water quality standards. When a stream is polluted to the level that the water quality standards are no longer met, it is designated by the state or federal government as impaired. This triggers the next step in the CWA requirements - a study of the reasons for the impairment and a measurement of the amount of pollution that needs to be reduced, known as the Total Maximum Daily Load (TMDL) study. Watershed managers need to know the sources and amounts of pollutants so that they can develop and implement plans to make the needed improvements.

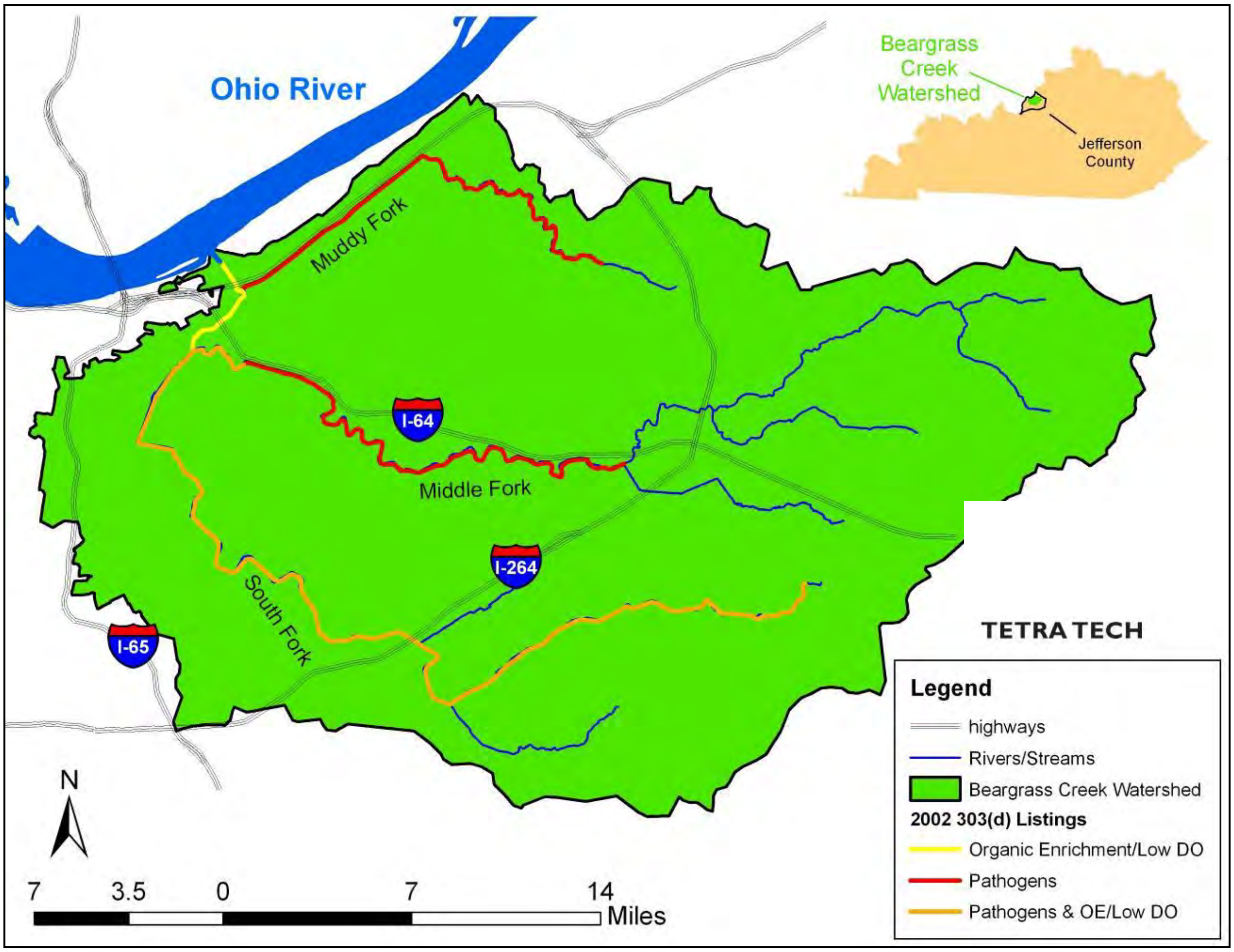
Water quality in streams and rivers is a result of the interactions between the water flow, pollutants, living systems, weather, and chemical changes. Water resource engineers have developed computer programs that simplify these systems so that they can be better understood. These computer programs, or models, can also be modified to predict the effects of changes in pollution levels and other systems in "what if" scenarios.

2.9.5.1 Beargrass Creek Receiving Water Modeling Objectives

Beargrass Creek has a 61 square-mile watershed with a variety of landuses, ranging from farmland, suburban residential areas, historic parks, and urban areas. Discharges to the stream include stormwater runoff from the Municipal Separate Storm Sewer System (MS4), nonpoint source discharges, CSOs, and SSOs.

KDEP has determined that portions of Beargrass Creek do not support the Designated-Use Criteria for Primary Contact Recreation and Aquatic Life due to pathogens, organic enrichment/low dissolved oxygen, and habitat alteration. These segments are in the Middle Fork (25-mi^2 drainage area), Muddy Fork (9-mi^2 drainage area), and South Fork (27-mi^2 drainage area) sub-basins of Beargrass Creek. See Figure 2.9.29 below.

FIGURE 2.9.29 SEGMENTS OF BEARGRASS CREEK LISTED AS IMPAIRED BY PATHOGENS AND/OHIO RIVER ORGANIC ENRICHMENT/LOW DISSOLVED OXYGEN



The Beargrass Creek watershed is drained by an extensive system of natural stream segments, open concrete channels, storm sewers, sanitary sewers, and combined sewers. This watershed also has karst geology in some areas. The complex hydrology and combination of point and nonpoint sources pose significant technical obstacles for the prediction of water quality.

In the 1990s, MSD and the KDEP discussed the need for water quality improvements in Beargrass Creek, beginning with the preparation of TMDL studies to determine the pollutant loading reductions that would be needed to attain the stream's designated uses. MSD offered to partner with the KDEP to develop watershed and stream water quality models that would be used to develop the TMDLs. MSD wanted to use the models for use in planning sewer overflow controls and to ensure that the TMDLs include all sources of pollutant loading to the stream, not just CSOs.

The initial plan for a modeling system was to link two existing models: the watershed model Hydrologic Simulation Program – FORTRAN that had been developed by the USGS for part of the watershed, and the existing SWMM model used by MSD to simulate CSOs. These linked models would generate a continuous simulation of the runoff, sewer overflows, stream flows, and water quality to provide a more complete assessment of the water quality effects of overflows and runoff. The linked models were named the Beargrass Creek WQT.

Overflow Abatement Modeling Objectives

MSD's objectives for the modeling system were to quantify the effects of sewer overflows on water quality and to provide a tool that could be used to predict the future effects of various overflow abatement projects. The ability to predict water quality impacts of projects would allow MSD to prioritize efforts to get the best results.

When the WQT was being planned, MSD used the AAOV of each CSO as a measure of its relative importance and need for abatement, but recognized that this method may oversimplify the relationship and could cause inefficient use of capital funds by focusing on the larger, more expensive abatement projects. CSOs affect receiving stream water quality by the amount of overflow, but factors such as frequency, location, receiving stream flow rate and water quality should also be taken into account.

Overflow abatement costs are also not always directly associated with the AAOV. There are many types of abatement, each with its application and costs that vary widely depending on the specific location and amount of control desired.

Water Quality Modeling Objectives

Because the water quality impairments in Beargrass Creek include both pathogens and organic enrichment, the models had to have the ability to simulate the movement of pollutants in the stream and the dissolved oxygen concentrations that result directly from the pollutants and indirectly from algae in the stream.

Accurate prediction of fecal coliform concentrations must take into account the transport and mixing of the bacteria, including association with solids and storage in stream sediments. In addition, there is a loss of bacteria over time due to die-off, which varies with temperature and exposure to sunlight.

Dissolved oxygen in a stream is affected by many variables, including direct consumption of oxygen from bacteria that break down organic compounds, respiration of aquatic life (both plants and animals), increased oxygen from aeration, temperature effects, sunlight/shade, etc.

MSD recognized that the connection of a complex stream water quality system with a complex CSS would make for complex relationships between the two and that a computer modeling system would be needed to guide overflow abatement.

Environmental Data Variance

Environmental data variance is discussed extensively in Appendix 2.9.1, Beargrass Creek Water Quality Tool Model Calibration and Validation Report. The fecal coliform and dissolved oxygen data sets, in particular, show a great deal of variability, which caused some areas within the water quality model calibration to fall short of the targets within the Quality Assurance Project Plan (QAPP). The best available data sets were used for calibrating the Beargrass Creek water quality model, although additional data is being continuously collected by MSD.

In order to address variability and QAPP calibration targets, a review of the QAPP targets may be needed as well as additional stream monitoring and sampling using more stringent data collection, equipment calibration, and data quality control procedures. These activities are being discussed for Beargrass Creek among the parties involved in the development of the draft Beargrass Creek TMDLs and associated water quality model.

However, for the purpose of assessing CSO impacts under existing system conditions and simulating anticipated conditions after implementing MSD's proposed Final Long Term Control Plan, the water quality model for the Beargrass Creek is sufficiently accurate and the best available assessment tool to support the analysis of water quality impacts from the demonstrative CSO control approach developed by MSD. The modeling approach undertaken for the system was supported by a relatively large amount of reliable environmental data and subjected to much third party scrutiny and quality control, in comparison with typical efforts.

2.9.5.2 Beargrass Creek Water Quality Model Selection

As discussed above, the initial plan for the WQT was to use the Hydrologic Simulation Program – FORTRAN and SWMM models that were already available and in use separately, combining them to operate as a single system. Initially, the plan was to modify these models to run as an integrated system and then to calibrate and validate the resulting system's simulation results using monitoring data. This type of combination of Hydrologic Simulation Program – FORTRAN and SWMM was unprecedented. The models required substantial modification to merge them into an integrated system. For example, the Hydrologic Simulation Program – FORTRAN model had been developed for the Middle and South Forks of Beargrass Creek, but not the Muddy Fork. The SWMM model was set up to simulate specific rain events, rather than continuous simulation. Both models had specific data file requirements for input and output that were not directly compatible, requiring development of data transfer programs that could manage large and complex files.

As the WQT was developed and calibration was planned, the models were re-evaluated several times. The following models were considered as replacement models for all or part of the receiving stream simulation originally performed with Hydrologic Simulation Program – FORTRAN:

- CE-QUAL-W2 (version 3.1)
- CE-QUAL-RIV1 (version EPD-RIV1)
- CE-QUAL-ICM
- EFDC-WASP (WASP6)
- BRANCH-BLTM

MSD and its consultants also considered replacing some Hydrologic Simulation Program – FORTRAN functions with the SWMM model and other hydraulic models.

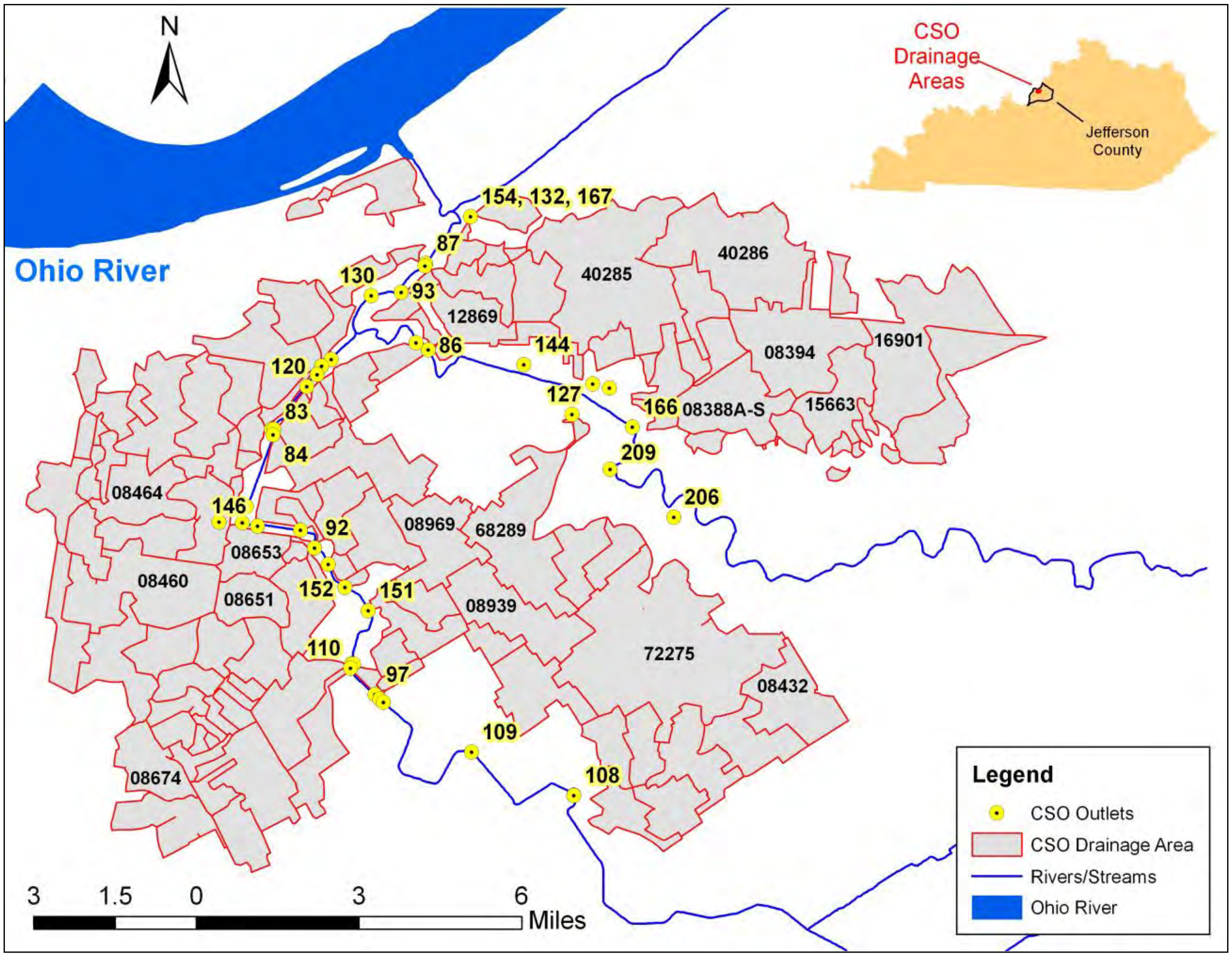
2.9.5.3 Beargrass Creek Water Quality Model Description

Although other models were considered, the Hydrologic Simulation Program – FORTRAN and SWMM models have remained a part of the WQT. Some additional models were added, however, to address specific needs. The following overview describes the functions of the WQT.

- Hydrologic Simulation Program – FORTRAN - the watershed model that uses actual precipitation data from a specific time period, landuse, and topography data to generate runoff and subsurface water flow that is routed to Beargrass Creek directly or indirectly through the storm sewer system, the CSS, or tributaries and ditches.
- XP-SWMM - the combined sewer model that receives runoff flow from the watershed model (see Figure 2.9.30), combines the stormwater flow with sanitary sewer flow that varies in amount throughout the day, and produces a CSO output.
- Simulated SSO flow from a separate simulation program that relates SSO volume to precipitation based on hydraulic model results.
- Hydrologic Simulation Program – FORTRAN, RIV1H, and WASP – the receiving stream models that simulate the flow rate and water quality of Beargrass Creek as a series of stream segments or reaches, getting inputs of flows and pollutants on a continuous basis from the above models; RIV1H and WASP are used in the lower Beargrass Creek area where more complex stream hydraulic conditions required the use of these models for both hydrology and water quality.

Data transfer programs known as bridge routines are needed to convert the large amounts of flow and water quality data at each location and time interval from one model's data format to another.

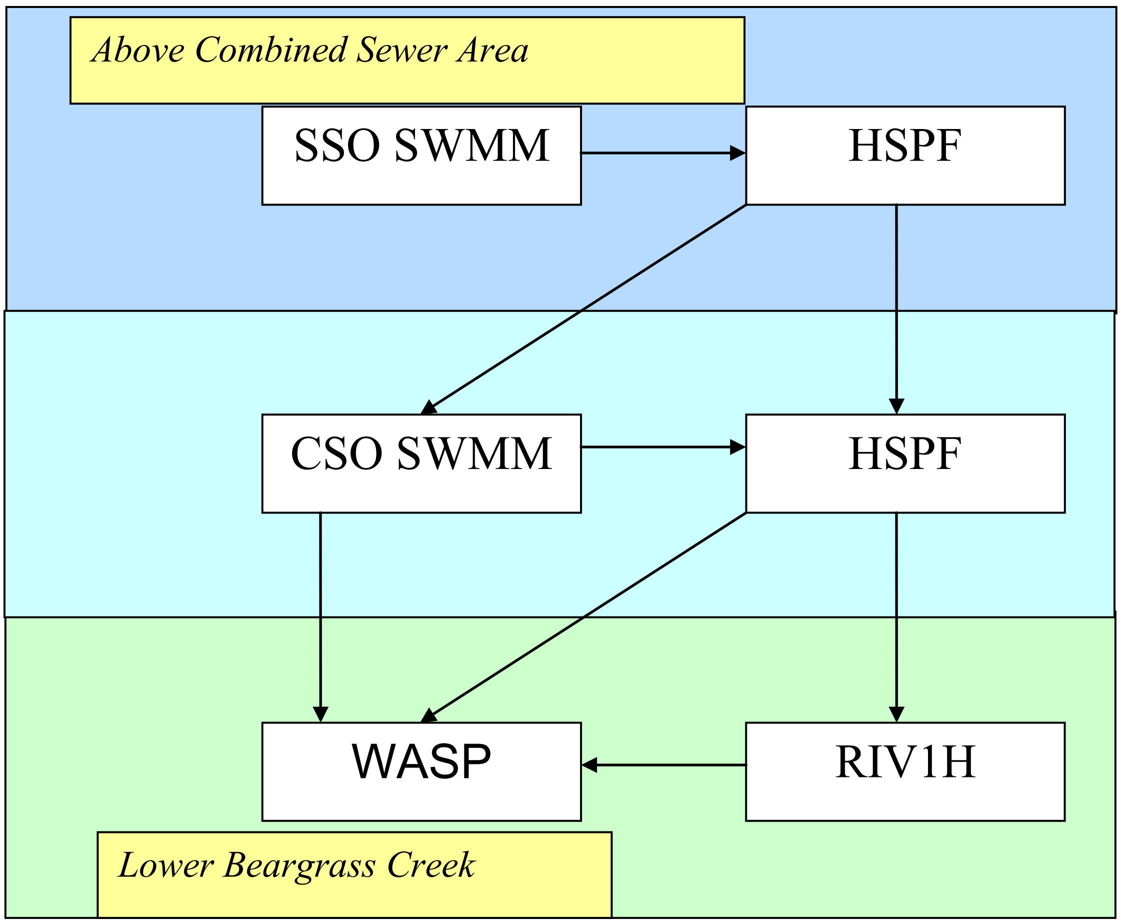
FIGURE 2.9.30 CSO DRAINAGE AREAS



The original models needed additional modifications to meet the project objectives. The Hydrologic Simulation Program – FORTRAN model's receiving water simulation was refined to smaller stream reaches, the CSO drainage areas were refined in the Hydrologic Simulation Program – FORTRAN watershed (Figure 2.9.30), precipitation information was processed to specific watershed areas, the SWMM model was converted from the EPA version to the XP Software version, and many other adjustments were made.

Figure 2.9.31 illustrates the inter-relationships between these models within the WQT.

FIGURE 2.9.31 RELATIONSHIPS BETWEEN THE MODELS OF THE BEARGRASS CREEK WATER QUALITY TOOL



2.9.5.4 Beargrass Creek Water Quality Model Development

Model development and calibration were performed in accordance with a QAPP and regular consultation with Dr. Lindell Ormsbee of the Kentucky Water Resources Research Institute. Peer reviewers Tony Donigian and Wayne Huber evaluated the model development process and final system, providing valuable input that improved the end result. The WQT calibration and validation have been completed and documented in the Tetra Tech report to MSD "Beargrass Creek Water Quality Tool Model Calibration and Validation Report," May 2008 (see Appendix 2.9.1).

The WQT performs a continuous simulation of rainfall, runoff, sewer overflows, stream flow, and water quality in surface water and groundwater over the five-year period from January 1, 2000, through December 31, 2004. The actual conditions for this period are the baseline condition against which TMDL allocations and overflow abatement scenarios are assessed. In some analyses, the year 2001 was used as a representative year for the comparisons.

2.9.5.5 Overview of Beargrass Creek Water Quality Model Results

In June 2008, the WQT was used to generate the pollutant load allocations used by Kentucky Water Resources Research Institute to develop both fecal coliform and organic enrichment/low dissolved oxygen TMDLs for the KDEP. Currently, the WQT is being used to quantify pollutant loads and their effects on Beargrass Creek water quality for various scenarios considered for overflow abatement planning. The following summarizes the results of these efforts.

TMDLs

The TMDL reports have been completed by Kentucky Water Resources Research Institute and submitted to the KDEP for review. The fecal coliform TMDL was presented for public comment on September 11, 2008. The TMDLs were developed on a sub-basin basis, with each of the major basins (Muddy, Middle, and South) subdivided into three or four subwatersheds. Loads were allocated on an annual basis and then expressed in terms of a daily load. The TMDL is the maximum load that, with a margin of safety, could be applied to Beargrass Creek without causing water quality standards violations above a minimal level. Two scenarios were used to develop load allocations for the TMDL. Both scenarios included elimination of SSOs and modification of minor sources.

- Scenario I - CSO reduction (95 percent reduction in volume, 50 percent concentration reduction).
- Scenario II - Sewer separation (100 percent).

In the Organic Enrichment TMDL, the pollutant loading is expressed as biochemical oxygen demand. Sources are SSOs, CSOs, stormwater, and groundwater. Of these sources, the stormwater source is the largest (65 percent) and CSOs are the next-largest source (28 percent). The total biochemical oxygen demand wasteload reductions in the TMDL range from 49 to 71 percent for Scenario I (CSO reduction through storage) and 49 to 65 percent for Scenario II (sewer separation).

The fecal coliform TMDL was prepared using similar methods in terms of the load allocation scenarios and sub-basins. Stormwater is the largest source of fecal coliform (61 percent) and CSOs are the next-largest source (38 percent). The total fecal coliform wasteload reductions in the TMDL range from 95 to 96 percent for both scenarios.

Overflow Abatement Scenarios

Various scenarios have been evaluated with the WQT to predict the water quality effects of planned abatement approaches. Results are evaluated in terms of attainment of the fecal coliform water quality standard, which has 30-day geometric mean and instantaneous maximum criteria. (See Figures 2.9.32 and 2.9.33) There are also different levels for these criteria in the summer or recreational season and the winter season. Scenarios are compared to the baseline or actual condition for the five-year period 2000 - 2004 or for the representative year 2001.

Scenarios are developed by MSD and its overflow abatement consultants as the planning work proceeds. Several scenarios have been completed and more are expected to be performed in the future. The following summarizes the findings to date.

<u>No CSOs/SSOs</u>

The WQT simulated the effects of eliminating SSOs and CSOs completely. The results were used in development of the TMDLs. This scenario reduced, but did not eliminate, violations of the primary recreation and aquatic life water quality standards (fecal coliform and dissolved oxygen criteria, respectively).

<u>CSO-Only</u>

The WQT was set up to make CSOs the only source of fecal coliform bacteria, eliminating the pathogens from all other sources. This scenario is designed to distinguish the effect that CSOs have on water quality alone. The predicted water quality standard compliance for this case was much higher than baseline confirms with background loads, virtually eliminating excursions in the upper reaches of all three forks. However, there remained violations of the geomean standard at the mouths of South (41 percent of the year), Middle (<one percent), and Muddy Forks (four percent). At the confluence with the Ohio River, the predicted nonattainment rates were 48 and 17 percent for the geomean and maximum standards, respectively. The simulation also predicted that the maximum standard would be exceeded four to seven percent of the time from the mouth of South Fork to the Beargrass Creek Flood Pumping Station.

CSO-Only with Reductions

An additional set of simulations was added to the above scenario that reduced the fecal coliform concentrations in the CSOs by 50 and 90 percent. All other parameters remained the same. The reductions further reduced but did not eliminated violations. For example, at the Beargrass Creek Flood Pump Station the scenarios predicted geomean water quality standard violations would drop from 72 percent for the baseline to 41 percent for CSOs-only to about 11 percent for the 90 percent reduction case. The effects of the CSO-only simulations were greater on the 30-day geometric mean standard attainment, especially the winter standard.

Simulated zero, two, four, and eight overflows per year scenarios were evaluated in August 2008. This analysis varied from previous WQT simulations in that the CSS hydraulic model had changed from XP-SWMM to the new InfoWorks model. These simulations showed that reductions in CSOs did have an effect, but the differences between the levels of control were small. The results are shown on Figures 2.9.32 and 2.9.33. Figure 2.9.32 incorporates the 20 percent allowance for exceedance of the maximum standard.

After the IOAP projects were defined, the WQT was used to predict the water quality effects of the planned controls on SSO and CSO discharges to Beargrass Creek. These simulations, discussed in detail in Chapter 4, Section 4.4.2, predict that, when these levels of control were combined with the CSO-Only assumption, both geometric mean and instantaneous maximum water quality standards would be met in the stream for the entire typical year.

FIGURE 2.9.32 RECREATIONAL WATER QUALITY STANDARD ANALYSIS (MAXIMUM CRITERIA) FOR VARIOUS OVERFLOW SCENARIOS AS COMPARED TO CURRENT CONDITIONS (BASELINE) AT THE MOUTH OF BEARGRASS CREEK AT THE OHIO RIVER

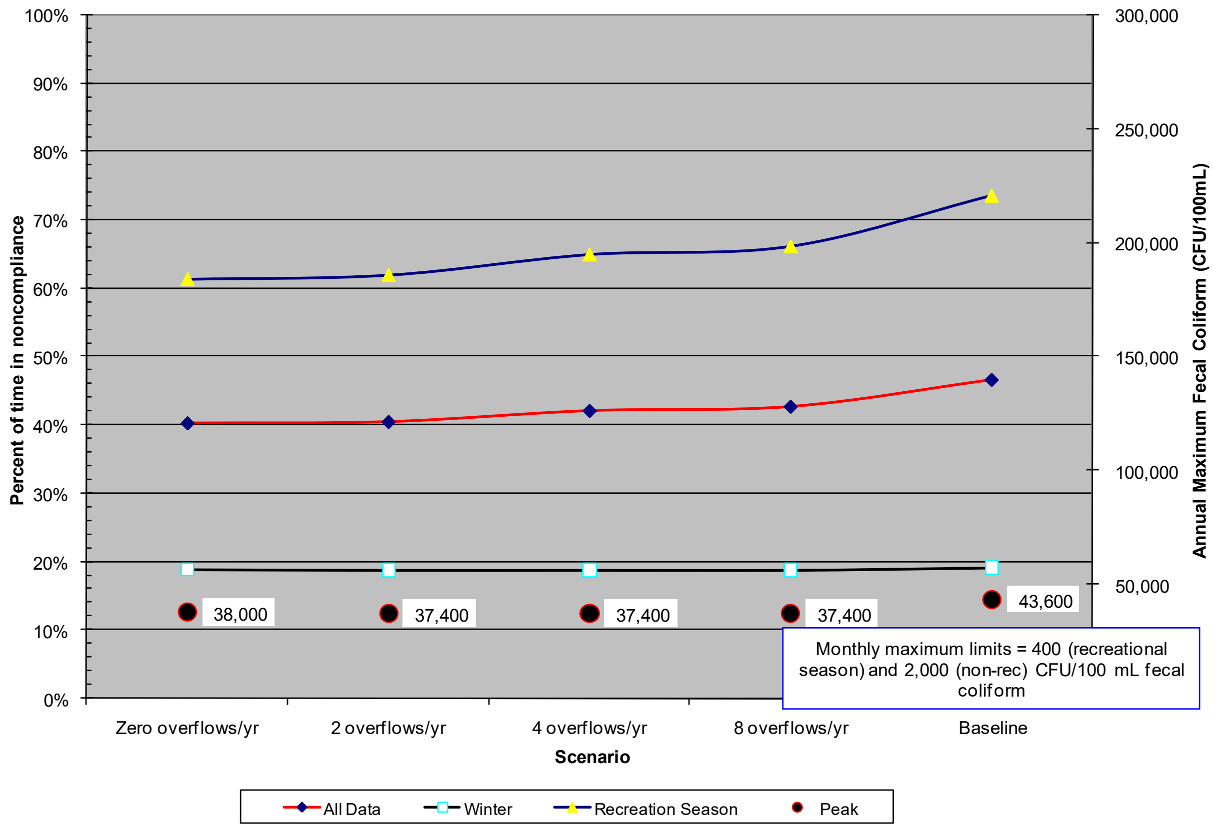
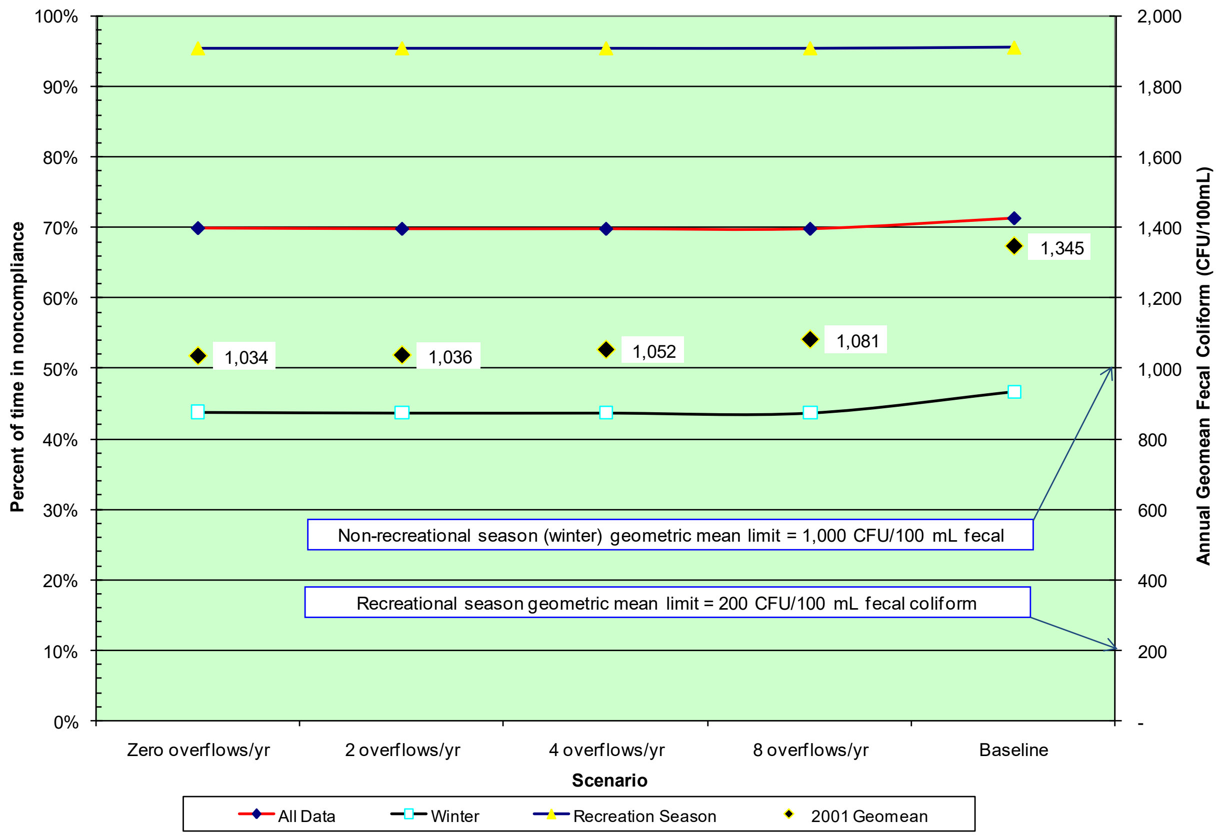


FIGURE 2.9.33 RECREATIONAL WATER QUALITY STANDARD ANALYSIS (GEOMEAN CRITERIA) FOR VARIOUS OVERFLOW SCENARIOS AS COMPARED TO CURRENT CONDITIONS (BASELINE) AT THE MOUTH OF BEARGRASS CREEK AT THE OHIO RIVER



2.9.6 Ohio River Water Quality Model

The Ohio River water quality model was initially developed in 2005 as part of a demonstration project along the Ohio River conducted by the Ohio River by ORSANCO. This section provides an overview of the development and application of the Ohio River water quality model applied for development of the Final CSO LTCP.

2.9.6.1 Ohio River Water Quality Modeling Objectives

The specific objective of the water quality models developed for the CSO LTCP is to predict the water quality expected to result from the various CSO control alternatives that are being considered. Water quality predictions will be characterized in several ways, including:

- Percent of time in compliance with the geometric mean water quality standard for fecal coliform bacteria;
- Percent of time in compliance with the single sample maximum water quality standard for fecal coliform bacteria; and
- Maximum fecal coliform concentration.

Results will be provided for multiple locations throughout Beargrass Creek and the Ohio River, as well as for both the recreational season and the non-recreational season. These results will be used to support a cost-benefit analysis that defines the relationship between the cost of the pollution control alternatives and the resulting water quality benefit. This information will allow MSD (and its stakeholders) to select a LTCP that best balances improvements in water quality with the cost of implementation.

2.9.6.2 Ohio River Water Quality Model Selection

The water quality model selected for the Ohio River portion of this study was originally developed as part of a wet weather demonstration project conducted on the Ohio River by ORSANCO (2005). This section presents the model selection process originally applied for the ORSANCO project, and demonstrates the relevance of the water quality model selection to the current CSO LTCP process. The factors considered in selecting a water quality model include the following categories:

- Management objectives
- Project constraints
- Site-specific characteristics

Specifics on how these factors are incorporated into the model selection process are detailed elsewhere (ORSANCO, 1999). However, primary emphasis in model selection was given to the study's modeling objectives, which included:

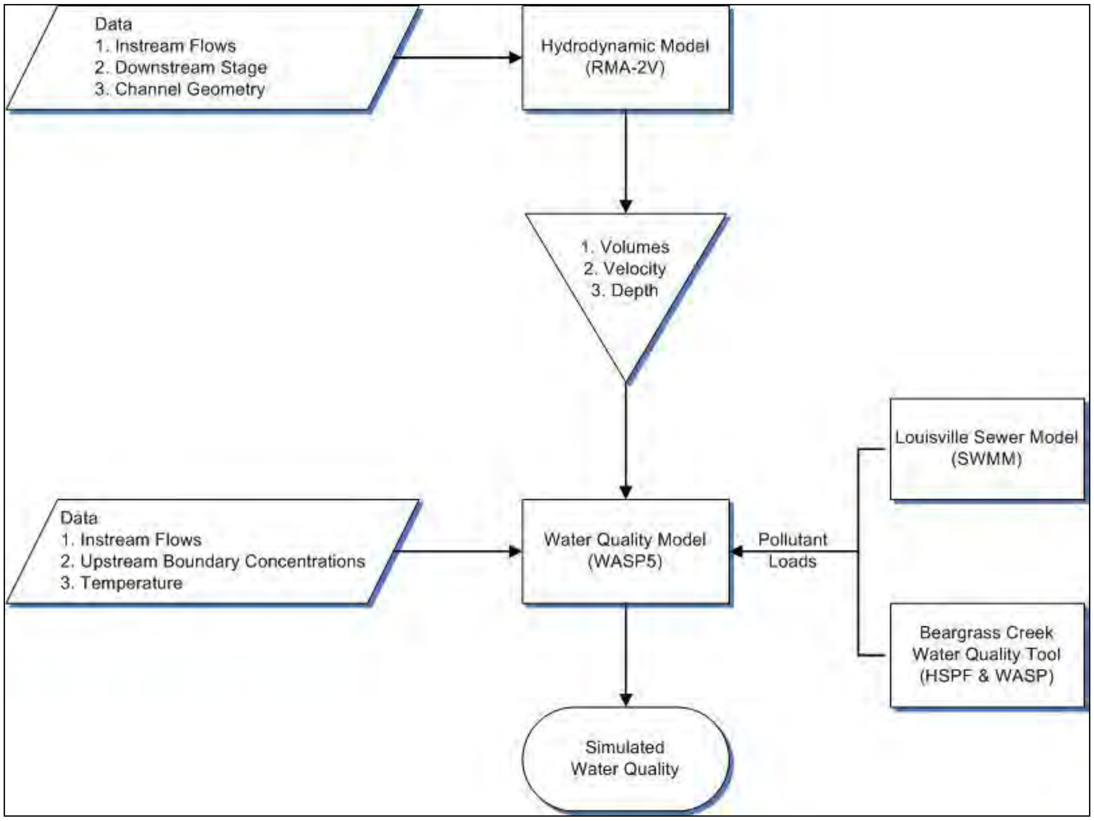
- Define the parameters that violate water quality standards during wet weather in the Ohio River under present conditions. Parameters considered include fecal coliform, E. Coli and, potentially, dissolved oxygen.
- Estimate the duration of criteria exceedance for all parameters.
- Provide a description of the spatial extent (that is, area) of exceedance.

These original ORSANCO objectives are consistent with the objectives of the water quality model for the CSO LTCP process.

Based upon these objectives, project constraints, and site-specific characteristics of the Ohio River, the "Water Quality Analysis Simulation Program, Version 5 (WASP5) was selected to be used as the water quality model for the Ohio River. This model is supported by the EPA and has been widely used. It has the capability to simulate all of the parameters of concern in the study, to provide time-variable simulations capable of defining the duration of criteria exceedances, and to simulate lateral and longitudinal concentration gradients important in large rivers. The WASP5 model was successfully applied to the section of the Ohio River near Cincinnati in a similar wet weather demonstration study (ORSANCO, 2002, A Study of Impacts and Control of Wet Weather Sources of Pollution on Large Rivers).

Application of the WASP5 model to the Ohio River required interaction with other models. Because lateral variation in flow and quality are important in the Ohio River, the USACE hydrodynamic model, Resource Management Associates-2V, was applied by the USGS for the original ORSANCO study to describe the routing of the water flowing through the river. Resource Management Associates-2V simulates lateral and longitudinal variability in river hydraulics. CSO discharging directly to the Ohio River were defined using the CSS model developed by O'Brien and Gere. CSO and stormwater loads from Beargrass Creek were simulated with the Beargrass Creek Water Quality Tool. A flowchart depicting how the Ohio River Water Quality Model interacts with these other models is shown in Figure 2.9.34.

FIGURE 2.9.34 OHIO RIVER WATER QUALITY MODELING FLOW CHART



2.9.6.3 Ohio River Water Quality Model Description

This section describes the basic formulations used in the WASP5 water quality model. WASP5 is a three-dimensional finite difference model that computes constituent concentration in a compartmentalized representation of the physical study area using the principle of conservation of mass. WASP5 can simulate the dynamic response of aquatic systems to pollutant loadings, including CSO discharges and tributary inflows.

The model balances water volume and constituent mass in each model segment over space and time using a governing equation that includes the following water quality processes: 1) transport processes, such as advection, diffusion, dispersion and boundary exchanges; 2) external loadings such CSO; and 3) transformation such as decay. A more rigorous description of the governing equation and water quality processes used in the model is available in the user's manual (Ambrose et al., 1993).

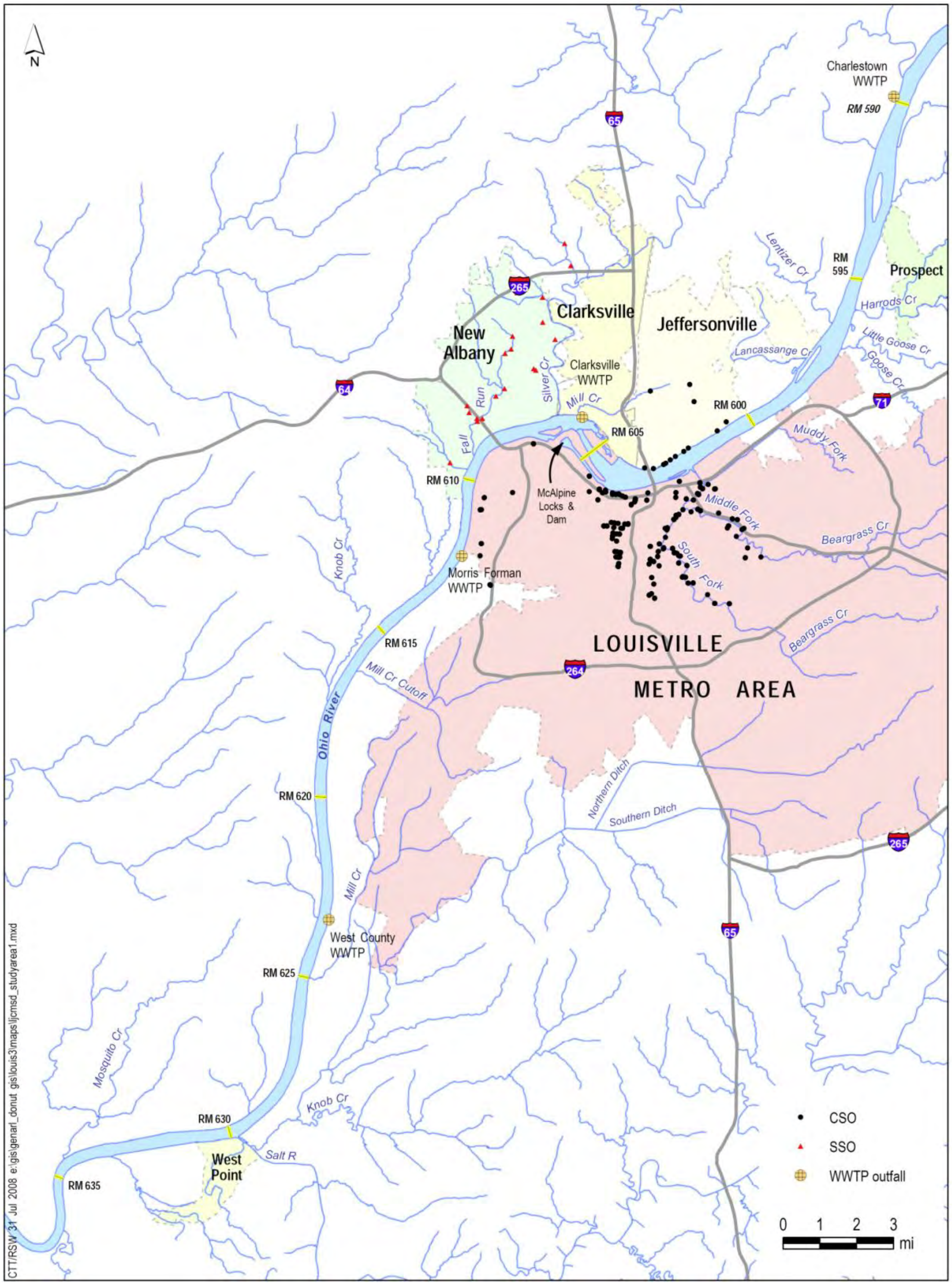
For this study, WASP5 was applied in a two-dimensional mode to address lateral and longitudinal variations in concentration. Model simulated concentrations represent a vertically averaged (or depth-averaged) concentration. EUTRO5 is a sub-component of the WASP5 model used to simulate conventional pollution such as dissolved oxygen, biochemical oxygen demand, nutrients and eutrophication, while TOXI5 is the sub-model used to simulate toxic pollution resulting from constituents such as metals, organic chemicals and bacteria.

In the ORSANCO (2002) study of the Ohio River near Cincinnati, the EUTRO5 model code was modified so that bacteria and dissolved oxygen constituents could be simulated simultaneously in a single model run. This version of the model was used for calibration and validation, although bacteria were the only constituent simulated in this study.

The WASP5 model was constructed in two sections to correspond to the Resource Management Associates-2V model formulations of the study area. The first section covered the portion of the study area upstream of McAlpine Locks and Dam, or approximately from river mile 590 to river mile 607. The second section of the model covered the portion of the study area downstream of McAlpine Locks and Dam, approximately from river mile 607 to river mile 635. These sections were later combined into a single model.

The water quality model covers (see Ohio River Study Figure 2.9.35) the portion of the Ohio River from upstream of the Louisville Metro area (river mile 590) extending downstream to just below the confluence with the Salt River at river mile 635. McAlpine Locks and Dam are located in the center of the model domain at river mile 607. The hydrodynamic model domain was split into two sections with McAlpine Locks and Dam as the boundary between the sections. McAlpine Locks and Dam system includes upper and lower sets of tainter gates and a hydropower plant whose operations vary depending on flow through the system. The increased flow complexity around the McAlpine Locks and Dam necessitated the split in the hydrodynamic modeling. The water quality model was originally set up in the two sections that corresponded to the hydrodynamic model sections and was then combined into a single model prior to calibration and validation.

FIGURE 2.9.35 OHIO RIVER STUDY AREA



Model Segmentation

The water quality model is two-dimensional, describing concentration variations both laterally and longitudinally. Water quality model results are vertically averaged. The modeled area includes all of the CSOs from both Louisville MSD and Jeffersonville, Indiana discharging directly into the Ohio River as well as tributaries that receive CSO loads from these sewerage districts and SSO loads from New Albany, Indiana.

- Kentucky tributaries considered in the model consist of Harrod's Creek, Little Huckleberry Creek, Goose Creek, Beargrass Creek, Mill Creek Cutoff, and Mill Creek.
- Indiana tributaries considered in the model are 14-Mile Creek, Lancassange Creek, Lentizer Creek, Silver Creek, Fall Run, Vincennes Run, French Creek, and 4-Mile Creek. Discharges from WQTCs with outfalls to the Ohio River are also included in the model domain.

Consequently, the portion of the Ohio River simulated with the water quality model is the area where the biggest impacts from CSOs are expected and where near shore effects would be most pronounced.

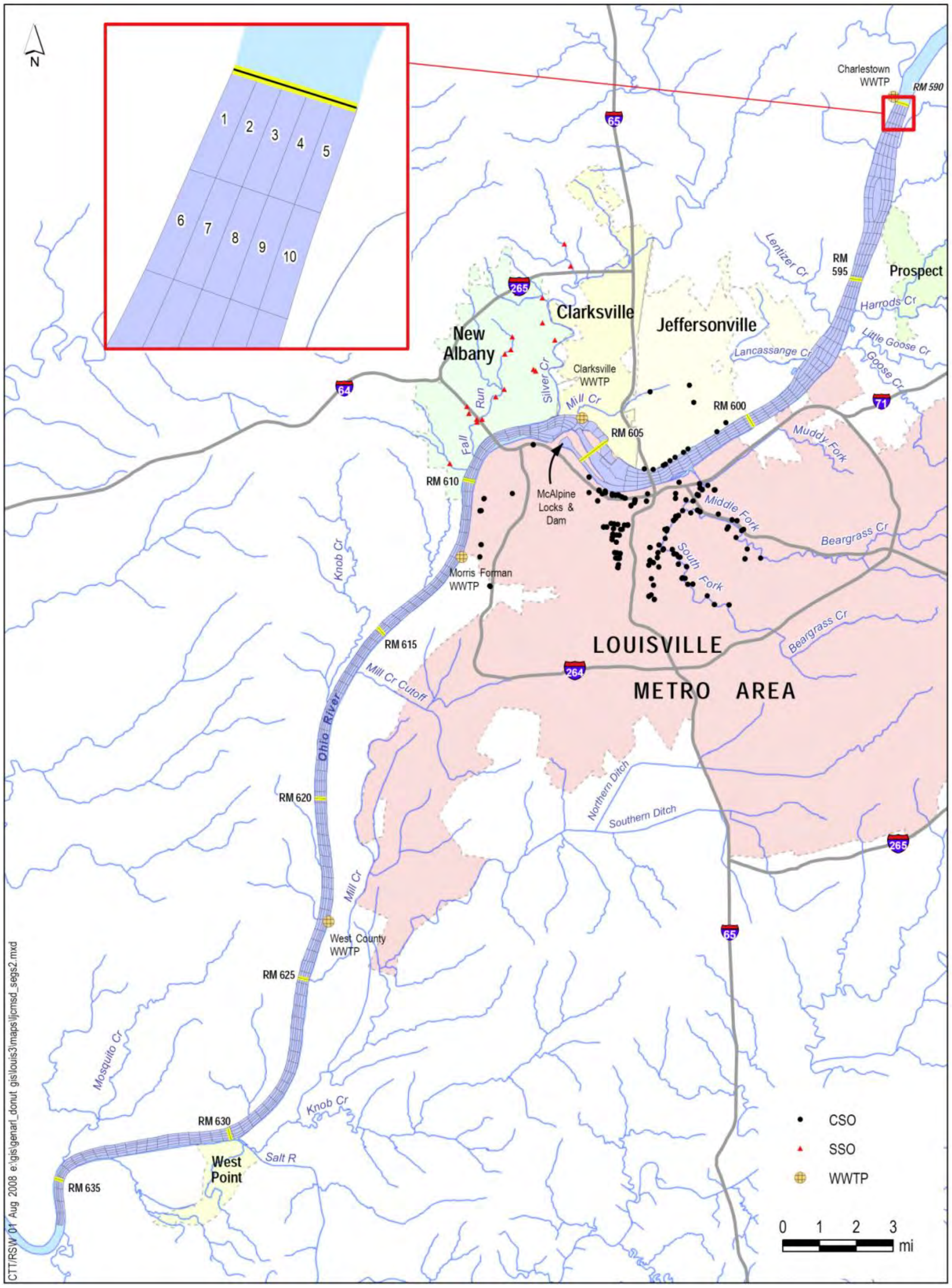
The scale required by the Resource Management Associates-2V model for hydrodynamic stability was too refined to adapt directly for use in the water quality model. As a result, the WASP5 water quality model segmentation was defined as a "subset" of the hydrodynamic grid, where a WASP5 segment contained, on average, twenty-four hydrodynamic model elements. The model's spatial resolution was based upon the approach used in the Cincinnati project (ORSANCO 2002), where it was determined that the model would consist of five lateral segments, approximately divided as follows:

- Bankside channels (one on each shore) = ~10 percent of each cross-sectional area
- Intermediate channels (one on each side of the centerline) = ~20 percent of each cross-sectional area
- Center segment = ~40 percent of each cross-sectional area

The average segment lengths were defined by the length of the hydrodynamic elements and were approximately 0.30 miles in length. The model segmentation immediately upstream of McAlpine Locks and Dam was much larger than the rest of the model domain so that the flow through the Locks and Dam under varying conditions could be reasonably simulated using some simplifying assumptions. The area immediately downstream of the Locks and Dam does not maintain the five segment lateral geometry because of the complexity in river bathymetry and flow patterns through the Locks and Dam area. The WASP5 segmentation is shown in Figure 2.9.36.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 2.9.36 WASP5 MODEL SEGMENTATION



The water quality model contains 738 segments in the Ohio River. Of these, 228 segments span the reach upstream of McAlpine Locks and Dam and 510 segments span the reach downstream of McAlpine Locks and Dam.

Linkage to Hydrodynamic Model

The hydrodynamic model results are used to drive the transport in the water quality model. However, direct use of the Resource Management Associates-2V model results in the WASP5 model is not possible for several reasons. First, the Resource Management Associates-2V model is spatially defined by a set of nodes whereas the WASP5 model is spatially defined by a series of segments. The Resource Management Associates-2V model produces a velocity field defined at the nodes, while WASP5 requires a set of balanced and routed steady state flows defined for segment interfaces. Thus, the Resource Management Associates-2V results have to be translated into WASP5 segment space. The second reason is that Resource Management Associates-2V conserves momentum but does not inherently conserve water mass, which is required by the WASP5 model under the steady state flow conditions for which the Resource Management Associates-2V simulations were conducted.

A computer program was created and used to convert finite element nodal information from the hydrodynamic model into water quality model segment volumes, dispersion areas and mixing lengths. A series of three programs were created to transform the Resource Management Associates-2V model results into inputs for the WASP5 model. These programs performed the following operations:

- Converted strings of Resource Management Associates-2V nodes into WASP5 segment interfaces;
- Smoothed (balanced) the inter-segment flows calculated by Resource Management Associates-2V for the WASP5 segment interfaces;
- Converted the individual smoothed segment flows into flow routings through the WASP5 model so that water volume was balanced in each water quality model segment.
- As expected for a large river system, the linkage between the Resource Management Associates-2V model and the WASP5 model routes the majority of the flow downstream from one segment to a segment immediately downstream of it rather than laterally to an adjacent segment.

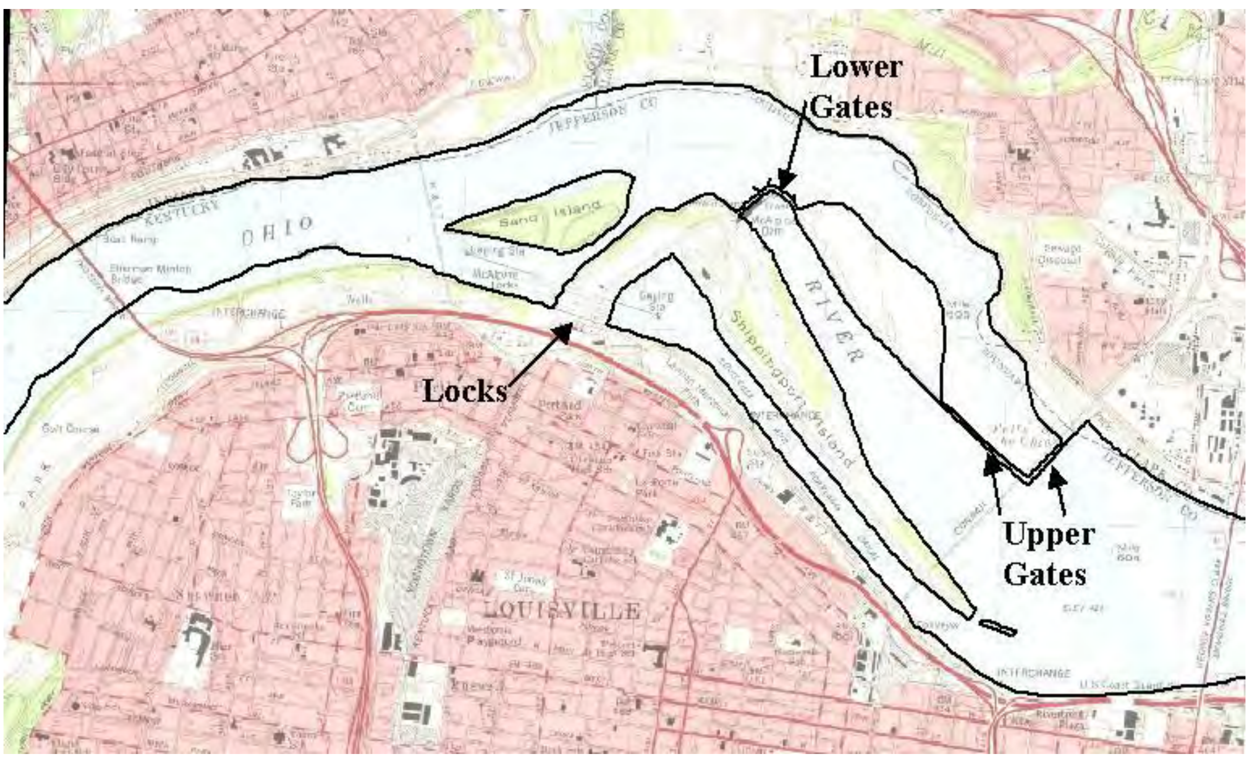
Flow around McAlpine Locks and Dam

The hydrodynamic-water quality model linkage was complicated by the need to incorporate a representation of the McAlpine Locks and Dam and its operating rules into the routings. The area of the river immediately upstream and downstream of McAlpine Locks and Dam (approximately 1.5 miles in either direction) is complex and varies depending on the upstream flow and hydropower needs. Routings through the McAlpine Locks and Dam area were balanced by hand as described below.

McAlpine Locks and Dam consist of structures on the Ohio River extending from river mile 604.4 to river mile 607.4. There are three discharge points, which are illustrated in Figure 2.9.37:

- The lower gates consist of four gates and a number of hydropower units for producing electricity
- The upper gates consist of five gates
- The locks discharge a relatively small portion of the flow

FIGURE 2.9.37 MCALPINE LOCK AND DAM



Each hydropower unit discharges at a rate of several thousand cubic feet per second (cfs) when operating. The remaining flow, other than the Locks, is split between the lower gates and the upper gates depending on the ratio of feet of gate opening for each (that is, one gate open one foot gives one foot of gate opening). Configurations vary based on the time of year, number of hydropower units in operation, etc. Thus, it may not be possible to predict the specific operation of the dam at a given time. However, Table 2.9.17 presents information prepared by the USGS showing typical modes of operating procedure.

TABLE 2.9.17
OPERATING PROCEDURES OBSERVED AT MCALPINE DAM

Discharge, cfs	Lower Gate Opening, ft	Upper Gate Opening, ft	Hydro Units in Operation
200,000	32	65	5
100,000	4	39	6
43,000	7	1	7
36,000	9	0	5
23,000	11	0	1
23,000	2	0	4
16,000	1	0	3
6,500	1	0	1
cfs - cubic feet per second			

A set of empirical equations was developed by regression analysis, based on the data in Table 2.9.17 to predict a reasonably likely operating procedure for a given flow. Equation 1 (r^2 = 0.999) relates flow to hydropower units in operation and feet of gate opening. This equation predicts a discharge of 3,882 cfs from each operating hydropower unit (slightly less than the USGS estimate of 4,000 to 4,400 cfs per unit), a discharge of 1,835 cfs for each foot of total gate opening, plus a constant 951 cfs, which is assigned to the locks discharge.

$$Flow,(cfs) = [3{,}882 * (\#HydroUnits)] + [1{,}835 * (GateOpening, ft)] + 951 \qquad \text{(Eq'n 1)}$$

Equation 2 (r^2 = 0.502) relates the number of hydro units in operation (when the result is rounded to the nearest integer) to the flow.

$$\text{Units} = -10.61 + 1.407 \times (\ln(\text{Flow, cfs} - 951)) \qquad \text{(Eq'n 2)}$$

From equations 1 and 2, the flow through the locks, the hydro units, and the total gate flow is predicted. The remaining variable is the split in gate flow between the lower and upper gates. Equation 3 (r^2 = 0.887) relates the ratio of flow through the lower gates to total gate flow, to the total flow. As in Table 1, no flow is predicted through the upper gates if total flow is less than 36,000 cfs.

$$\frac{\text{Lower Gate}}{\text{Gate Total}} = 1.0 \quad \textit{if} \; (\text{discharge} \leq 36{,}000 \text{ cfs}) \quad \text{(Eq'n 3b)}$$

$$\frac{\text{Lower Gate}}{\text{Gate Total}} = \min\left(1.0,\, 0.1667 + \frac{1.083e9}{(\text{Flow, cfs - 951})^2}\right) \quad \text{(Eq'n 3b)}$$

A spreadsheet was developed which uses the Resource Management Associates-2V to WASP5 flow routing just above the dam, the above equations, and simple hand-developed flow routing relationships to route flow through the dam and downstream to the start of the downstream Resource Management Associates section. The routings generally transport flow to the segment immediately downstream of the segment being routed.

An analysis of routings around the McAlpine Locks and Dam indicates that the fraction of flow through each model segment can be described using routings corresponding to three flow regimes. The low flow routings simulate conditions when the upper gates are closed and are based on the spreadsheet results for a flow of 22,900 cfs, which corresponds to the 25th percentile flow at the USGS Gauge (gauge number 03294500) below McAlpine Locks and Dam. The average flow routings simulate conditions between 36,000 cfs and 70,000 cfs when the upper gates are open but less so than the lower gate openings (see Table 2.9.17). The average flow routings for this flow regime were developed from the spreadsheet results for a flow of 42,150 cfs, the median summer flow based on records at the USGS gauge. High flow routings simulate conditions above 70,000 cfs when the flow is split largely between the hydropower units and the upper gates with only a small fraction of flow going through the lower gates. The high flow routings for this flow regime were developed from the spreadsheet results for a flow of 96,625 cfs, which corresponds to the 75th percentile flow at the USGS gauge below McAlpine Locks and Dam. The choice of representative routing used in the model is dependent on the upstream flow at the boundary of the model domain and can be changed daily.

2.9.6.4 Ohio River Water Quality Model Calibration and Validation

Water quality model calibration consists of performing model simulations for some period of historical conditions for which observed water quality data are available. Model predictions are compared to the observed data to ensure that the model matches observed conditions and, as necessary, certain model parameters are adjusted to allow model predictions to best match observed data. The Ohio River water quality model calibration consisted of two parts, 1) calibration of lateral mixing coefficients to dye survey data, and 2) calibration to observed wet weather Ohio River bacteria concentrations.

ORSANCO conducted two dye surveys in the Ohio River during the Fall of 1999 and Spring of 2000 to determine the magnitude of this mixing under a range of flow conditions. The results from these surveys were used to calibrate dispersion coefficients in the WASP5 water quality model as described below.

The Ohio River Water Quality Model was calibrated to data collected by ORSANCO for four wet weather water quality surveys between 1998 and 2001. The model was originally calibrated for the ORSANCO study, and then improved upon for the LTCP. The landside loadings used in the original version of the Ohio River Water Quality Model were taken from an HSPF-based model named the Louisville/Southern Indiana Water Quality Model (ORSANCO, 24). The Louisville/Southern Indiana Water Quality Model did not explicitly model CSOs, and used regression equations to predict CSO volume as a function of precipitation. Complete documentation of the ORSANCO study is contained in Appendix 2.9.2, Wet Weather Impact Study on the Ohio River (Louisville/Southern Indiana Area). Significant efforts have been made in improving the landside loading inputs to the Ohio River Water Quality Model as part of this LTCP effort. The Beargrass Creek Water Quality Tool (described earlier in this report) was used to calculate all landside loading to Beargrass Creek, as well as their transfer to the Ohio River. The InfoWorks CS (also described earlier in this report) model was used to calculate all direct CSO discharges to the Ohio River.

In the current recalibration phase, the improved landside loads have been applied to the existing model and the model has been rerun. In addition to comparing model output to observed data at specific points in time, specific calibration metrics were defined. Application of these metrics demonstrated that the quality of the current calibration is as better than the original calibration. Complete documentation of the Ohio River Water Quality model is contained in Appendix 2.9.3, Ohio River Water Quality Model Calibration Report.

2.9.6.5 Overview of Ohio River Water Quality Model Results

The Ohio River water quality model was run to predict fecal coliform concentrations in the Ohio River for a series of alternative loading scenarios. Five scenarios were analyzed, corresponding to baseline, zero overflows per year, two overflows per year, four overflows per year, and eight overflows per year. The baseline simulation corresponds to no additional controls, while the remaining simulations reflect the control of CSOs to a given number per year. Simulations were conducted to represent year 2001 environmental conditions.

These simulations reflect loading reductions from Louisville Metro/Jefferson County CSOs that discharge directly to the Ohio River, as well as CSOs that indirectly reach the Ohio River via Beargrass Creek. O'Brien & Gere provided hydrographs for those CSOs discharging directly to the Ohio River for the baseline condition, as well as the two, four, and eight overflows per year conditions. fecal coliform load loading from these CSOs was simulated by applying an assumed Event Mean Concentration of 650,000 colony forming unit (cfu)/100 ml), based upon previous analysis done during the ORSANCO study. TetraTech provided results from their Beargrass Creek Water Quality Tool to represent the total Beargrass Creek load. These loads reflect both CSO and stormwater loading to Beargrass Creek. Upstream boundary concentrations were based on recently observed data, and were set at a concentration of 73 cfu/100 ml when river flows were 200,000 cfs or less, and 655 cfu/100 ml when river flows were greater than 200,000 cfs. All other external loads to the Ohio River (i.e. other tributaries, Indiana CSO and stormwater loads) were left unchanged from the scenario analysis conducted previously for the ORSANCO Ohio River water quality modeling work.

Figure 2.4.21, which summarized of CSO water quality data, demonstrated the high degree variability in observed fecal coliform concentrations throughout the collection system. Average CSO fecal coliform concentrations at individual CSOs are seen to range from less than 100,000 up to 1,000,000 cfu/100 ml. Given the wide range of the observed data between locations, and the fact that most of the data used to derive the 250,000 cfu/100 ml estimate were collected from the Beargrass Creek watershed, the decision was made to maintain the difference in assumed Event Mean Concentrations between CSOs discharging into Beargrass Creek and those discharging directly to the Ohio River. Insufficient data specific to Ohio River CSOs was available to justify changing the previously estimated values for these CSOs and potentially invalidate the calibration of the Ohio River water quality model.

Results were examined at five locations along the length of the Ohio River, in terms of peak concentration and compliance with existing water quality standards. The locations examined are:

- Upstream of the Louisville Metro area
- Immediately upstream of Beargrass Creek
- At the I-65 bridge
- Downtown Louisville Metro
- Below the Morris Forman WQTC
- At the confluence of the Salt River

Results are summarized in Table 2.9.18 in terms of percentage noncompliance with the single sample maximum water quality standard and the maximum concentration during the recreational season (cfu/100 ml). Percent noncompliance with the geometric mean water quality standard was also evaluated and was 0 percent at all locations for all scenarios.

TABLE 2.9.18
SUMMARY OF OHIO RIVER MODEL RESULTS

Location	% Noncompliance with Maximum Standard during Recreational Season					Maximum Concentration during Recreational Season (cfu/100 ml)				
	# of Overflows/Year					# of Overflows/Year				
	Baseline	8	4	2	0	Baseline	8	4	2	0
Upstream	33	33	33	33	33	650	650	650	650	650
Above Beargrass Creek	33	33	33	33	33	9,900	9,900	9,900	9,900	9,900
I-65 Bridge	33	33	33	33	33	6,600	6,700	6,700	6,700	6,700
Downtown	100	33	33	33	33	6,900	5,300	5,300	5,300	5,300
Below Morris Forman WQTC	100	83	83	83	83	100,000	46,000	46,000	46,000	46,000
Confluence Salt River	67	67	67	67	67	56,000	56,000	56,000	56,000	56,000

These results demonstrate that an improvement in water quality is seen both in downtown Louisville Metro and below the Morris Forman WQTC when moving from baseline conditions to a CSO control scenario of eight overflows per year, both in terms of compliance with water quality standards and maximum concentration. Water quality benefits of CSO control are not observed in the Ohio River when reducing CSO overflows to less than eight per year, nor are the benefits observed in the areas upstream and far downstream of Louisville Metro. These results also indicate that elimination of CSOs will not result in compliance with water quality standards at any of the locations investigated, as stormwater sources alone are sufficient to cause water quality standards violations.

TABLE 2.4.5
SUMMARY OF CSO DATA FOR BIOCHEMICAL OXYGEN DEMAND **(BOD), FECAL COLIFORM-AND TSS**

Site		BOD							Fecal							TSS						
Location	Description	No.	Min	Ave	Max	Stdev	Ave-1 Stdev	Ave+1 Stdev	No.	Min	Ave	Max	Stdev	Ave-1 Stdev	Ave+1 Stdev	No.	Min	Ave	Max	Stdev	Ave-1 Stdev	Ave+1 Stdev
C0000008	CSO 206	38	1	45	303	65	0	110	38	1	195060	3000000	568375	1	763435	39	1	162	1540	328	0	490
C0000009	CSO 209	17	1	23	88	28	0	51	30	1	19220	216000	45283	1	64503	17	0	91	713	173	0	264
C0000011	CSO 108 N Unit	6	8	10	11	1	9	11	6	11000	70000	98000	32150	37850	102150	6	32	49	58	10	39	58
C0000012	CSO 108 S Unit	6	9	11	17	3	8	14	6	3200	56333	93000	39784	16549	96117	6	55	66	83	10	56	77
C0000024	CSO 110	39	1	36	138	33	3	69	39	1	999820	34000000	5432671	1	6432491	40	1	129	567	125	4	254
C0000025	CSO 117	28	1	111	430	127	0	238	30	1	232297	2093000	505435	1	737732	28	1	246	1023	246	1	492
C0000026	CSO 125	15	7	193	1330	462	0	655	16	580	267524	1200000	465486	1	733010	15	28	125	538	140	0	265
C0000027	CSO 127	20	1	59	241	67	0	126	26	1	91631	1200000	246505	1	338136	19	1	214	780	219	0	433
C0000028	CSO 140	8	3	28	85	28	0	57	9	430	158067	1200000	391367	1	549433	9	1	118	312	136	0	254
C0000029	CSO 151	32	1	75	434	80	0	155	39	1	159507	1200000	305968	1	465475	33	1	207	797	202	5	408
C0000030	CSO 152	34	1	51	231	55	0	105	35	1	132094	1200000	273698	1	405792	34	0	137	402	120	18	257
C0000031	CSO 153	1	291	291	291				3	120000	120000	120000	0	120000	120000	1	623	623	623			
C0000042	CSO 016															8	1	325	552	210	115	535
C0000043	CSO 019															6	256	413	548	121	292	535
C0000044	CSO 050															11	49	97	176	45	53	142
C0000045	CSO 189															5	256	296	408	63	233	359
C0000046	CSO 190															2	136	164	192	40	124	204
C0000104	CSO 146	3	336	351	367	16	335	367								3	600	698	865	145	553	843
C0000017	CSO 210															11	1	347	660	227	120	573
C0000016	CSO 211															14	1	468	1260	200	168	768

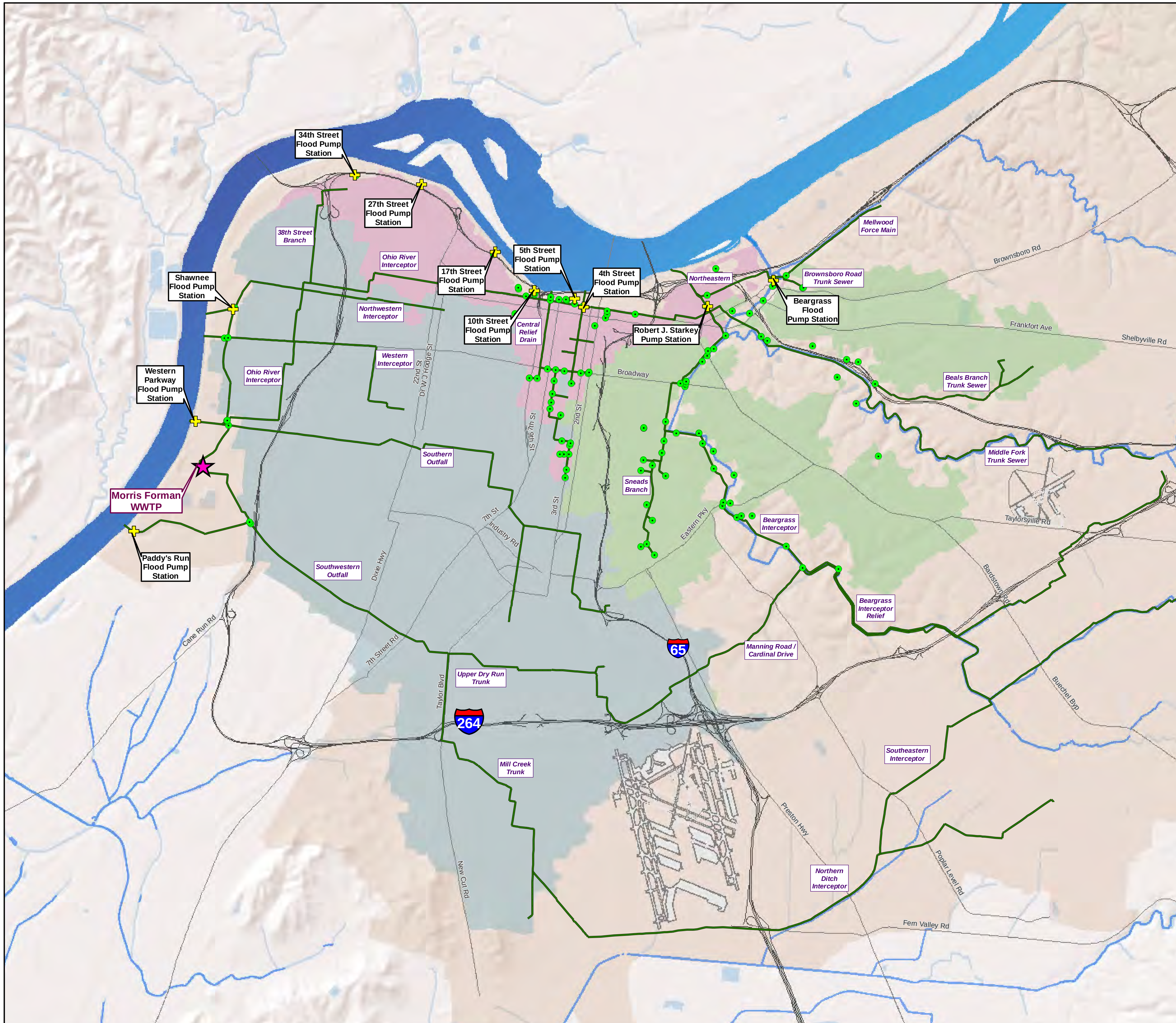
TABLE 2.7.4
OVERALL SUMMARY OF THE RECREATIONAL USE SURVEY RESULTS

Park ID	Park Name	Watershed	# of Site Visits	Total Observed			Avg Observed			Non-Contact Activities			Contact Activities			Contact	% Children	% Potential	% Contact
				Total	Adults	Children	Total	Adults	Children	Total	Adults	Children	Total	Adults	Children	Observed		Contact	
1	**Farnsley - Moremen Landing**	Ohio River	104	962	880	82	10	9	1	939	857	82	23	23	0	1	8.52%	2.29%	0.10%
2	**Riverview Park**	Ohio River	104	2,631	2,411	220	27	24	3	1,630	1,435	195	1,001	976	25	74	8.36%	35.23%	2.81%
3	**Waterfront Park**	Ohio River	104	4,294	3,703	591	42	36	6	3,302	2,751	551	992	952	40	47	13.76%	22.01%	1.09%
4	**Cox Park**	Ohio River	104	4,890	4,677	213	48	45	3	2,434	2,240	194	2,456	2,437	19	71	4.36%	48.77%	1.45%
5	**Louisville Soccer Park**	Muddy Fork BGC	104	829	502	327	9	5	4	827	500	327	2	2	0	1	39.45%	0.12%	0.12%
6	**Cherokee Golf Course - Lexington Rd**	Middle Fork BGC	104	793	783	10	9	8	1	292	291	1	501	492	9	9	1.26%	62.04%	1.13%
	Cherokee Park - Shelter	Middle Fork BGC	104	2,427	2,175	252	24	21	3	2,427	2,175	252	0	0	0	0	10.38%	0.00%	0.00%
8	**Seneca Park - Scenic Loope**	Middle Fork BGC	104	1,220	1,210	10	13	12	1	1,190	1,180	10	30	30	0	0	0.82%	2.46%	0.00%
9	**Seneca Park - Big Rock**	Middle Fork BGC	104	2,096	1,865	231	21	18	3	1,485	1,301	184	611	564	47	267	11.02%	16.41%	12.74%
10	**Seneca Golf Course**	Middle Fork BGC	104	1,799	1,792	7	19	18	1	1,785	1,778	7	14	14	0	1	0.39%	0.72%	0.06%
11	**Brown Park**	-	8	129	129	0	17	17	0	129	129	0	0	0	0	0	0.00%	0.00%	0.00%
12	**Joe Creason Park**	South Fork BGC	104	976	798	178	10	8	2	976	798	178	0	0	0	0	18.24%	0.00%	0.00%
13	**Louisville Junior Academy**	-	8	59	59	0	8	8	0	59	59	0	0	0	0	0	0.00%	0.00%	0.00%
14	**Eva Bandman Park - Ohio River**	Ohio River	94	2,348	2,281	67	26	25	1	2,135	2,068	67	213	213	0	3	2.85%	8.94%	0.13%
15	**Eva Bandman Park - BGC**	BGC Confluence	94	519	519	0	6	6	0	426	426	0	93	93	0	0	0.00%	17.92%	0.00%
16	**Beargrass Creek at Irish Hill**	Middle Fork BGC	32	202	190	12	7	6	1	202	190	12	0	0	0	0	5.94%	0.00%	0.00%
17	**Butchertown Greenway**	BGC Confluence	32	53	52	1	3	2	1	41	40	1	12	12	0	0	1.89%	22.64%	0.00%
		TOTAL =	**1,412**	**26,227**	**24,026**	**2,201**	**299**	**268**	**31**	**20,279**	**18,218**	**2,061**	**5,948**	**5,808**	**140**	**474**	**8.39%**	**20.87%**	**1.81%**

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.3.1
LOCATIONS OF EVALUATED FLOOD PUMP STATIONS



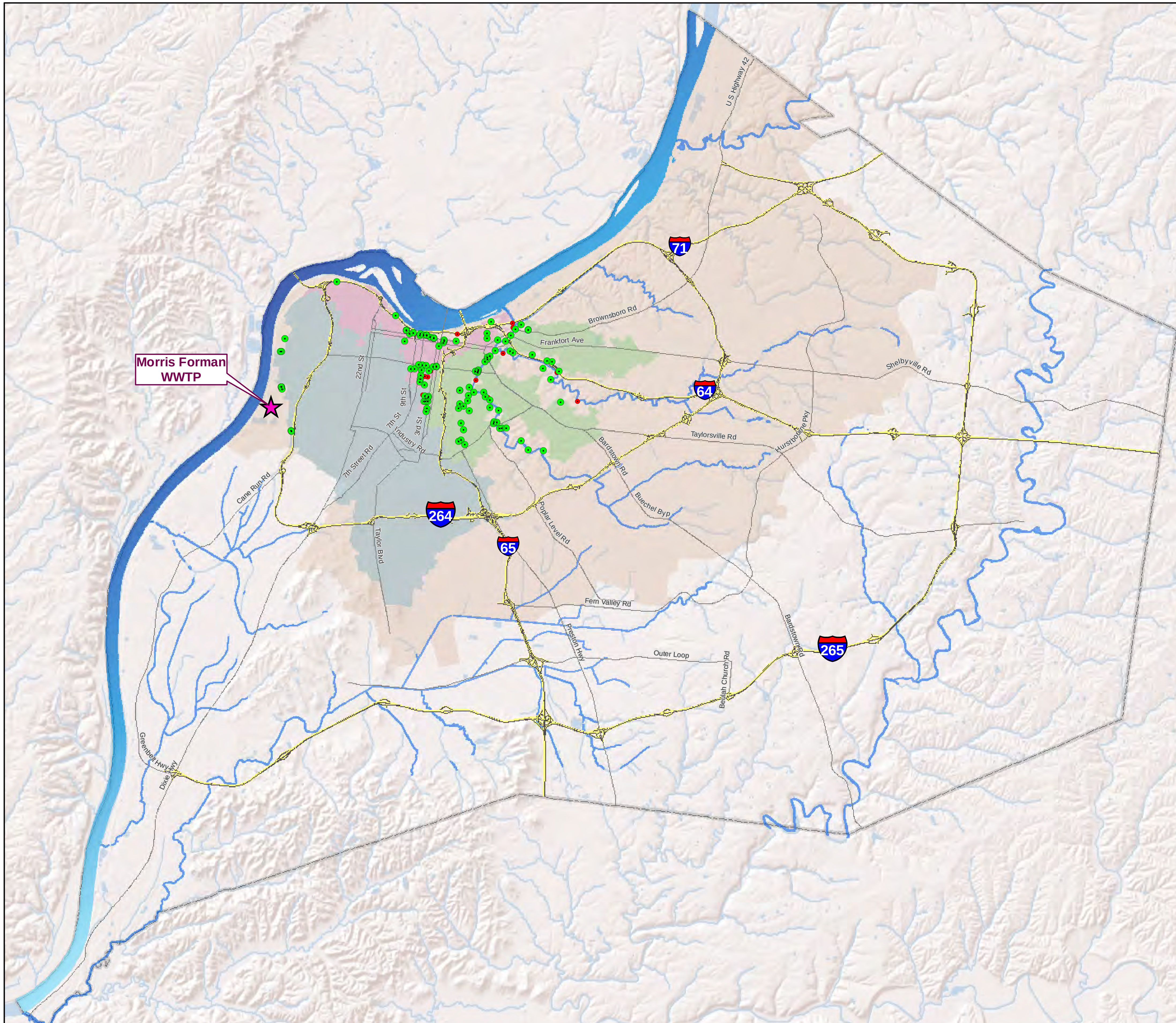
LEGEND

- Active CSO Location
- Flood Pump Station
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD Metropolitan Sewer District PROJECT WIN



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.1
Morris Forman WWTP
SERVICE AREA

LEGEND

- Active CSO Location
- Eliminated CSO Location
- Wastewater Treatment Plant
- Interstate
- Major Road

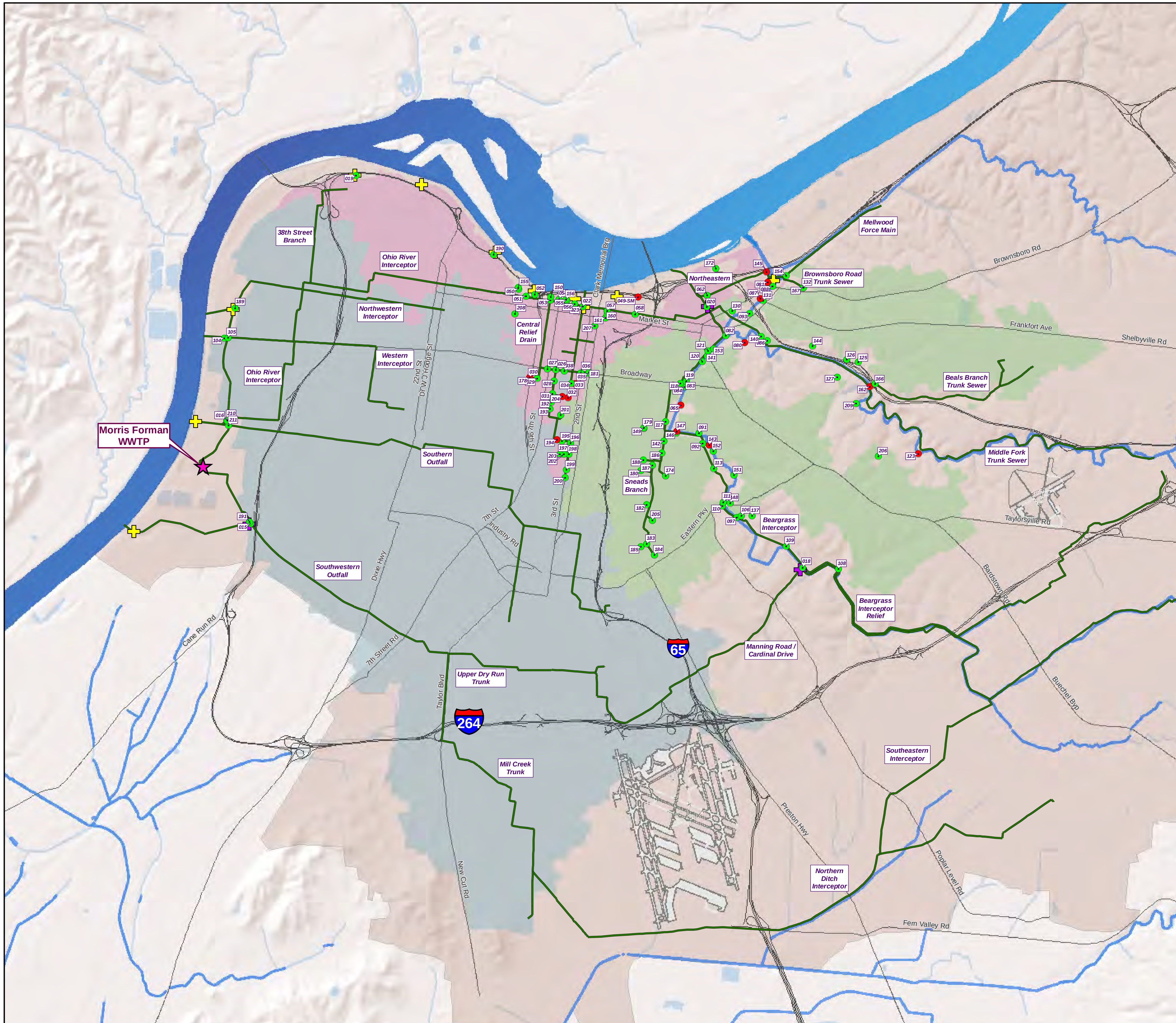
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature
- County Boundary

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.2
COMBINED SEWER SYSTEM REGION



LEGEND

- Active CSO Location
- Eliminated CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

FIGURE 2.4.3
TYPICAL SYSTEM CONSTRICTIONS
BEARGRASS INTERCEPTOR
BEARGRASS CREEK REGION

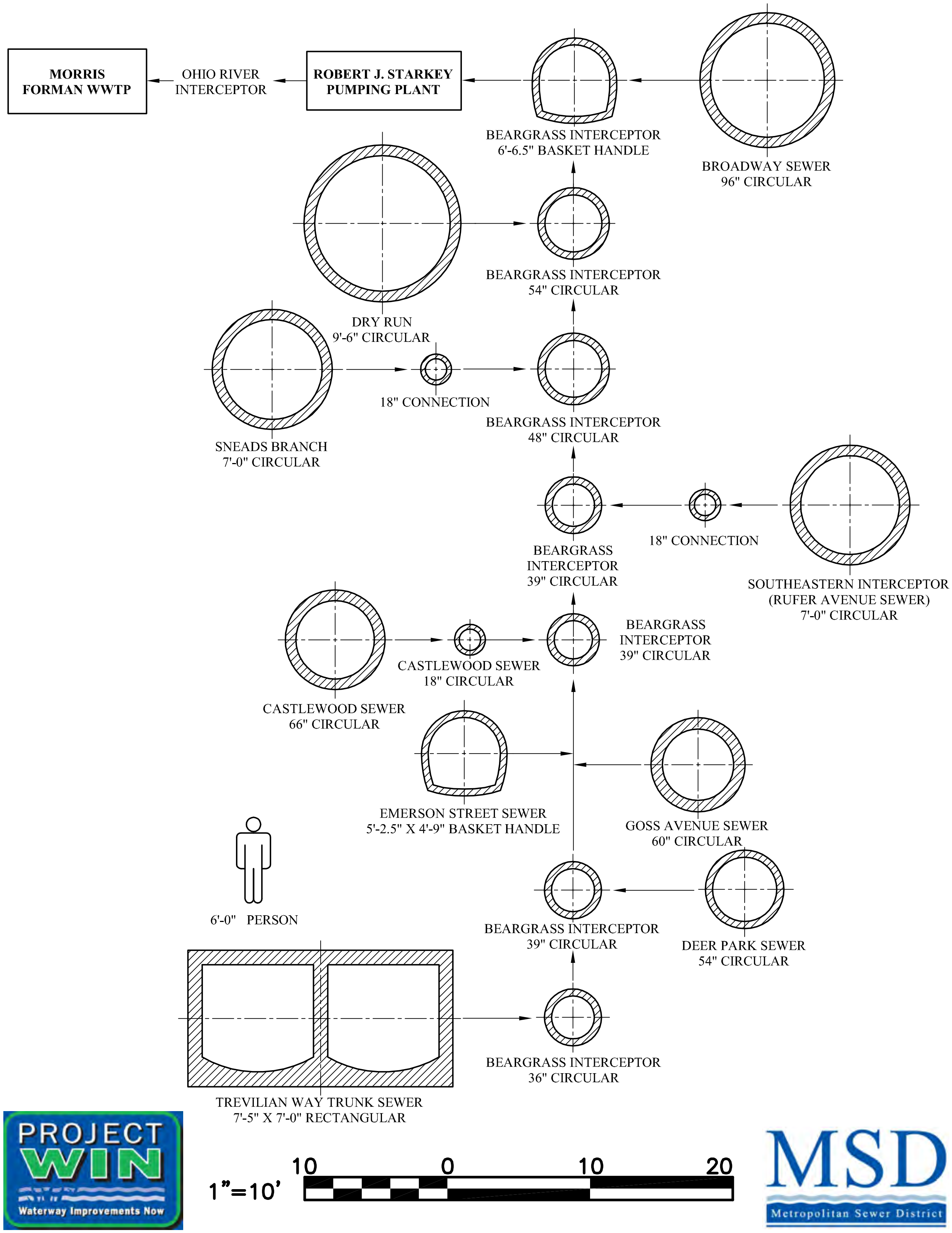
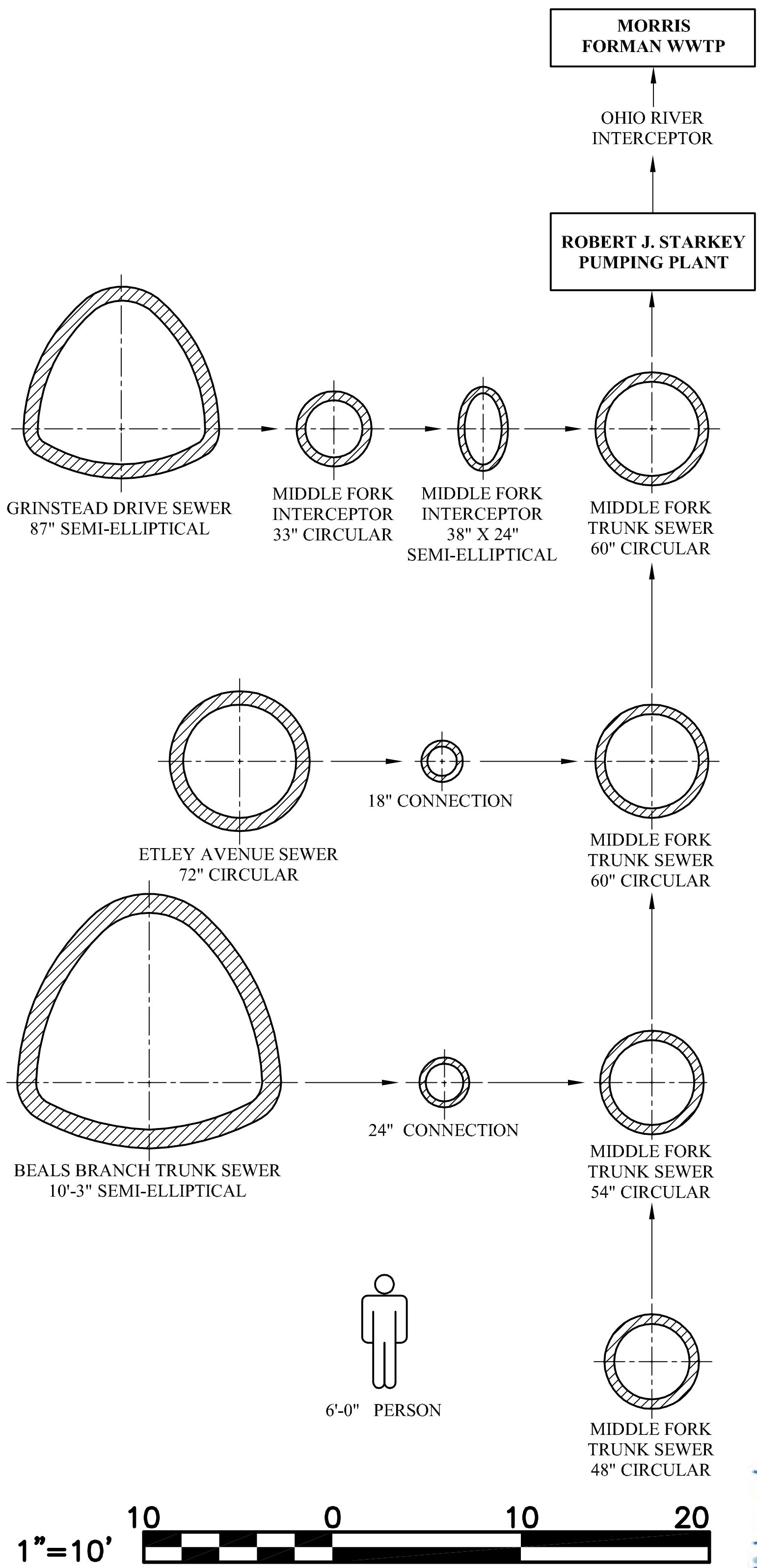


FIGURE 2.4.4
TYPICAL SYSTEM CONSTRICTIONS
MIDDLE FORK TRUNK
BEARGRASS CREEK REGION



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

FIGURE 2.4.5
TYPICAL SYSTEM CONSTRICTIONS
NORTHWESTERN CITY
OHIO RIVER WEST REGION

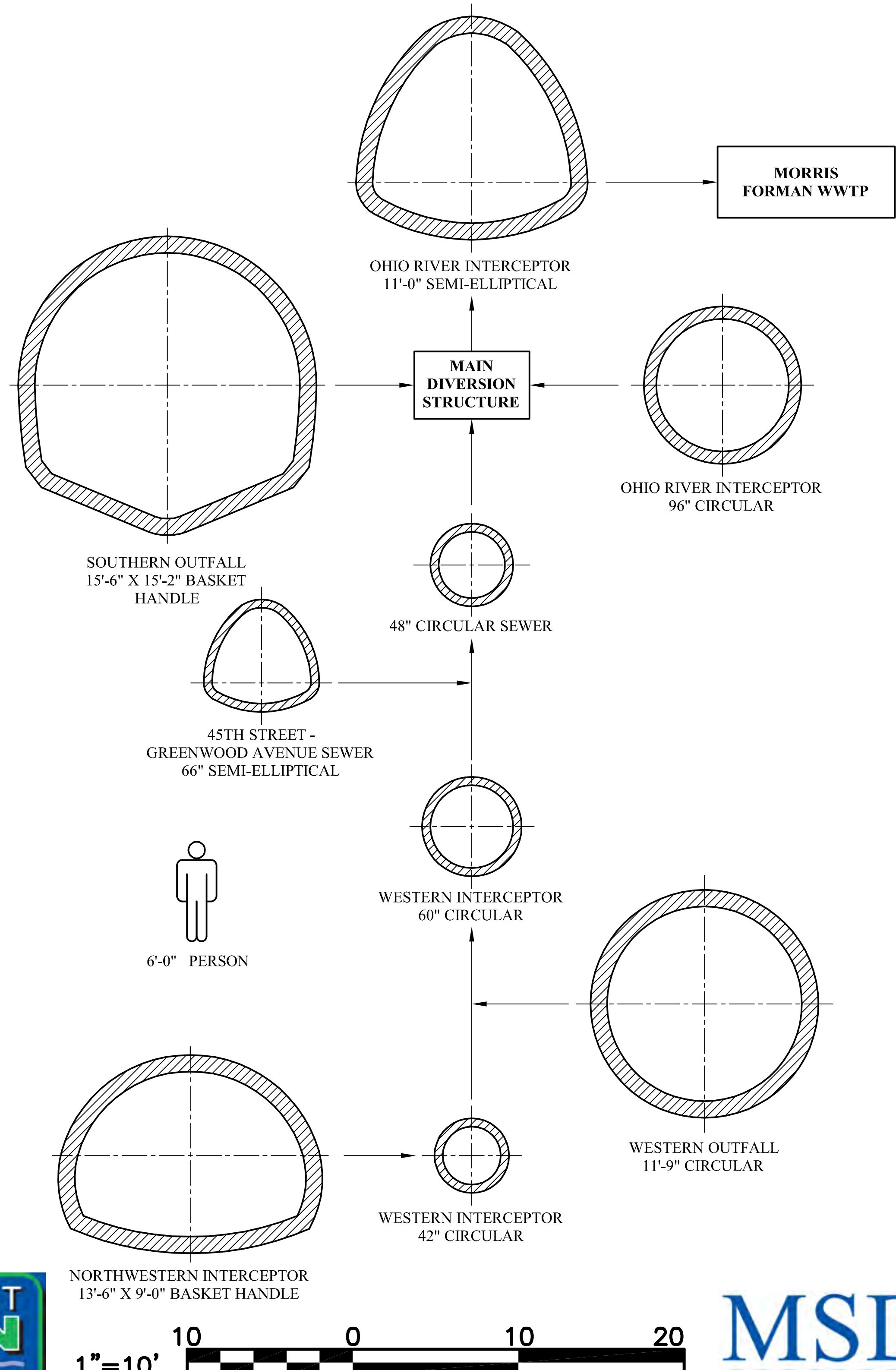
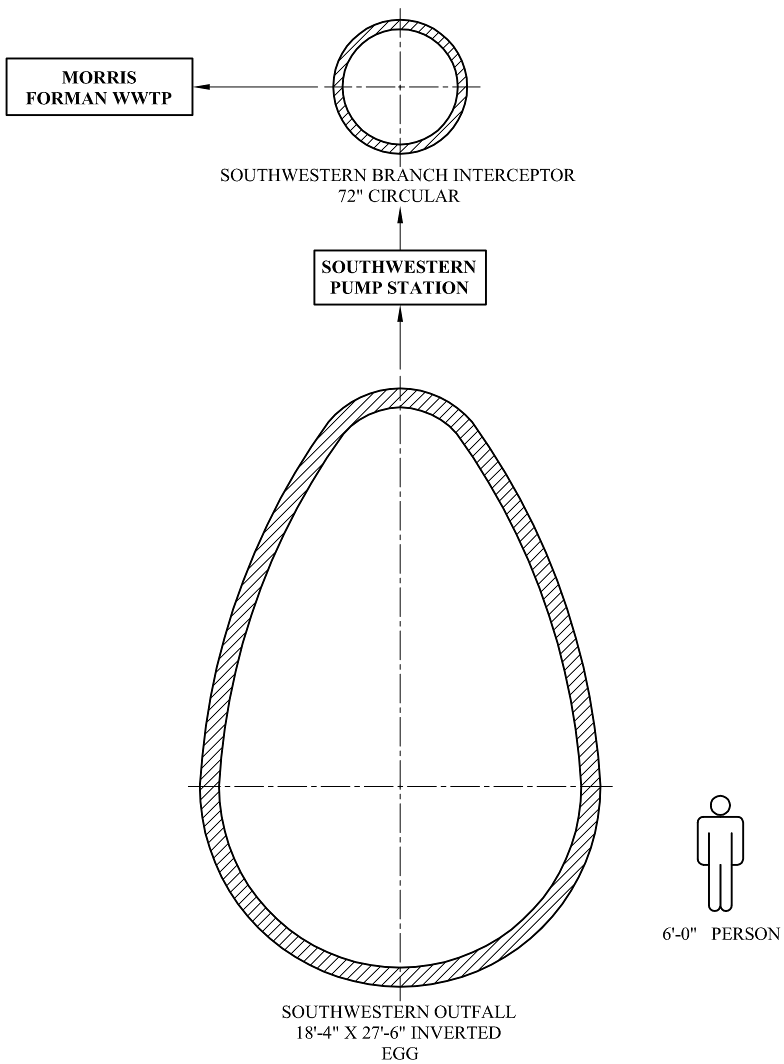
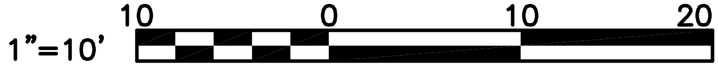


FIGURE 2.4.6
TYPICAL SYSTEM CONSTRICTIONS
SOUTHWESTERN OUTFALL
OHIO RIVER WEST REGION

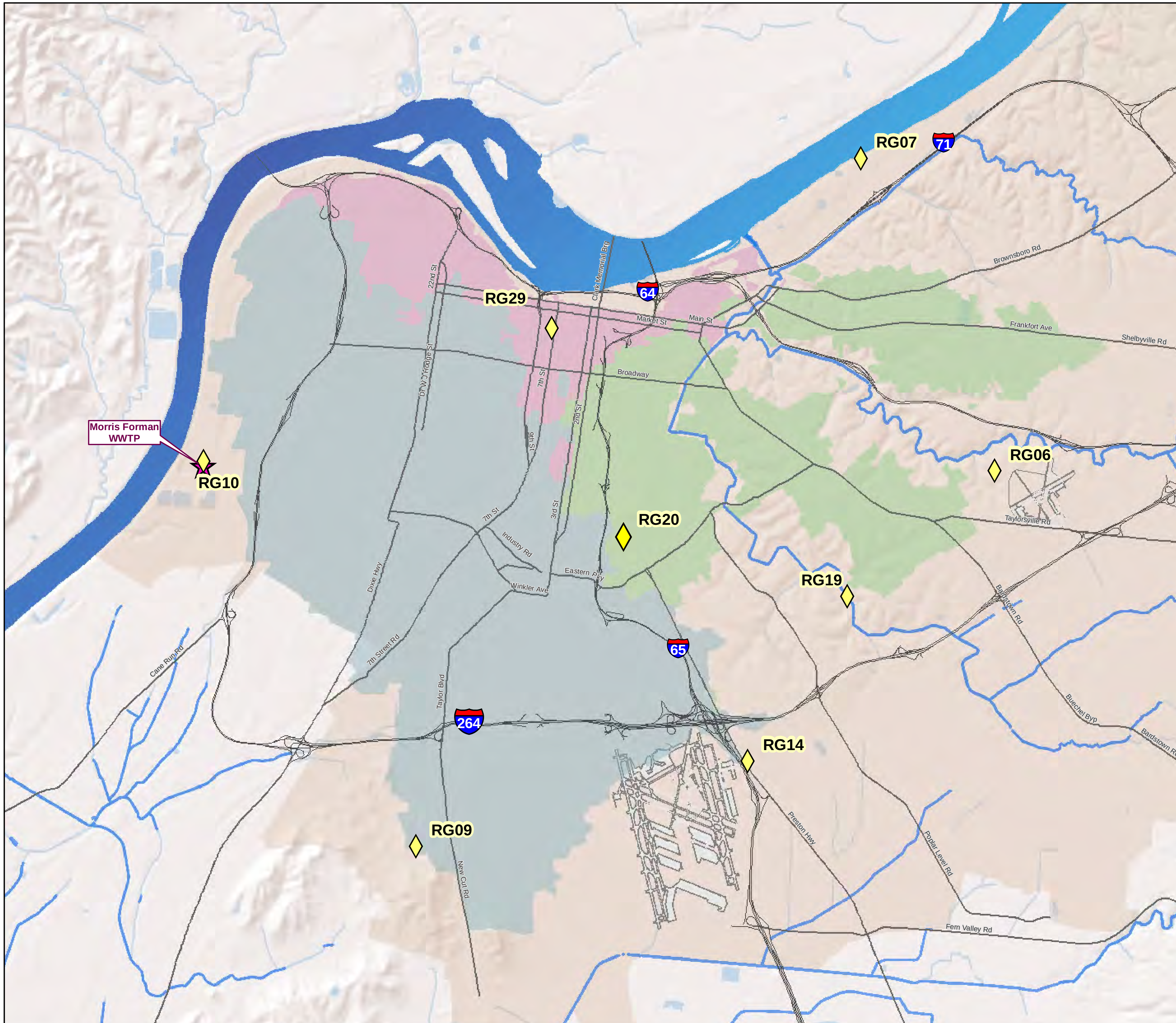




Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.9
ORIGINAL RAIN GAUGE LOCATIONS



LEGEND

- Rain Gauge Location
- Wastewater Treatment Plant
- Interstate
- Major Road

Regional Boundaries

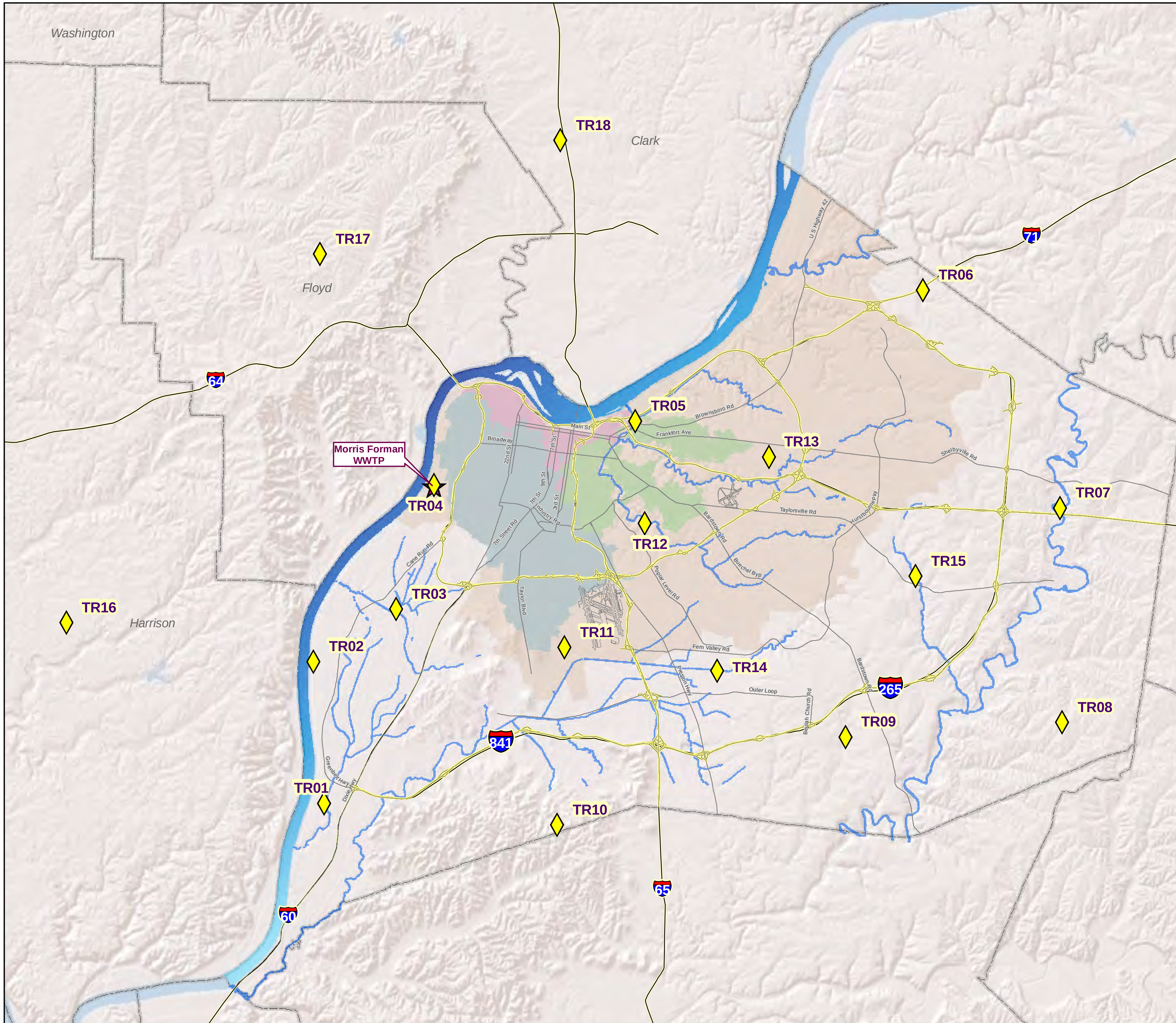
- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD PROJECT WIN

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.10
CURRENT RAIN GAUGE LOCATIONS



LEGEND

- Rain Gauge Location
- Wastewater Treatment Plant
- Interstate
- Major Road

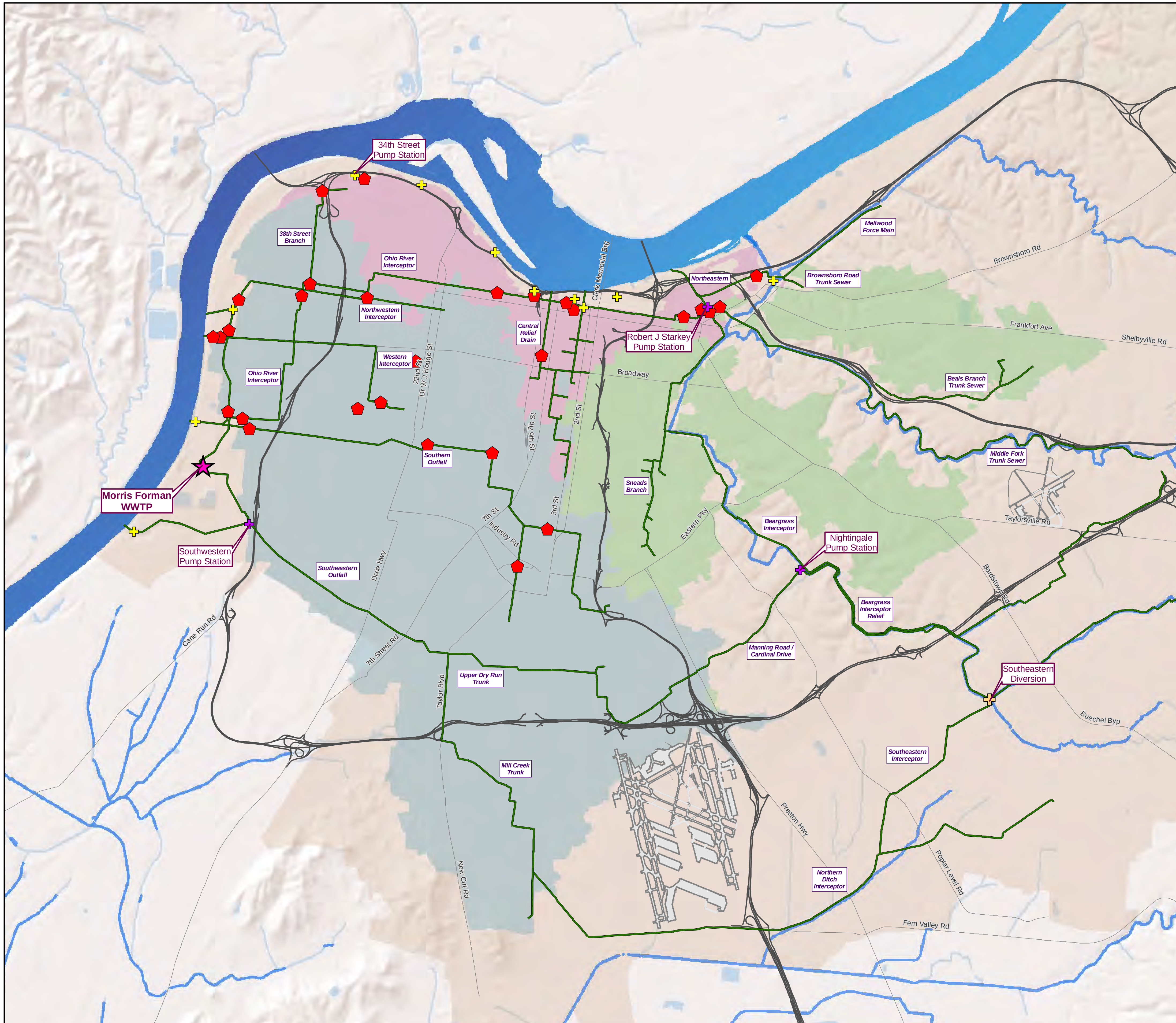
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature
- County Boundary

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.12
1992 PHASE I
FLOW MONITORING LOCATIONS



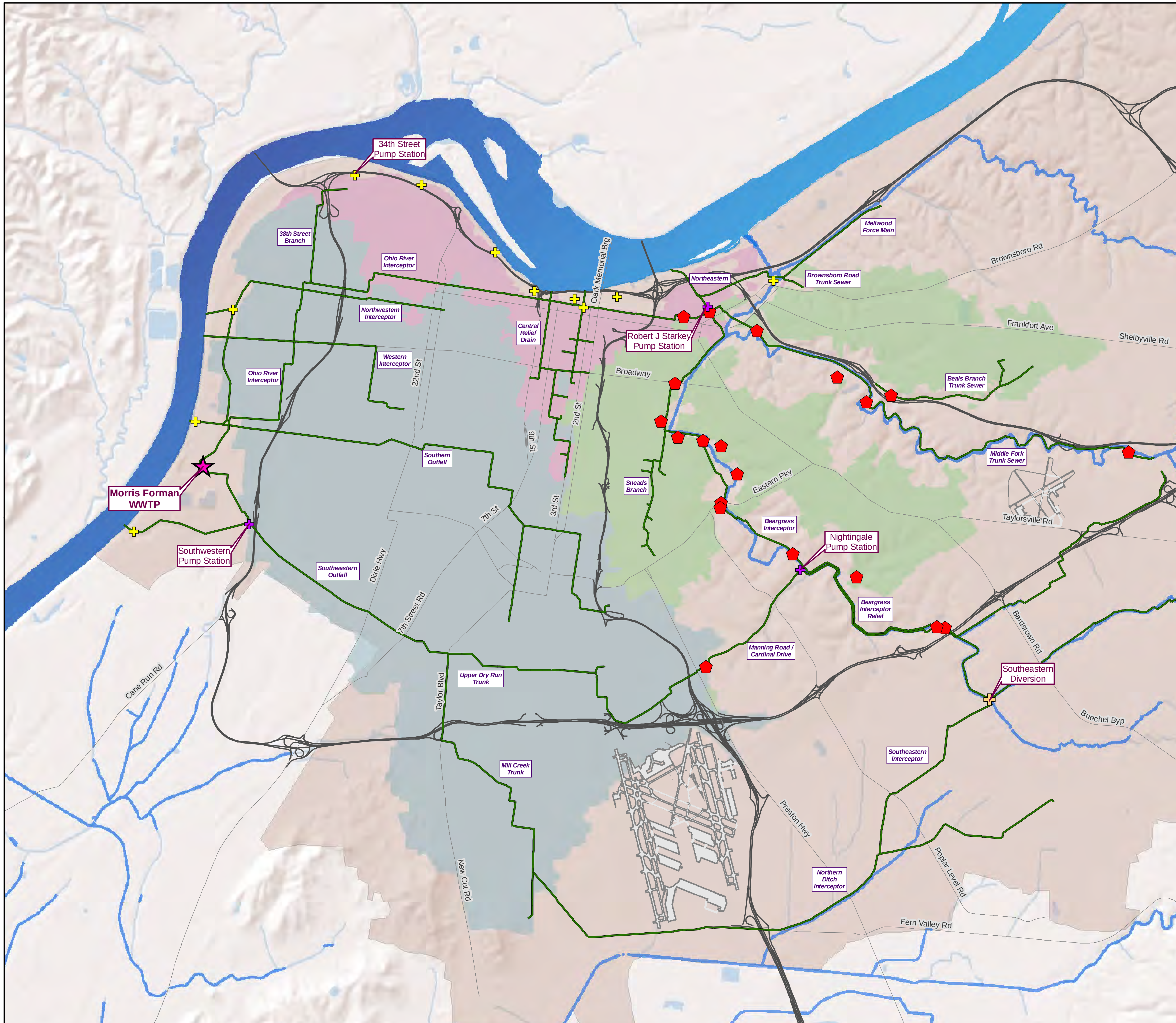
LEGEND

- 1992 Phase I Flow Monitoring Location
- Flood Pump Station
- Sanitary Pump Station
- Southeastern Diversion
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD PROJECT WIN



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.13
1992 PHASE II
FLOW MONITORING LOCATIONS

LEGEND

- Flood Pump Station
- Sanitary Pump Station
- Southeastern Diversion
- 1992 Phase II Flow Monitoring Location
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

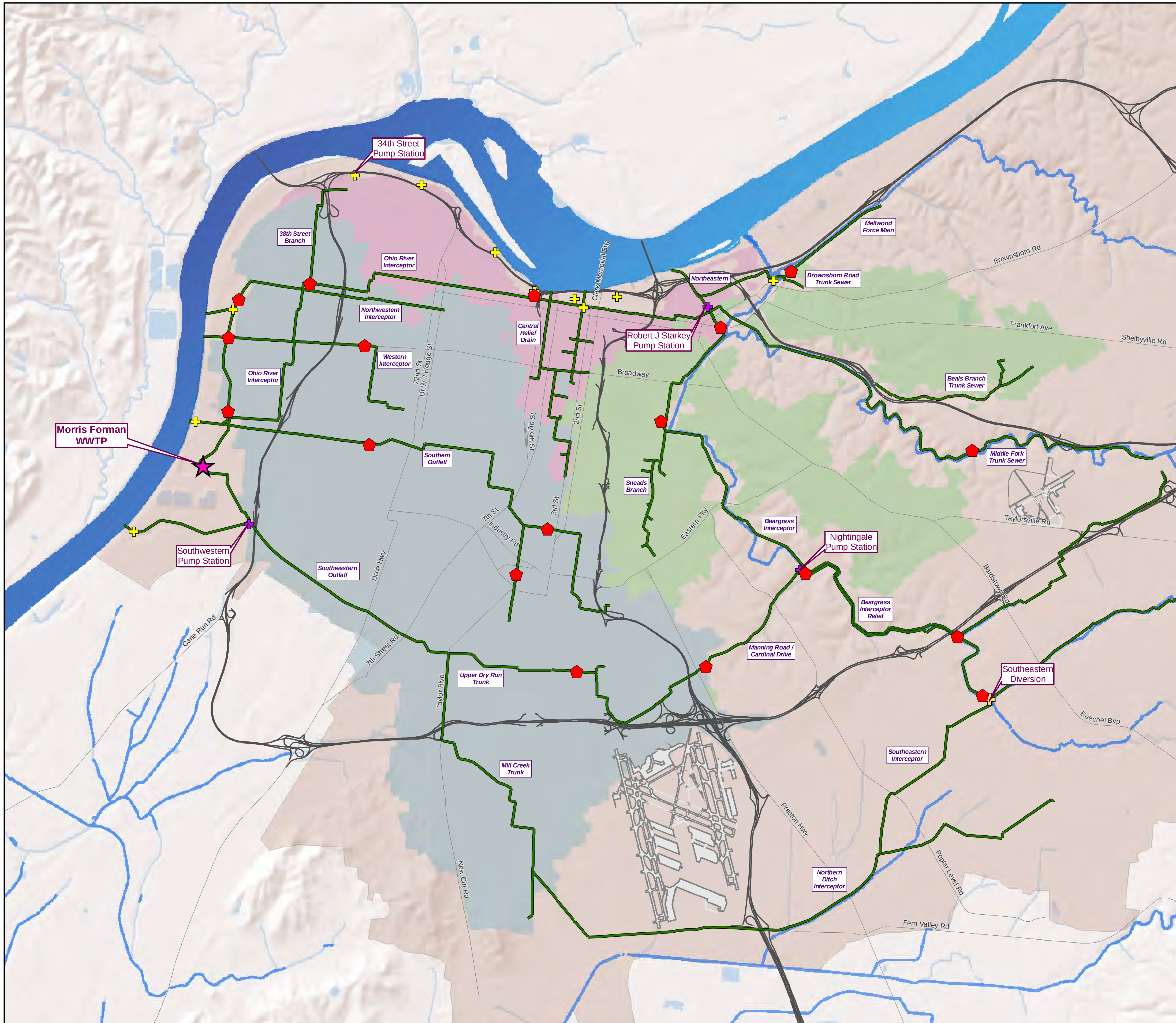
O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\2.4.13 1992 Phase 2 Flow Monitoring Location Map.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.14
2002
FLOW MONITORING LOCATIONS



LEGEND

- 2002 Flow Monitoring Location
- Flood Pump Station
- Sanitary Pump Station
- Southeastern Diversion
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

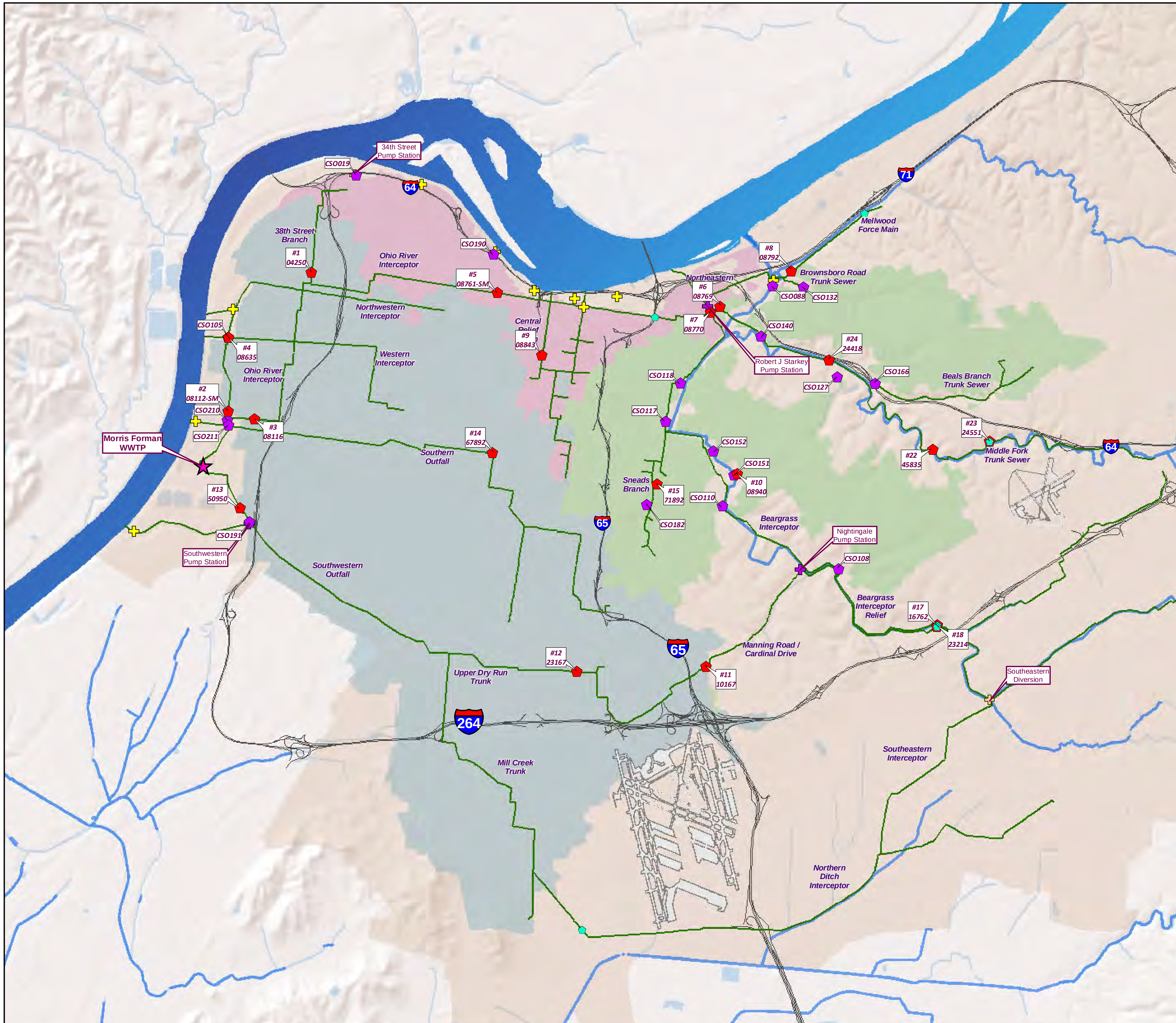
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.15
2007 FLOW MONITORING LOCATIONS



LEGEND

- In-System Flow Monitoring
- Overflow Monitoring
- Upstream Boundary
- Flood Pump Station
- Sanitary Pump Station
- Southeastern Diversion
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD PROJECT WIN

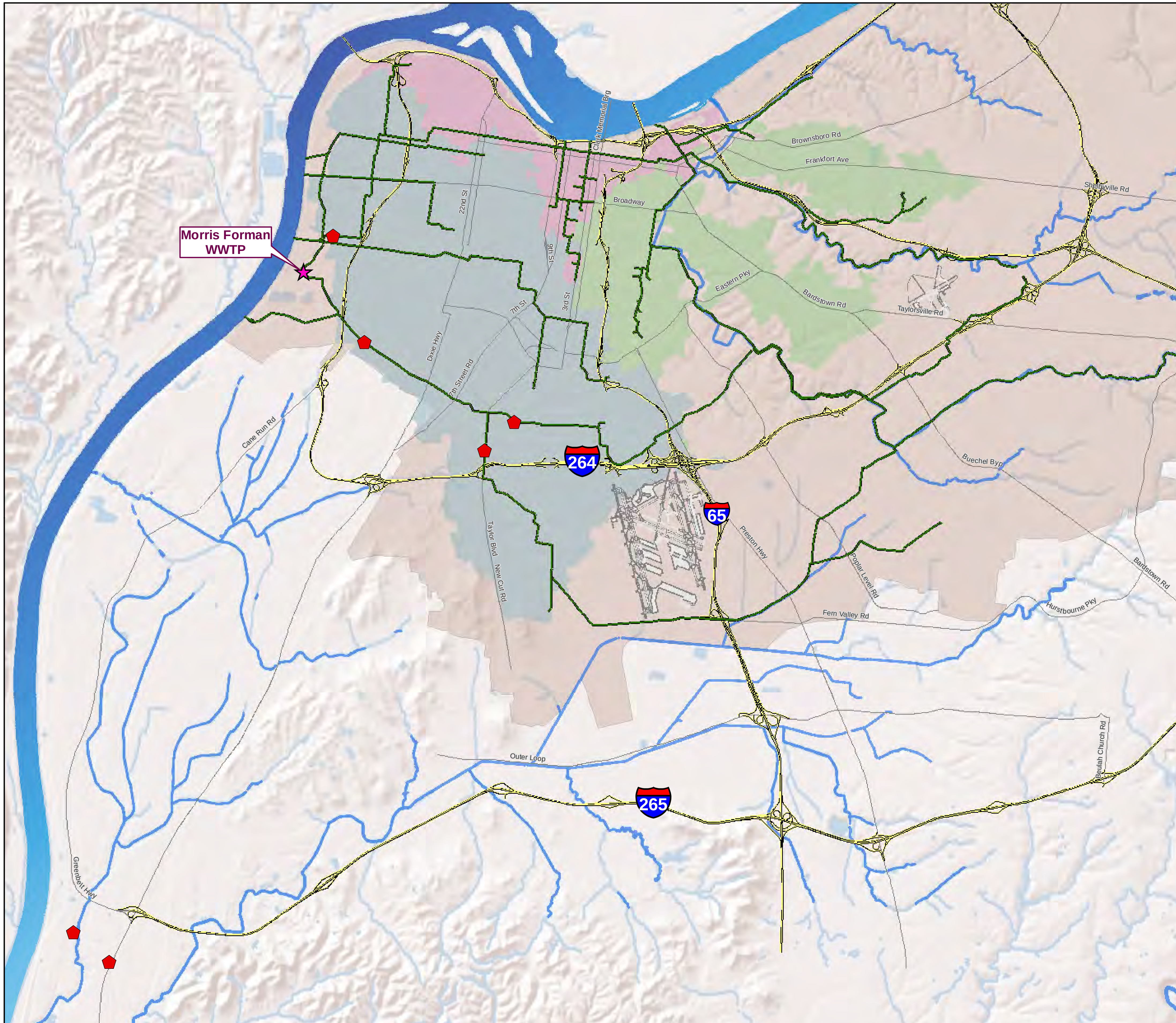
O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\2.4.15 2007 Flow Monitoring Locations.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.16
PERMANENT FLOW MONITORING LOCATIONS



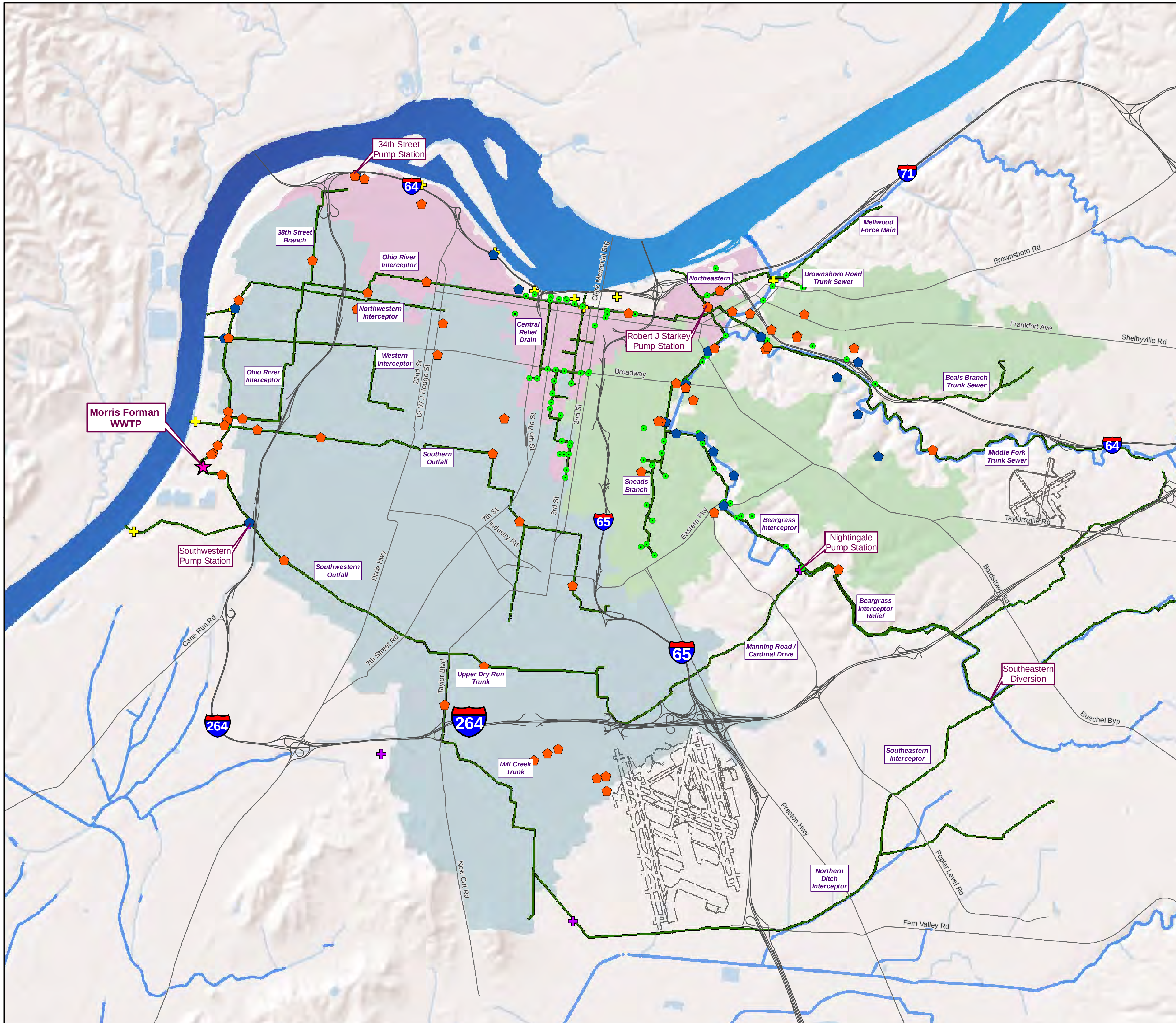
LEGEND

- Permanent Flow Monitoring Location
- Wastewater Treatment Plant
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD Metropolitan Sewer District PROJECT WIN



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.17
CSO AND CSS
SAMPLING LOCATIONS

LEGEND

- CSS Sampling Locations
- CSO Sampling Locations
- Active CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

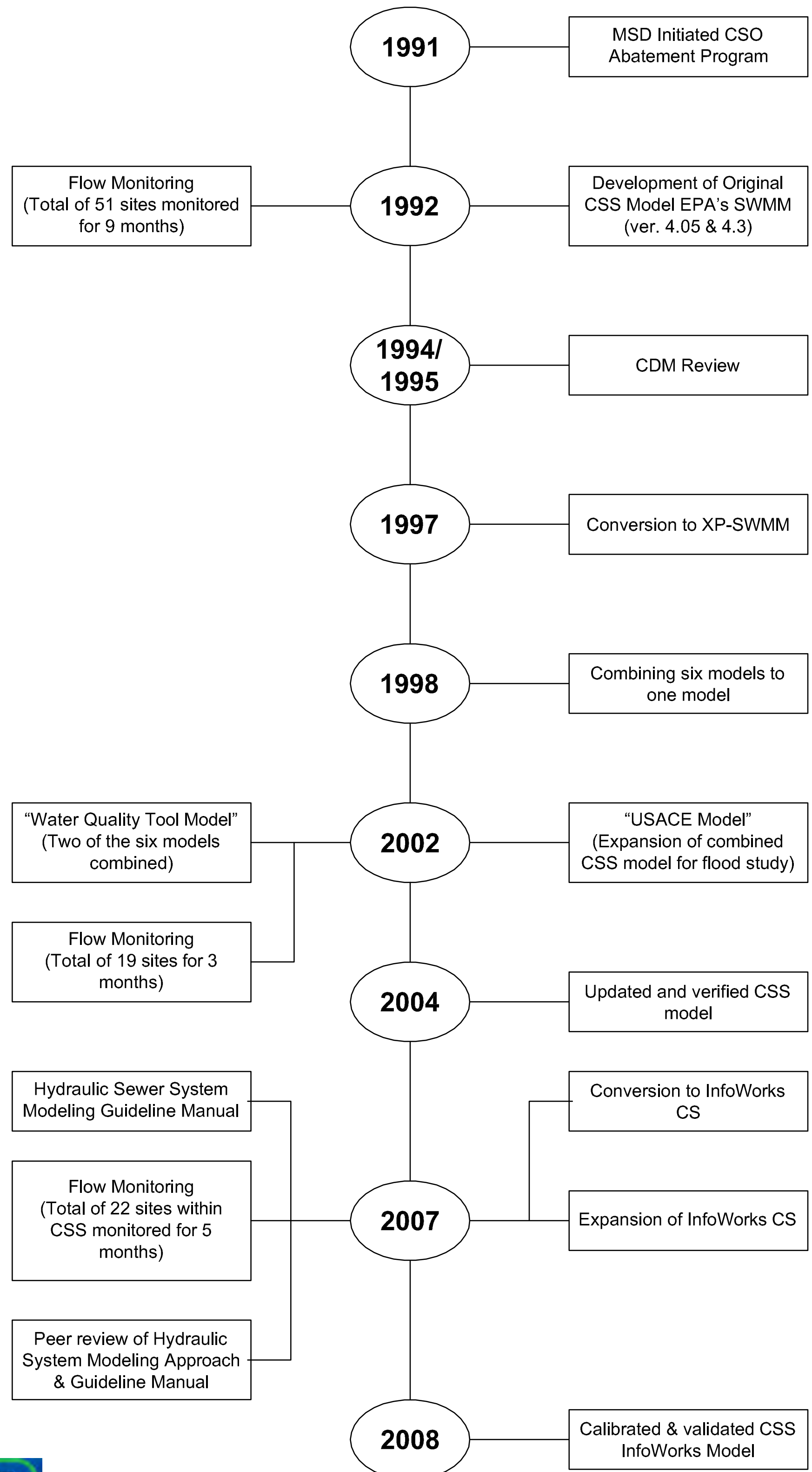
- Beargrass Creek
- Ohio River North
- Ohio River West
- Water Feature

LOJIC MSD Metropolitan Sewer District PROJECT WIN

O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\2.4.17 CSO and CSS Sampling Locations Map.mxd

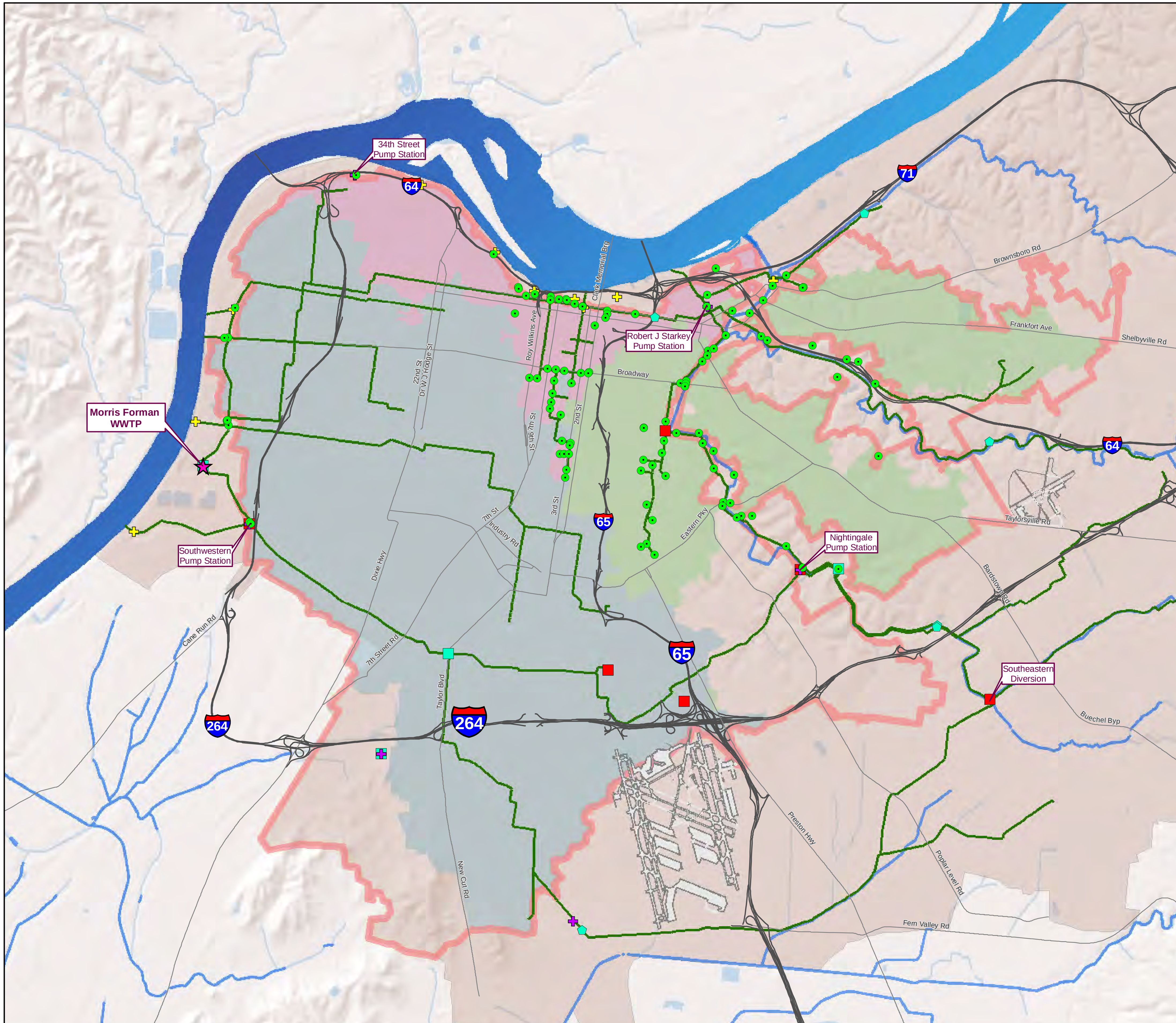
This document was developed in color. Reproduction in black and white may not represent the data as intended.

FIGURE 2.4.26
CSS MODEL HISTORY



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.4.27
COMBINED SEWER SYSTEM MODEL AREA

LEGEND

- Upstream Boundary
- Real Time Control Phase 1
- Real Time Control Phase 2
- Active CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

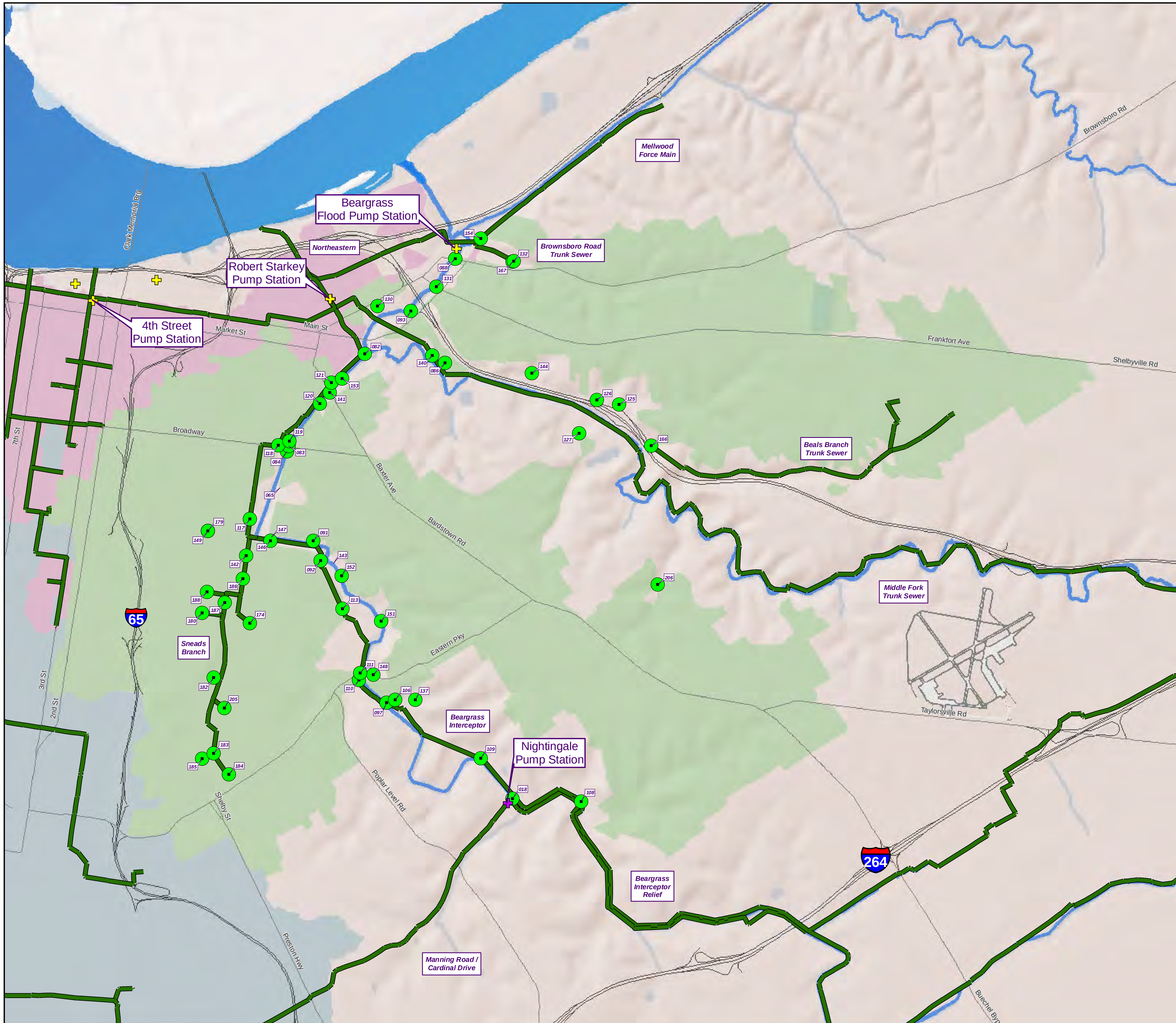
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- CSS Modeling Boundary
- Morris Forman Service Area
- Water Feature

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.5.1
BEARGRASS CREEK
REGION



LEGEND

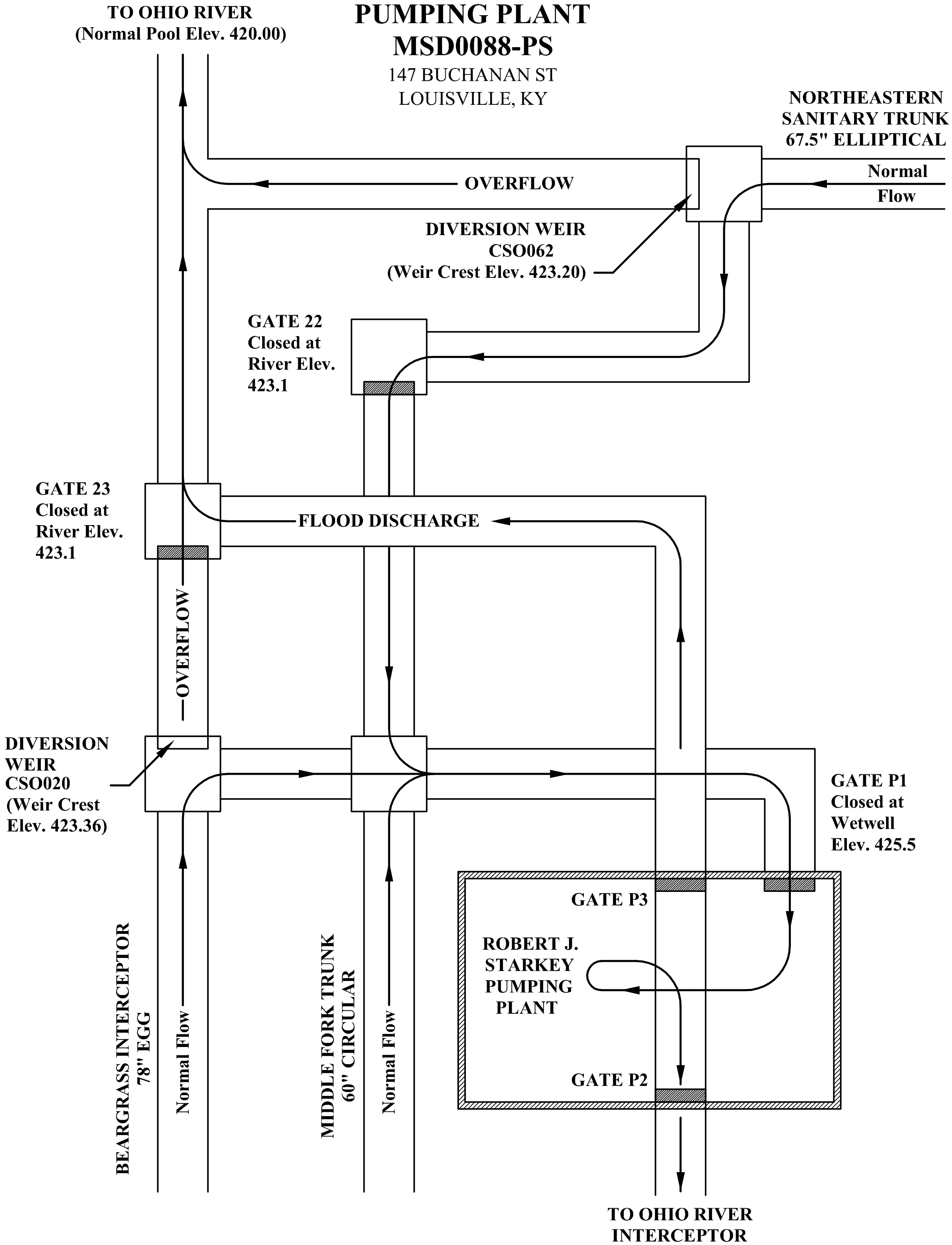
- Active CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

FIGURE 2.5.2
ROBERT J. STARKEY PUMPING PLANT
MSD0088-PS

147 BUCHANAN ST
LOUISVILLE, KY

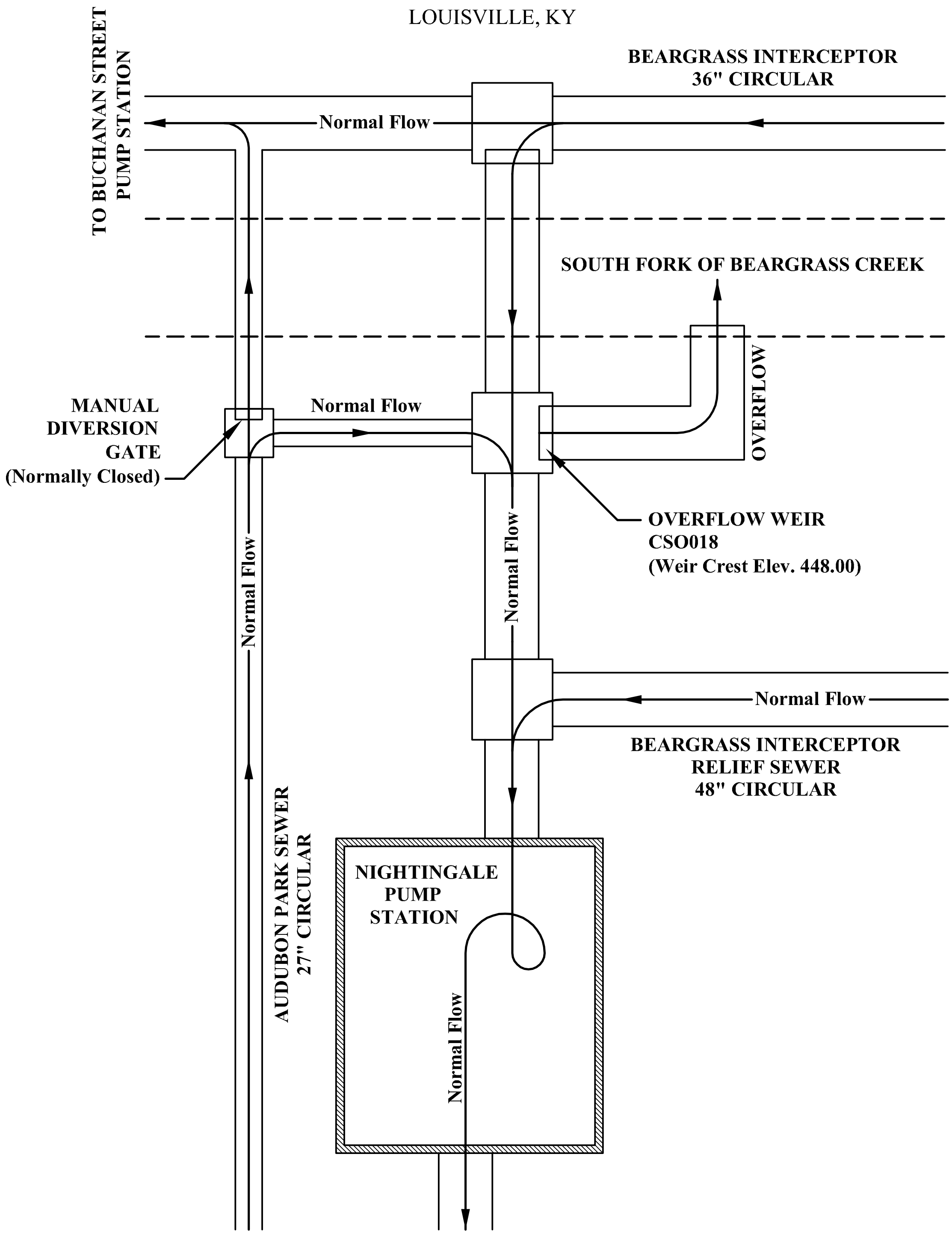


PROJECT WIN
Waterway Improvements Now

MSD
Metropolitan Sewer District

FIGURE 2.5.3
NIGHTINGALE PUMP STATION
MSD0022-PS

1800 NIGHTINGALE RD
LOUISVILLE, KY



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

FIGURE 2.5.4
CSO SAMPLE DATA SHEET

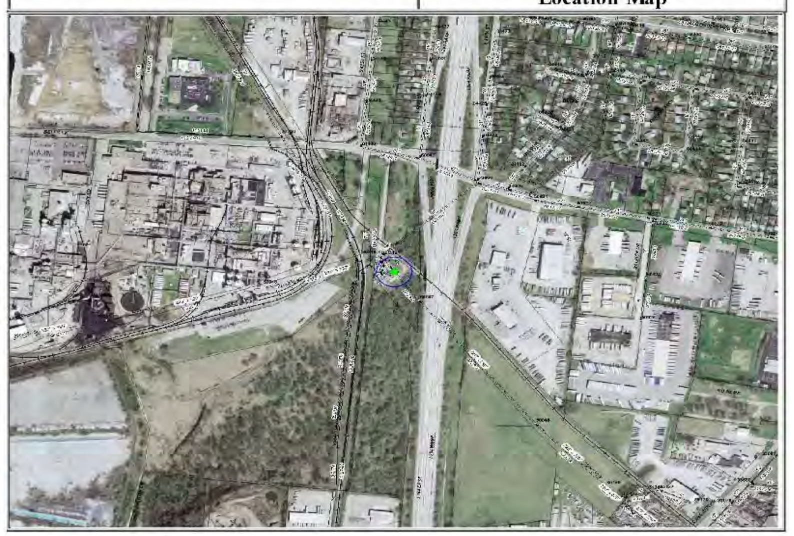
CSO Inspection Sheets

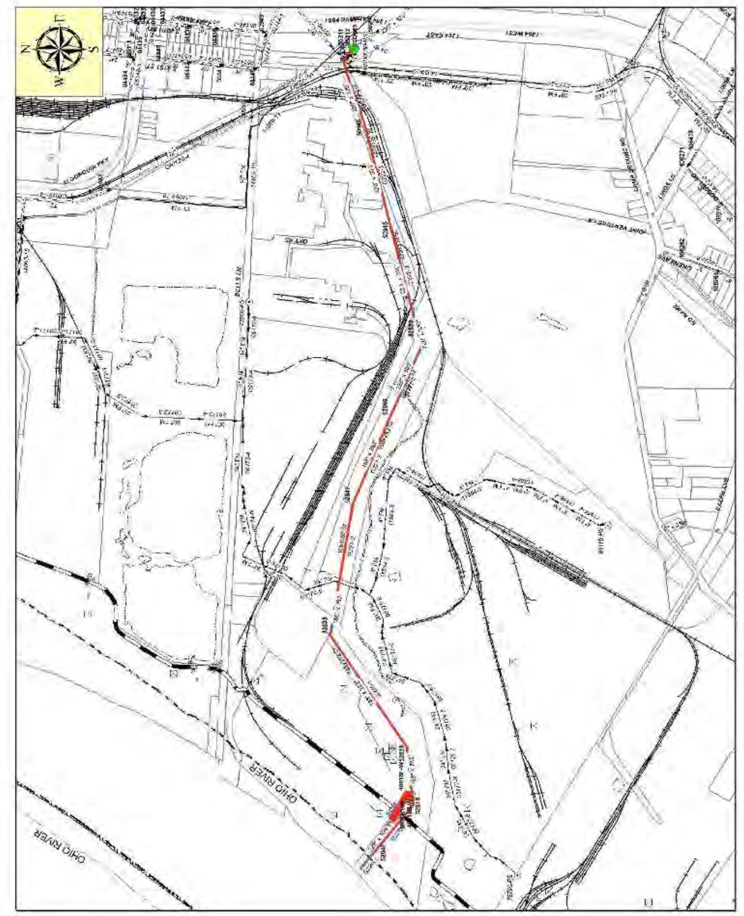
MSD
Louisville-Jefferson County Metropolitan Sewer District

CSO015
4010 BELLS LN
Report as of 10/21/2008

Record#: ORI89-3
MSD Atlas: BC212
Map#: MAL17

Location Map





MSD

PROJECT WIN

CSO 2008 Baseline Characteristics Report

CSO Number: CSO015

CSO Name:	Southwestern Pump Station
Overflow Type:	Diversion Dam
Solids and Floatables Device:	Baffle
Drainage Area (Acres):	7,496.70
Percent Impervious Surfaces:	47.47%
Receiving Stream:	Ohio River
General Location:	Ohio River West
2008 AAOV (in MG/ Yr):	494.56
Number of Overflow Incidents (in Number / Yr):	61
Average Duration of Overflow (in Hours):	7.23
Average Volume per Incident (in 1000 G / Incident):	8,107.52
Residential Landuse:	50.91%
Commercial Landuse:	10.34%
Industrial Landuse:	16.68%
Parks:	2.47%
Vacant Property:	11.03%
Population Estimate:	51,487

Based on LOJIC data as of June 2008 and InfoWorks Version 8 baseline characteristics.
CSOs listed having 0.00 Drainage Areas serve as system relief points.
While a CSO may display 0.00 AAOV, note that this is based on typical year rainfall data.

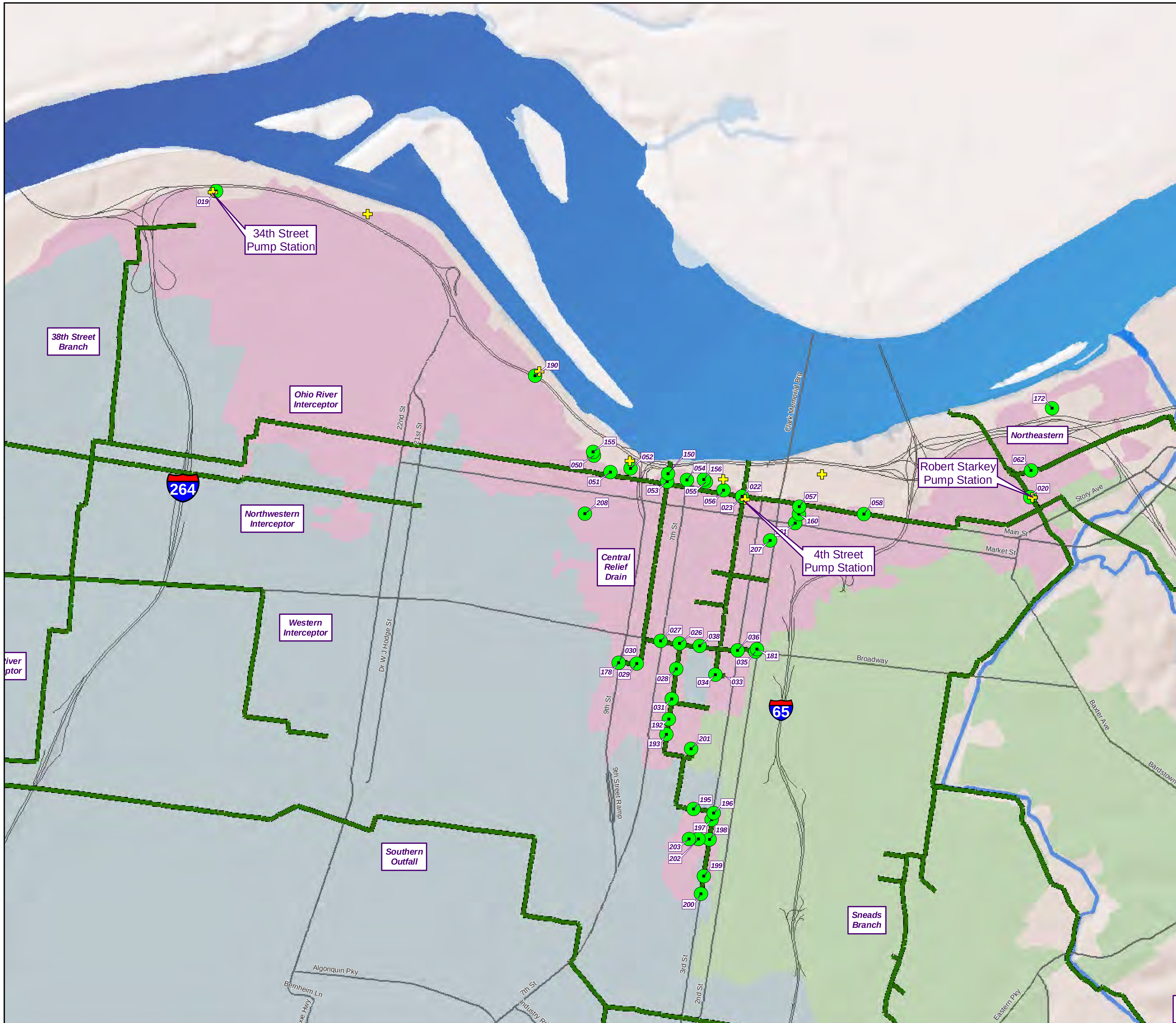
Monday, October 20, 2008 Page 1 of 1

LOJIC MSD Metropolitan Sewer District PROJECT WIN

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.6.1
OHIO RIVER NORTH REGION



LEGEND

- Active CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

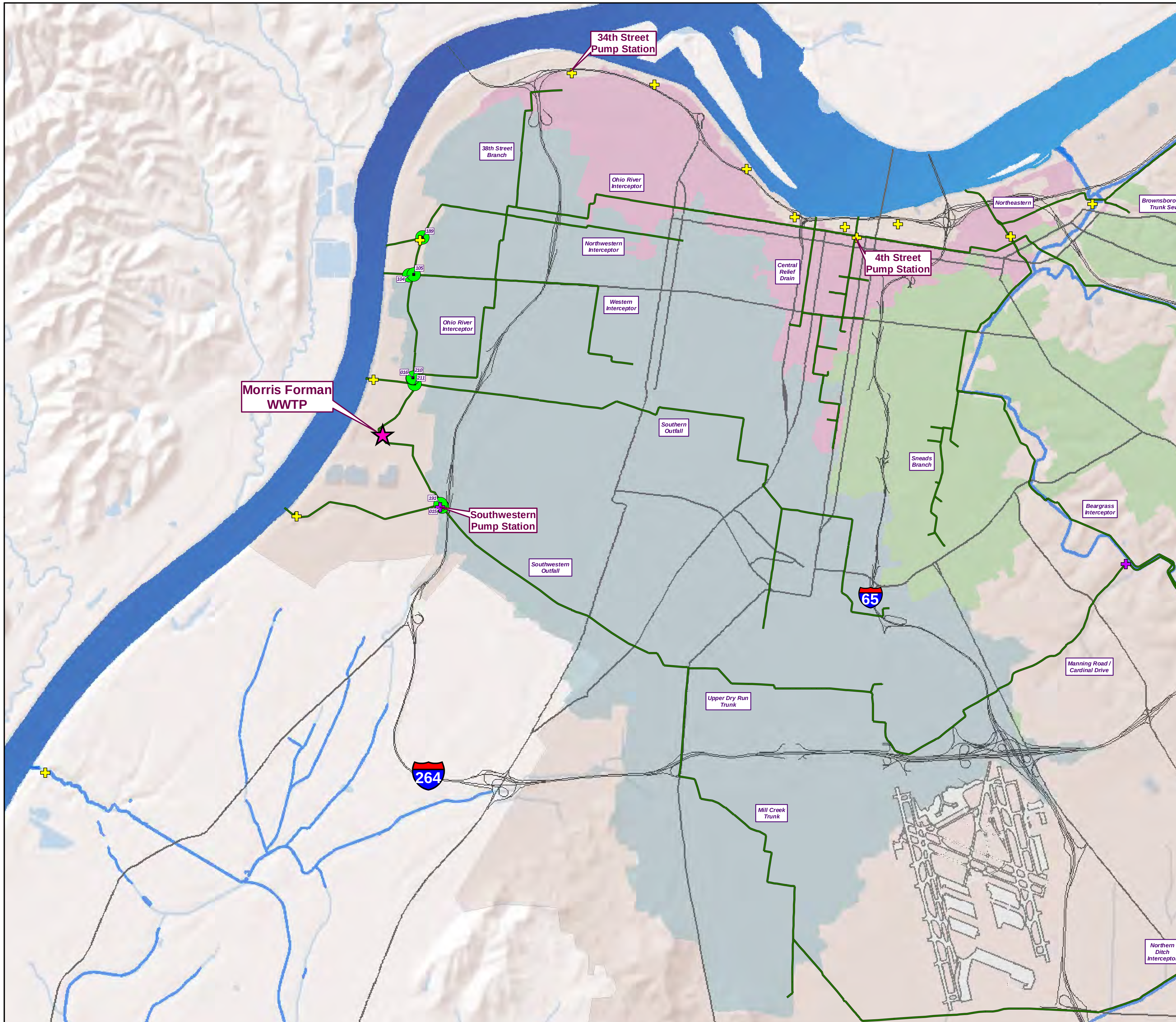
LOJIC MSD PROJECT WIN

O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\2.6.1 Ohio River North Regional Map.mxd

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.6.2
OHIO RIVER WEST REGION



LEGEND

- Active CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

FIGURE 2.6.3
FOURTH STREET PUMP STATION
MSD0087-PS

342 WEST MAIN STREET
LOUISVILLE, KY

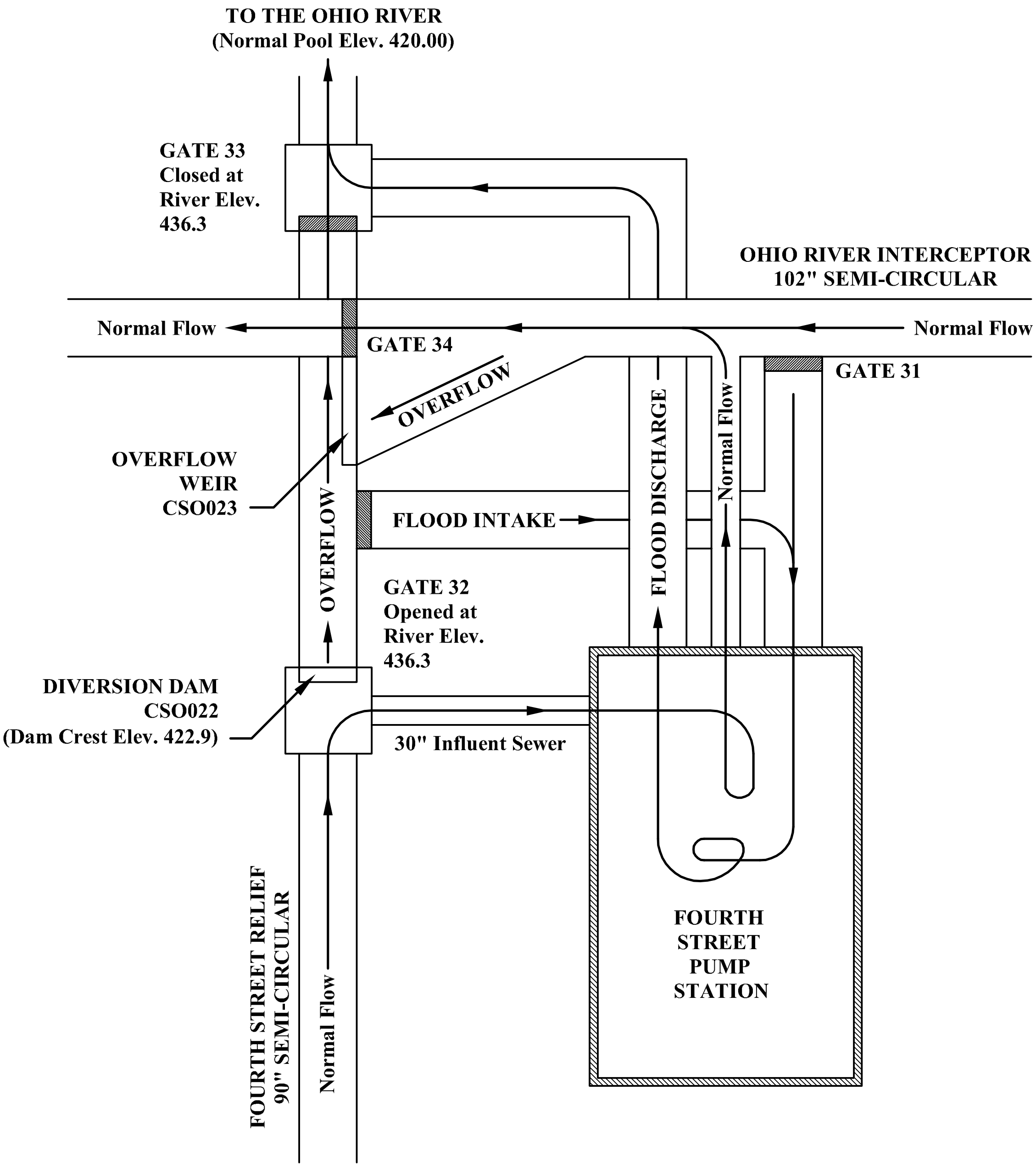
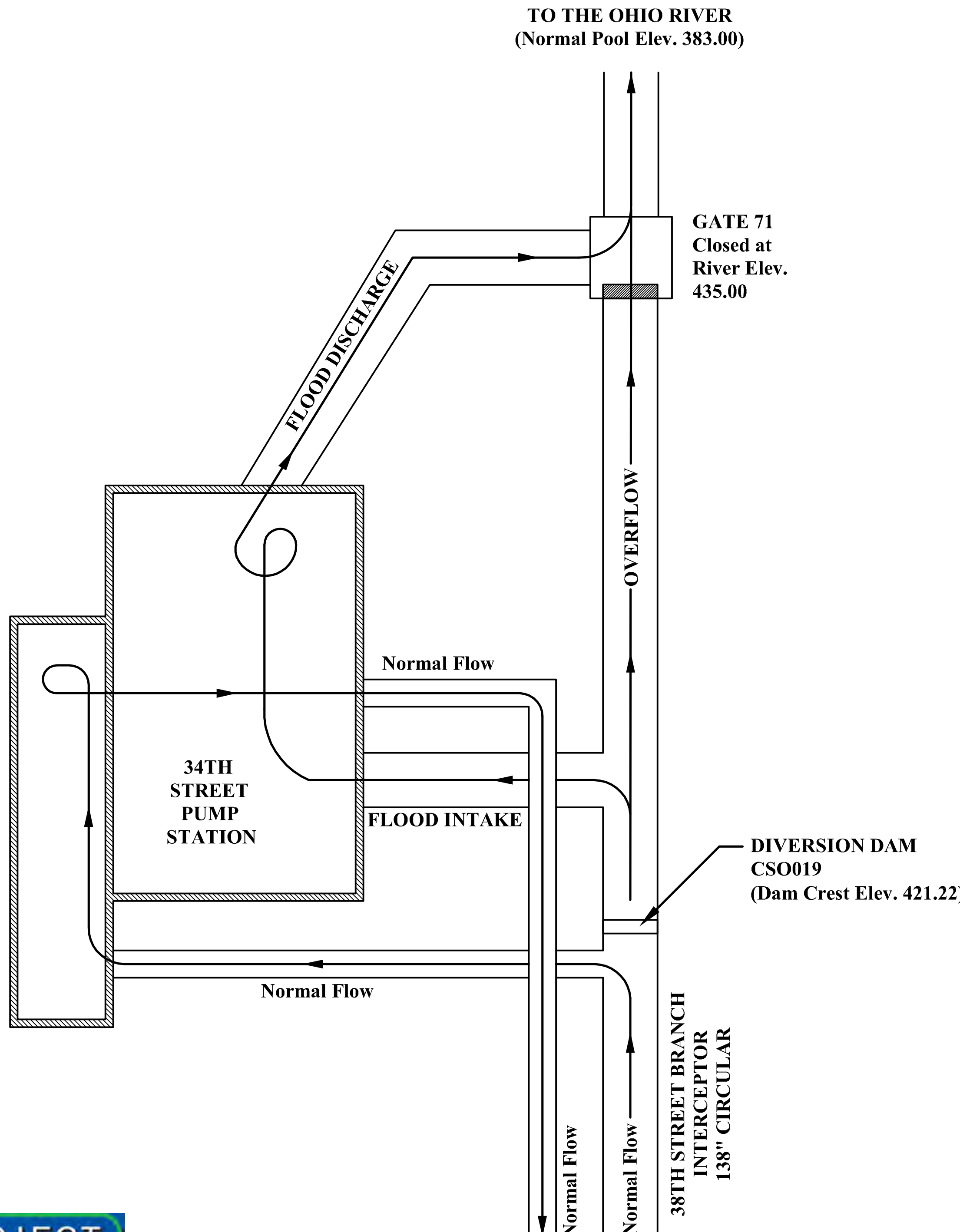


FIGURE 2.6.4
34TH STREET PUMP STATION
MSD0082-PS

816 NORTH 34TH STREET
LOUISVILLE, KY



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

FIGURE 2.6.5
NORTHERN DITCH
PUMP STATION
MSD0015-PS

341 MAC BRAE RD
LOUISVILLE, KY

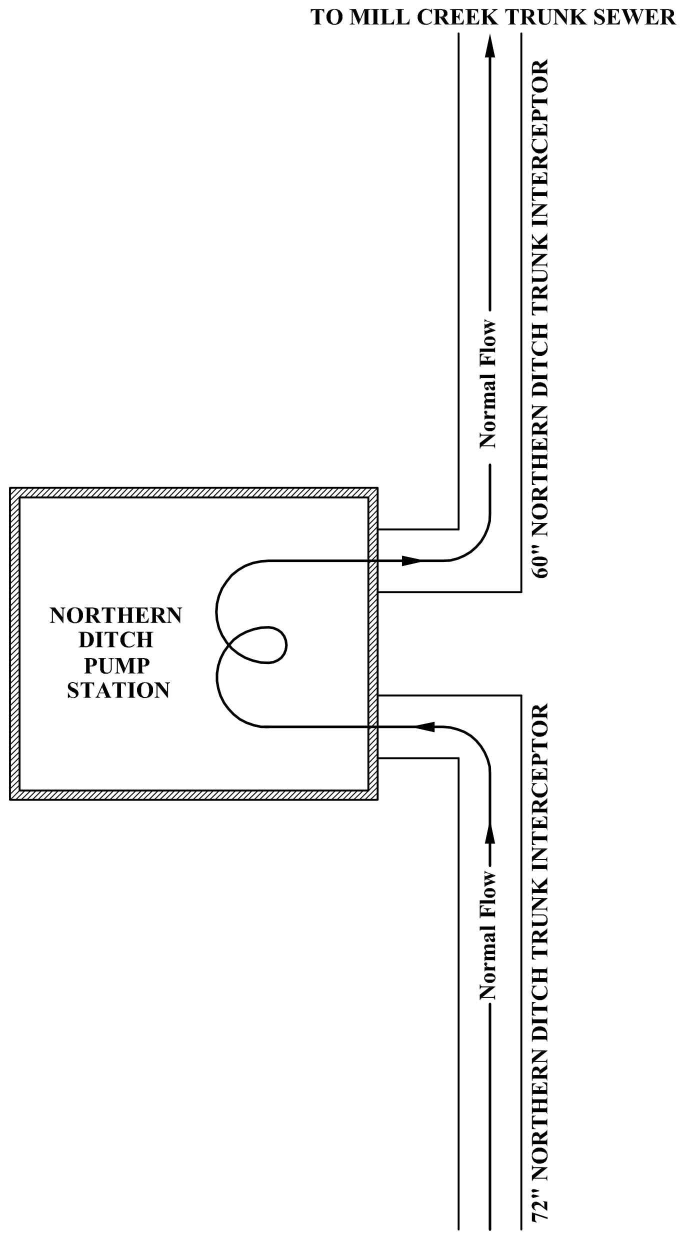
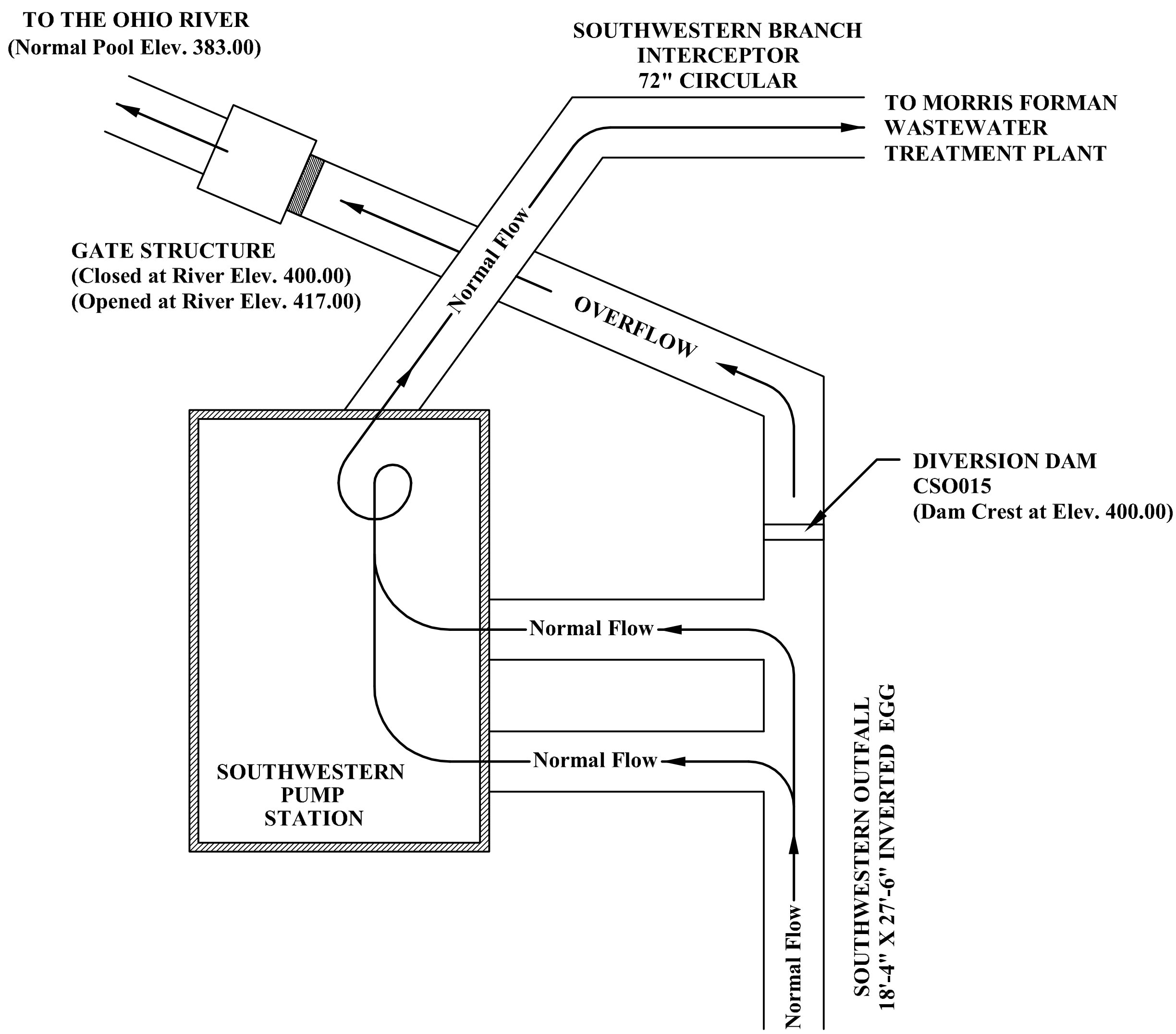


FIGURE 2.6.6
SOUTHWESTERN PUMP STATION
MSD0080-PS

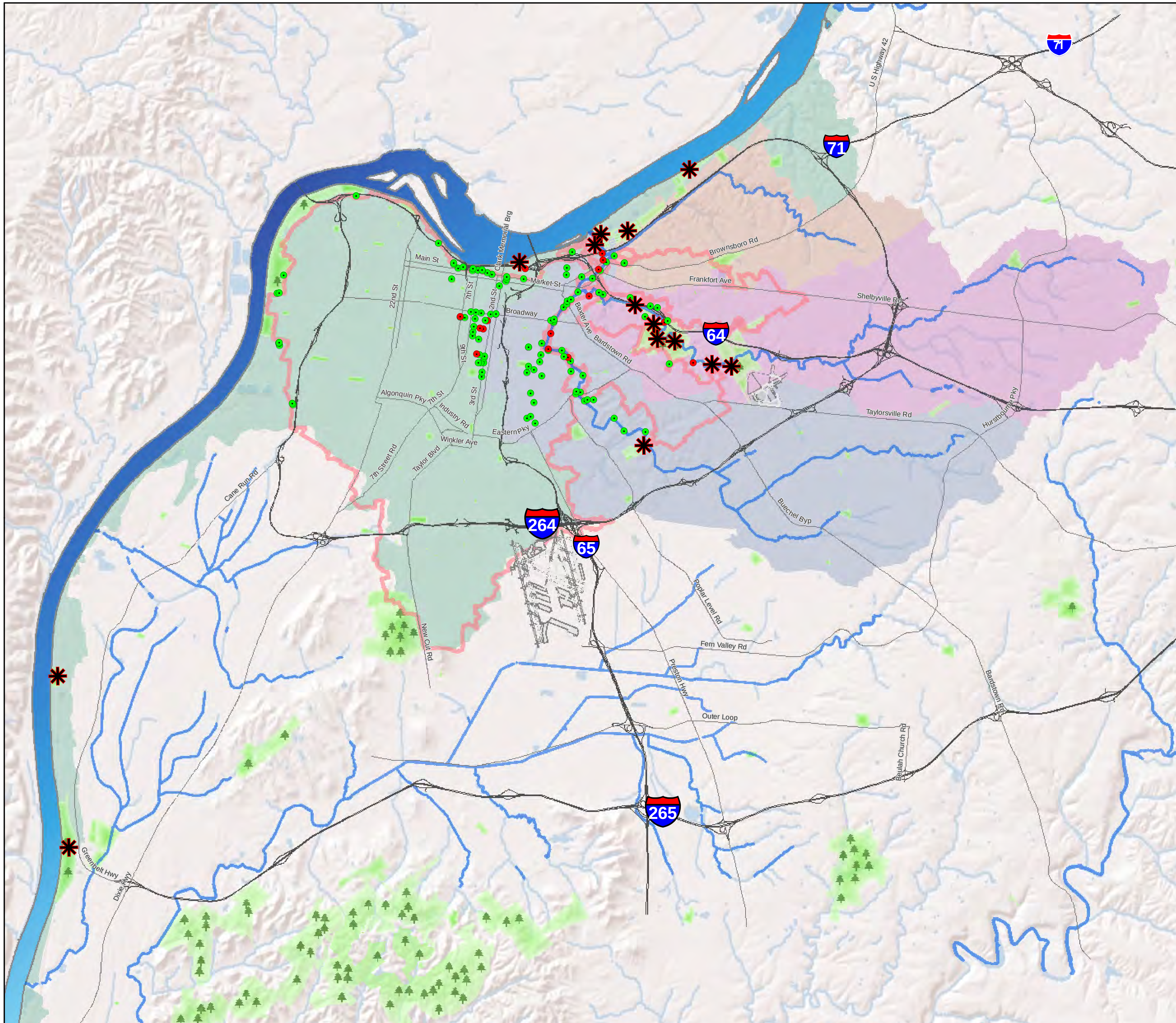
4010 BELLS LN
LOUISVILLE, KY



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.7.1 RECREATIONAL USE SURVEY SITES



LEGEND

- Recreational Use Survey Location
- Active CSO Location
- Eliminated CSO Location
- Interstate
- Major Road

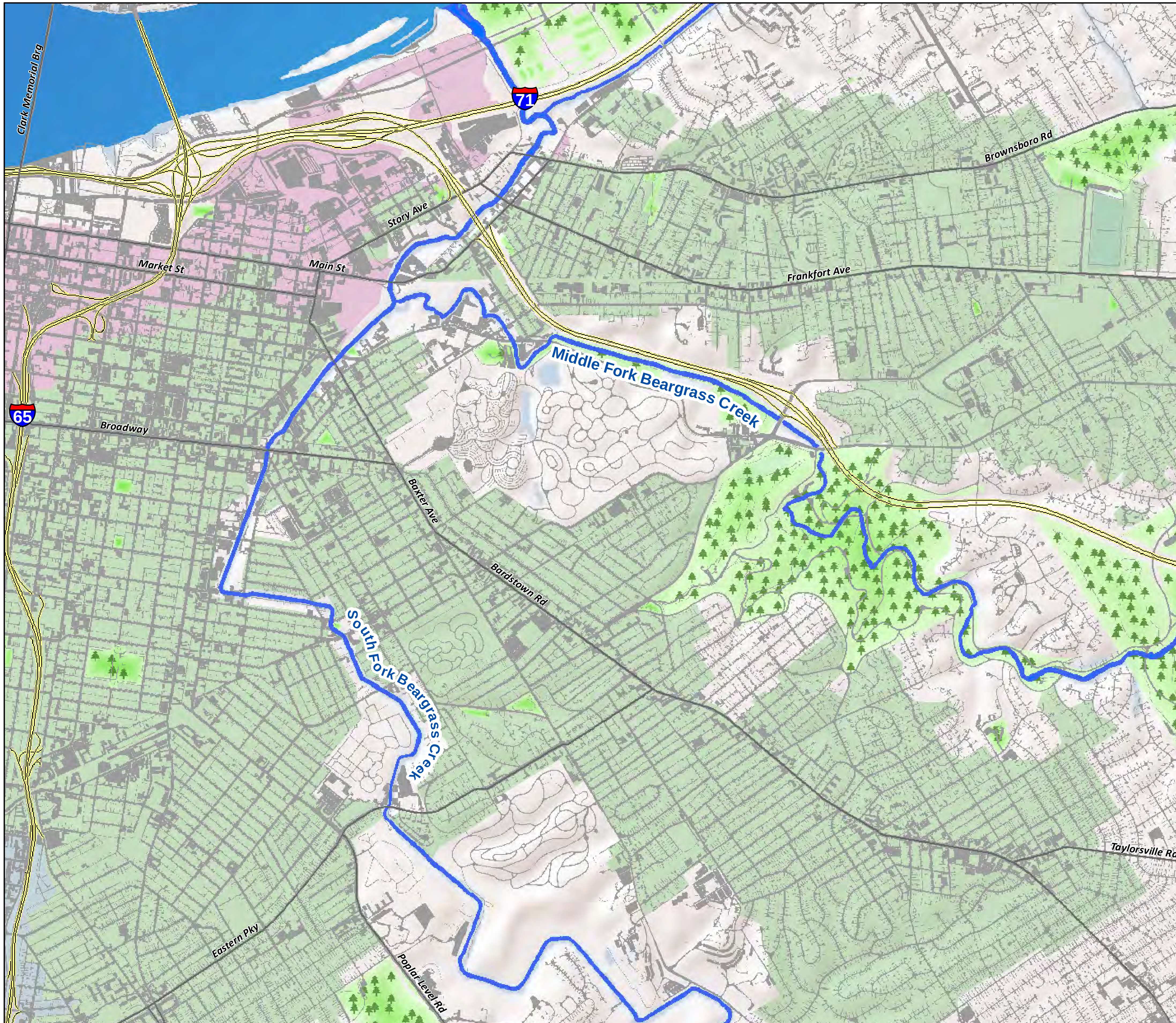
Watershed Boundary:

- Ohio River
- Middle Fork Beargrass Creek
- Muddy Fork Beargrass Creek
- South Fork Beargrass Creek
- CSO General Boundary
- Metro Park
- Water Feature

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.8.1
PAVED SURFACES AROUND BEARGRASS CREEK



LEGEND

- Interstate
- Major Arterial Street
- Paved Surface

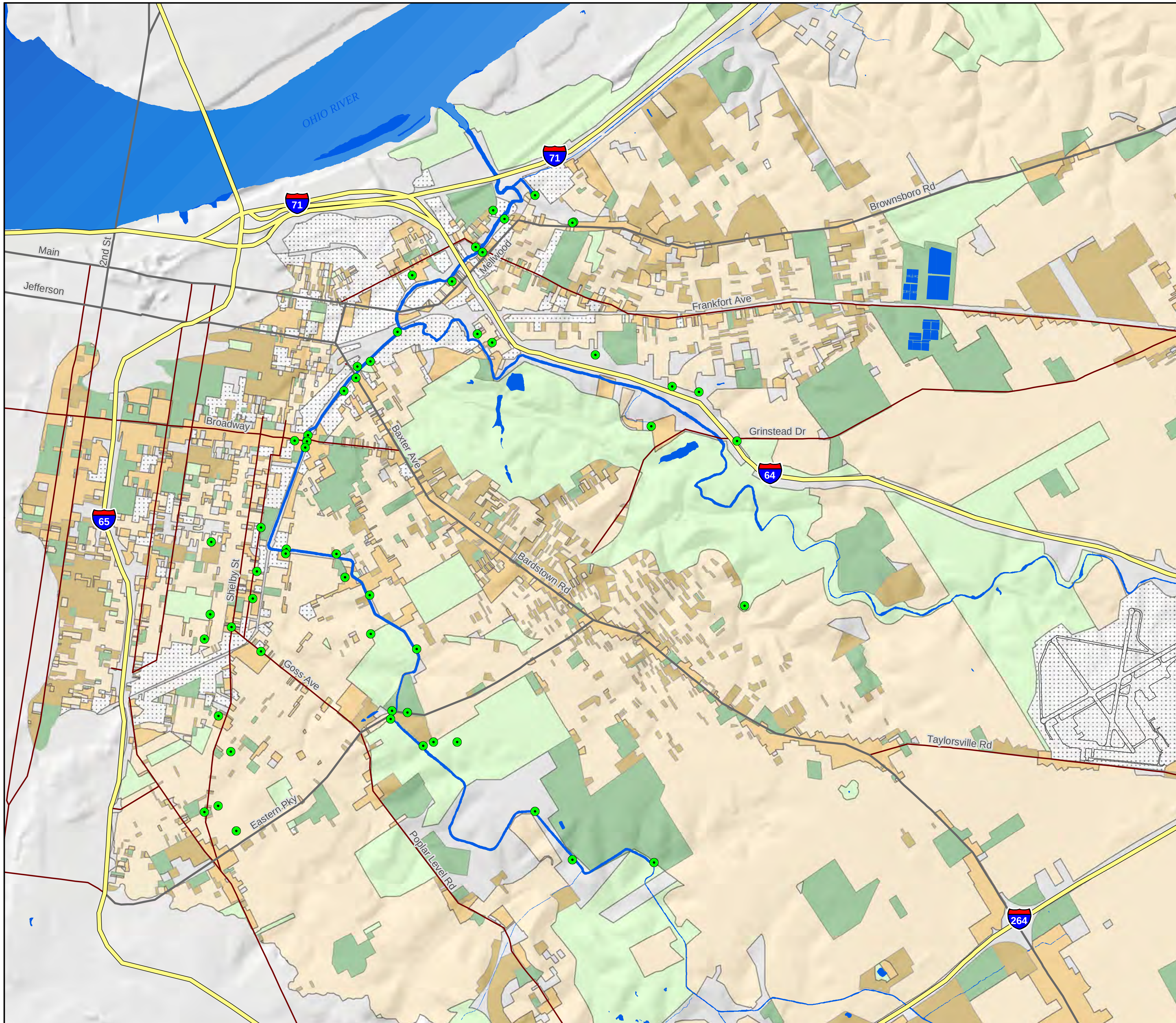
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Metro Park
- Water Feature

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.8.4
BEARGRASS CREEK
LAND USE



LEGEND

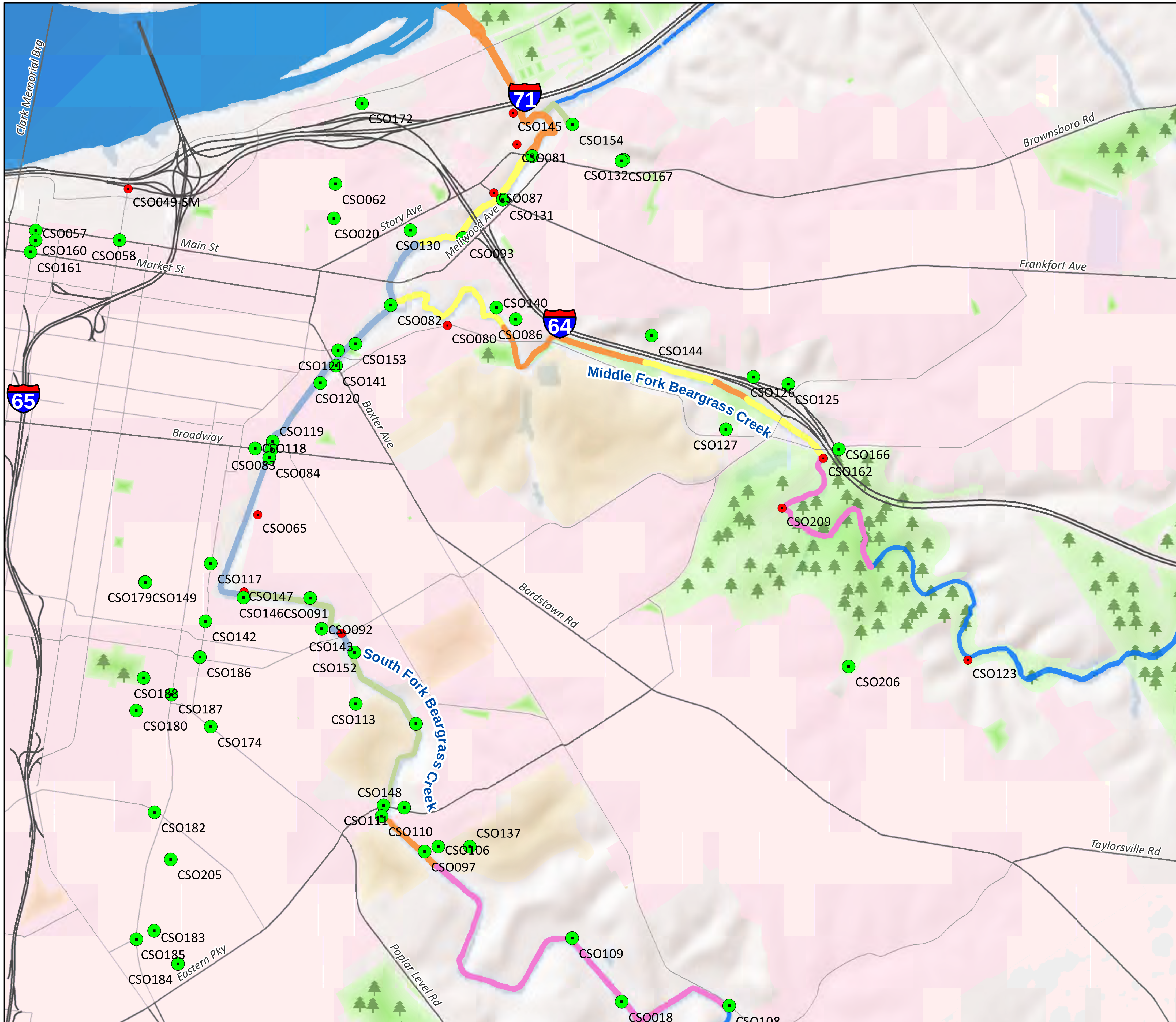
- CSO
- Interstate
- Highway
- Major Road
- Parks, Cemeteries, etc.
- Public and Semi-Public
- Single Family Residential
- Multi-Family Residential
- General Commercial and Office
- Industrial
- Vacant and Undeveloped
- Water Feature

NOTE: Land use data were created by Louisville Metro Planning and Design Services in 2005.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 2.8.6
DISTRIBUTION OF STREAM PRIORITY RATING



LEGEND

- Active CSO Location
- Eliminated CSO Location
- Interstate
- Major Arterial Street
- Minor Arterial Street

Stream Priority Rating

- Lowest
- Medium / Low
- Medium
- High / Medium
- Highest
- Stream Segment Not Evaluated
- CSO Boundary
- Metro Park
- Cemetery

Revision Date: August 7, 2009

LOJIC MSD PROJECT WIN

Chapter 3

CHAPTER 3: DEVELOPMENT AND EVALUATION OF ALTERNATIVES FOR CSO CONTROL

Special Note: This chapter was developed in 2008. The statistical data for the CSO's reported, specifically related to individual CSO overflow volumes and frequency in a typical rainfall year, were derived from the CSS model calibrated in 2007. Since then, a more detailed calibration and validation effort has adjusted the average annual overflow volumes and frequencies in the typical year. This information is provided in Chapter 5. The vast majority of the physical system characterization in this chapter is still accurate.

TABLE OF CONTENTS

SUPPORTING INFORMATION

Appendix 3.2.1 2008 CSO LTCP System Hydraulic Modeling Condition Technical Memo
Appendix 3.2.2 Impervious Area Evaluation
Appendix 3.2.3 Historic and Natural Systems Mapping
Appendix 3.2.4 EPA Fact Sheets
Appendix 3.2.5 CITYgreen Analysis
Appendix 3.2.6 Regional Soils Evaluation
Appendix 3.2.7 Contamination Regions
Appendix 3.2.8 Green Opportunities Maps for Individual CSO Basins
Appendix 3.2.9 Seven Focus Areas
Appendix 3.2.10 Concept Plans
Appendix 3.2.11 Biofiltration Technique Cross Sections
Appendix 3.2.12 Porous Concrete Cross Sections
Appendix 3.2.13 Drywell Cross Sections
Appendix 3.2.14 Drywell Rule Authorization Form
Appendix 3.2.15 Wetland/Sinkhole Preliminary Evaluation
Appendix 3.2.16 Downspout Disconnection Reductions and Program Flowchart
Appendix 3.2.17 Rain Barrel Program Flow Chart
Appendix 3.2.18 Residential Rain Garden Program Flowchart
Appendix 3.2.19 Green Infrastructure AAOV Impact Assessment and Modeling
Appendix 3.2.20 MFWTP Wet Weather Standard Operating Procedure
Appendix 3.2.21 MFWTP Expansion TM
Appendix 3.2.22 Initial Project Fact Sheets
Appendix 3.2.23 Initial Project Location Maps
Appendix 3.2.24 Initial Project Cost Summary
Appendix 3.2.25 Initial Project Benefit Summary
Appendix 3.2.26 Initial Project Ground Truthing Documents

CHAPTER 3: DEVELOPMENT AND EVALUATION OF ALTERNATIVES FOR CSO CONTROL

The Final Combined Sewer Overflow (CSO) Long-Term Control Plan (Final CSO LTCP) approach to reduction required by the 1994 CSO Control Policy is based on identifying the solutions that provide the greatest benefit-cost ratio and/or improves overall performance of the combined sewer system (CSS) in containing and treating pollutants. This chapter discusses the approach toward creating the Final CSO LTCP, the process toward development of CSO control alternatives, and the tools used to evaluate CSO control alternatives.

3.1 LONG-TERM CONTROL PLAN APPROACH

In this section, structured approaches to establish targets for CSO controls that will protect water quality and designated uses are addressed. The processes and tools used to create and convey solutions are discussed.

3.1.1 Demonstration Versus Presumption Approach

The CSO Policy identifies two methods, the “demonstration” and the “presumption” approaches, to establish targets for CSO controls that will protect water quality and designated uses (59 Code of Federal Regulations {CFR} 18688). In developing CSO alternatives, the Louisville and Jefferson County Metropolitan Sewer District (MSD) initially used a presumptive approach that was based on the number of overflows per year.

To establish the best technical solution for each of the 106 CSOs, a range of technical alternatives were developed to achieve an initial control level of four overflows per year. The costs and benefits of each technical alternative were developed, and a benefit-cost tool used to select the preferred technical approach for each CSO. The preferred alternative may be a project to control a single CSO outfall, or a project that consolidates control of a cluster of several CSO outfalls. Each of the preferred alternative solutions was then resized to achieve other levels of control, namely zero, two, and eight overflows per year. The benefit-cost evaluation was repeated for each level of control, and the optimal level of control then established for each solution.

Concurrently, water quality models were utilized to predict water quality effects of the various levels of control. The Beargrass Creek water quality simulation results demonstrated that reductions in CSOs did have an effect on water quality, but the differences between the levels of control were small. Similar to the Beargrass Creek water quality model results, the Ohio River water quality model demonstrated an improvement in water quality between baseline conditions and eight overflows per year, but no water quality benefits of CSO control are observed for the other levels of control.

Based on the water quality model results and benefit-cost evaluation results, MSD selected a system-wide solution which meets the criteria of the both presumptive and demonstrative approaches.

The selected plan exceeds the minimum presumptive approach of 85 percent capture of CSO (per the CSO Control Policy) and also successfully meets the criteria of demonstrative approach (per the CSO Control Policy) listed below:

- The planned program captures 96 percent of combined sewer overflow in a typical year, and water quality models for the Ohio River and Beargrass Creek predict that CSOs will not cause violations of the water quality standards with background pollutant loads from other sources removed.
- Benefit-cost evaluation and water quality modeling of the control plan demonstrate that the selected plan provides the maximum pollution reduction benefits reasonably attainable.
- The selected plan will be designed to allow for reasonable expansion or retrofitting of controls to meet water quality objectives based on post construction compliance monitoring. Additional options to modify the plan include expansion of the Green Infrastructure Program, if proven cost-effective, to reduce source runoff to the CSS.

MSD will monitor the reduction of other pollutant sources to Beargrass Creek and the Ohio River as it implements the Final CSO LTCP and its post-construction monitoring program. Monitoring will include application of the Beargrass Creek and Ohio River water quality models to assess attainment of water quality standards for bacteria in both water bodies plus dissolved oxygen in Beargrass Creek.

3.1.2 Decision Process

The risk management-based decision process that was applied to develop and evaluate CSO control alternatives for the Final CSO LTCP utilized institutional knowledge of the CSS, Water Environment Federation (WEF) Guidance documents, U. S. Environmental Protection Agency (EPA) Guidance documents, and tools developed by the MSD's program technical team. The process addressed benefit determination, cost analysis, and public participation. The risk management-based decision process is described in detail in Volume 1 of the Integrated Overflow Abatement Plan (IOAP).

An initial Final CSO LTCP project list was established by reviewing numerous documents compiled over the previous 20 years related to both CSS and associated watershed studies. Workshops were conducted March 2007 and May 2007 with a group comprised of MSD senior management and technical personnel from the engineering firms having historical experience with the CSS. The historical knowledge by personnel was applied to create an initial wide-range of control technologies resulting in 198 projects. A screening exercise reduced this list to 136 viable alternatives. These 136 projects were conceptually designed, followed by determination of related costs and benefits. These projects consisted of CSO-specific, CSO-consolidation, and CSO-regionalization projects across an array of control technologies, including storage, treatment, separation, etc. A matrix of the control technologies reviewed by CSO is listed in Table 3.1.1 located at the end of this chapter. In addition, a Green Infrastructure Program considered multiple solutions to reduce the volume of stormwater entering the CSS. This program is described in detail in Section 3.2.5.

There were other elements of the Final CSO LTCP that were not subject to the evaluation process, primarily because no alternatives were considered. These were related primarily to the U. S. Army Corp of Engineers (USACE) Flood Protection System Infrastructure, combined sewage pump-back to the CSS following a wet-weather event, and completion of downspout disconnection programs that are partially complete as of December 31, 2008.

Regarding Flood Pump Stations, physical modifications are recommended to five existing stations developed per the Consent Decree. Modifications involve new gates, actuators, and operating guidelines, therefore, there were no comparative alternatives.

In addition, during the optimization of alternatives, the need to off-load existing interceptors was realized to allow return of stored CSO to the CSS. This necessitated upsizing an existing pump station, therefore no alternatives exist for this project. Related to interceptor capacity, the final hydraulic model run indicated the need for additional capacity in Beargrass Creek South Fork corridor in order to empty recommended storage basins within 48 hours, therefore a parallel interceptor project is recommended.

Finally, downspout disconnection programs are in progress in two CSO drainage areas contributing to Beargrass Creek Middle Fork. Two other projects are recommended to complete the downspout disconnection programs under this Final CSO LTCP.

3.1.2.1 Cost Model

The “Wet Weather Plan Project Cost Estimating Reference Document” (May 2007, CH2M Hill) was used to prepare conceptual cost estimates of proposed projects. The cost model utilized standard construction cost estimating unit factors, based on the “Engineering News Record – Construction Cost Index” (ENR-CCI), and was calibrated to MSD’s history of construction costs.

The cost model was used to generate capital and 20-year present worth costs for each project under consideration for consistent comparison between projects and technologies. In anticipation of construction initiation by 2010, an ENR-CCI of 8550 was applied to advance planning-level costs into 2010 dollars. Following selection of the final gray infrastructure project list, these project costs were recalculated at the 2008 ENR-CCI of 8136, plus project/site-specific cost data and allowances in order to create a present-day program cost. This allowed MSD to apply an escalation factor over the life of the program in order to establish cash flow and funding requirements.

3.1.2.2 Benefit-Cost Analysis

Following establishment of the initial project list and subsequent conceptual designs and cost estimates, the benefits of the CSO control were determined to generate ultimately, a benefit-cost ratio for eventual project ranking and recommendation. For instance, the project list included a variety of technologies and project sites, and addressed single-CSO vs. multiple-CSO project groupings. The discussion of the benefit determination process is discussed extensively in IOAP Volume 1, Chapter 2.5 and is only discussed in this section in terms of application to the Final CSO LTCP.

Eleven community-based, project-specific and programmatic values (benefits) were established by the Wet Weather Team (WWT), of which five were ultimately selected to calculate a project's array of impacts to the community. To enhance the benefit-cost ratio process, the WWT assigned weighting factors on a 0-10 scale to each of the five project values to reflect the degree of importance to the overall control plan impact to the community. The values and assigned weights that were used to score benefits were as follows:

- Asset Protection 6
- Eco-Friendly Solution 6
- Environmental Enhancement 8
- Public Health 10
- Regulatory Performance 8

Information and data utilized to score three performance values: Asset Protection, Public Health, and Regulatory Performance, were generated by the hydraulic model of the CSS. Additionally, to account for the significant magnitude of scale of receiving stream flow, separate scales were established for the Ohio River and Beargrass Creek.

Regulatory Performance and Public Health were scored on a 25-point severity-frequency matrix according to CSO discharge volume and frequency. The baseline characteristics of the CSS were initially scored, followed by scoring the remaining overflow/frequency resulting from the proposed control. The difference in these values was the benefit score, with a higher score indicating a higher reduction in risk, or higher value of benefit.

The Asset Protection value was also scored on a 25 point severity-frequency scale (design storm versus damage impact) to account for reduction in surface flooding conditions by a proposed CSO control. This value was scored using one of two methods. Method 1 utilized design storms versus basement backup potential (hydraulic grade line) of the CSS during precipitation events. Method 2 utilized design storm versus customer flooding complaints.

To score Method 1, the baseline condition was first established by the CSS model, followed by determination of the sewer hydraulic grade line during various precipitation scenarios. A basement backup was considered possible if the hydraulic grade line reached a level within six feet of a manhole rim. As with the Regulatory Performance and Public Health values, the benefit was the difference in the two scores, with a higher score indicating a greater benefit.

To score Method 2, MSD Customer Information System complaint data was compiled according to storm event. The level of damage (ranging from standing water to severe structural damage) was plotted against the storm frequency. Higher degrees of damage during high frequency storms were considered the worst-case outcome. The scores from the two methods were compared and the worst-case condition was applied to a project. In practice, it was found that the hydraulic condition score (Method 1) governed the outcome as Customer Information System complaints were difficult to use to fully assess the nature of damage reported by the customer.

The Environmental Enhancement and Eco-Friendly Solution values were scored using several performance metrics that represent a variety of aspects related to the environment or ecosystems. Each of the aspects were scored on a 10-point negative-to-positive scale (-5 to +5). Environmental Enhancement primarily assesses aquatic impact, while Eco-Friendly Solutions assesses broader land/energy impacts of proposed CSO control alternatives. To score these subjective aspects, a diverse, objective group of professional engineers, certified ecologists, and aquatic biologists from different consultant entities were assembled. This group established methodologies of scoring, and then participated in scoring a majority of the alternatives.

3.1.2.3 Public Participation

In order to educate and engage the community in CSO control alternatives development, a series of public meetings were held throughout the Fall of 2007. The meetings were publicly advertised in the local newspaper, and an announcement was posted on the Project WIN (Waterway Improvements Now) website, www.msdlouky.org/projectwin.

MSD held a public meeting at the Girl Scouts of Kentuckiana offices. Attendees learned about Project WIN and the changes they could make to improve water quality.

The objectives of the public meetings were to provide an opportunity to review the in-progress draft IOAP, view maps of the sewer service area of affected neighborhoods, encourage dialogue between the public and MSD officials, and record and address questions regarding the planning process. Seven meetings were held, spatially distributed across the community. MSD staff conducted the presentations and communications, while IOAP technical team representatives attended to address the specifics of each solution. The meetings were conducted during evening hours to maximize the opportunity for attendance.

The public was also involved through the Stakeholder Group membership in the WWT. The WWT was extensively involved in CSO controls alternatives development and selection of the recommended plan. Their engagement, plus a list of meeting dates with associated agenda topics, is discussed fully in IOAP Volume 1, Chapter 3.2.

3.2 DEVELOPMENT OF ALTERNATIVES

In this section, the green and gray infrastructure technologies that control CSO discharges are discussed. Various alternatives exist in today's market; a brief description of the processes and performances of these technologies is presented. In addition, programmatic elements, such as source control/reduction and collection system storage are discussed.

MSD received a strong appeal from the WWT to integrate green technologies into the Final CSO LTCP to reduce the frequency and volume of CSO discharges. Because of this encouragement, plus commitment by MSD leadership to consider all solutions, a Green Infrastructure Program was evaluated for inclusion in the Final CSO LTCP. Along with the presentation of both technologies, this section also begins discussion of the initial CSO controls considered.

3.2.1 General Considerations and CSO Control Measures

Over the years, those involved with CSO abatement programs, such as consultants, equipment manufacturers, and CSO communities, have developed various practices and technologies for control and treatment of CSOs. The earliest technologies were in response to the nine minimum controls (NMC) requirements in the 1990s including technologies such as netting, screens, and trash racks for floatables control. As NMC technologies were implemented, the industry began to develop new technologies that represented the second generation of control strategies. Many of these next generation technologies are under consideration for application to MSD's CSS. The following Sections 3.2.2 through 3.2.4 review those technologies.

Each technology evaluated for applicability is grouped within one of three categories: Collection System Controls, Storage, and Supplemental Treatment. A detailed summary of each technology is presented along with examples of MSD's experience with applicable technologies.

3.2.2 Available Technologies - Collection System Controls

Collection system control technology is designed to increase the capacity of the sewer system and/or minimize extraneous flows into the system. The reasons behind the need for collection system modification or rehabilitation may include:

- Change in design philosophy, from a combined system to a separate system
- Inadequate capacity (e.g., land development exceeded expectations)
- Poor construction practices (e.g., improper bedding)
- Root intrusion (e.g., causing open joints)
- Chemical attack on the system (e.g., Hydrogen Sulfide)
- Normal aging and deterioration
- Damaged and leaking pipes
- Soil movement (e.g., causes joint separation)

Methods of collection system control include infiltration reduction, inflow reduction, and new sewer construction. The techniques are described in the following sections.

3.2.2.1 Infiltration Reduction

Infiltration is the introduction of groundwater into a sewer through defects in the sewer pipe or a manhole. Groundwater can enter a sewer through various sources such as defects or cracks in the pipe or manhole barrel, open joints caused by soil movement or root infiltration, or loose construction castings. As a result, groundwater utilizes the available capacity in the sewer that was intended for sanitary sewage and/or stormwater. Infiltration therefore results in loss of capacity to convey combined sewage flow. There are several rehabilitation methods of reducing groundwater infiltration.

Chemical Grouting

A quick-setting liquid is injected into defects in the pipe or manhole, open joints and/or minor cracks. Once set-up, the grout seals the joint and prevents groundwater from entering into the sewer at the point of repair.

Relining

If there are multiple defects in the sewer system, or if there is loss of structural integrity of the sewer or manhole, a liner can be installed over the entire length of the pipe/manhole. Relining can take the form of cured-in-place-pipe liners or prefabricated high-density polyethylene (liners (slip lining). The cured-in-place-pipe liners are easier to install within sewers since they do not require excavation but do require heated curing. On the other hand, slip lining requires some excavation to allow the installation of the high-density polyethylene pipe. The installation of a liner reduces the inside diameter of the sewer and, theoretically, the capacity of the sewer. However, the installation of the liner may reduce the resistance to flow (Manning’s Roughness Coefficient) such that there is no net loss of, or even a slight increase in, capacity. Infiltration can still occur at service lateral connections, so a comprehensive assessment should be undertaken when considering relining as an infiltration reduction method. MSD has applied sewer-relining technology with some success within the sewer system. MSD has been very successful applying sewer relining using in-house resources on sanitary house sewer lines that connect to the main sewer.

Pipe Bursting

If the installation of a liner, as previously described, reduces the inside diameter of a sewer and adversely impacts the sewer's capacity, it may be possible to perform an in-situ replacement of the sewer with a new pipe of the same, or slightly larger, diameter. Pipe bursting uses a pneumatic, hydraulic or static busting tool to fracture the existing pipe. Concurrent with the shattering of the existing pipe, a polyethylene pipe is pulled into the void. The size of the new polyethylene pipe is dependent on the surrounding soil conditions and the ability for the bursting tool to create a void that is sufficiently large to accommodate the new pipe. This no-dig process is suitable for enlarging the size of utility pipes, existing sewers or other pipelines without excavation. MSD has applied pipe-bursting technology in limited applications with some success. Additional excavations are required to reconnect building lateral sewers.

3.2.2.2 Inflow Reduction

Inflow is water that enters into the sewer system through undesirable connections, such as downspouts and basement sump pumps. Inflow is generally a term that is associated with separate sanitary sewers, since stormwater is not supposed to be conveyed by a sanitary sewer. In relation to a combined sewer, stormwater flow from downspouts, surface runoff into catch basins and cross connections with storm sewers are sources that often can be disconnected and redirected to other natural drainage systems or, be allowed to soak into the ground. The reduction of the wet weather flow component of a CSS leads to a potential reduction in CSOs.

Green infrastructure techniques include the disconnection of downspouts from the combined sewer. Once disconnected, the discharge is allowed to drain across the lawn and stormwater infiltrates into the ground. Downspouts can be rerouted to rain barrels or cisterns. The rainwater can then be stored and used to water gardens during dry periods. Rain gardens can be planted to absorb stormwater runoff. Porous pavement also can reduce runoff rates to attenuate peak flow within the combined sewer system. MSD investigated several green infrastructure technologies to be implemented as part of the Final CSO LTCP, which are discussed later. MSD has conducted downspout disconnection programs, sump pump disconnection programs, as well as rain barrel, rain garden, and porous pavement pilot projects.

3.2.2.3 New Sewer Construction

Sewer separation is the conversion of a CSS into a system of separate sanitary and storm sewers. Sewer separation, in theory, eliminates a CSO and this alternative is most likely to prevent sanitary wastewater from being discharged to receiving waters. Additionally sewer separation advantages include increasing available plant capacity and reducing the public's exposure to raw sewage. Construction of new sewers may cost much more than other viable treatment technologies. In addition, when combined sewers are separated, storm sewer discharges potentially contribute more untreated pollutant load to the receiving waters. In addition, partial sewer separation may not eliminate the overflow, but actually cause the overflow to be redefined as a sanitary sewer overflow (SSO). Sewer separation is typically the most expensive CSO control measure. Because of the high cost and the negative impacts of major construction projects on local traffic, sewer separations are traditionally planned for small areas or as part of a greater infrastructure rehabilitation project.

In practice, there are two distinct approaches to sewer separation:

> **Full Separation** - new sanitary sewer lines are constructed and the existing CSS becomes a storm sewer system. This is probably the most widely used form of separation. Another option involves an entirely new storm sewer system is constructed with the existing CSS remaining as a sanitary sewer system. This form of separation is not often used because the capacity of the existing CSS was designed to accommodate stormwater runoff, which exceeds what is required to accommodate sanitary flows.
>
> **Partial Separation** - a new storm sewer system is constructed for street drainage, but roof leaders and basement sump pumps remain connected to the existing CSS.

MSD has successfully implemented sewer separation projects as part of the CSO Program. However, as stated above, projects have typically been part of major redevelopment efforts in downtown Louisville Metro or implemented where circumstances made it cost effective. For example, the sewer systems for CSO206 and CSO209 already had separate pipe networks for both storm and sanitary sewage although these networks had common manholes. The scope of the projects, in these cases, consisted of separating the manholes, reconnecting some drainage basins, and correcting private property connections.

3.2.3 Available Technologies - Storage

The objective of storage is to reduce overflows by capturing combined sewage during wet weather for controlled release into wastewater treatment facilities after the storm flows subside. Storage technology has three major sub-groups: in-line, off-line and on-site. While the NMC requirements in the 1990s required the implementation of low-cost optimization of in-line storage such as raising an overflow dam, current storage technology is much larger in scale and more complex utilizing real-time controls (RTC) technology and flow control structures. A typical modern storage facility may include an RTC controlled diversion regulator and an open or covered storage unit, an RTC controlled return regulator and an emergency relief point. The emergency relief point may be equipped with netting, disinfection or other CSO control devices.

Storage facilities are widely used as CSO control because they effectively reduce the volume, frequency, and duration of CSO events. Storage facilities can provide a relatively constant flow into the treatment plant and thus reduce the size of required treatment facilities. A storage facility may be located at overflow points or near treatment facilities. A major factor determining the feasibility of using storage facilities is land availability. Operation and maintenance costs are generally small; requiring only collection and disposal cost for residual sludge solids, unless inlet or outlet pumping is required. The following sections outline the technologies that are important in regards to storage.

3.2.3.1 Real Time Control

RTC seeks to optimize sewer system performance during wet weather events. RTC is applicable in CSSs because these systems typically include large pipes for transport of wet weather flows. RTC uses system-wide dynamic controls to implement control tasks such as in-line storage flow maximization and flow diversion. There are two types of system-wide dynamic RTCs: reactive systems and predictive systems.

In reactive RTC, sewer level and flow data are measured in “real time” at key points in the sewer system. The collected data is transferred to a central computer where custom software applies feedback loops and optimization rules to operate system elements to maximize use of the existing sewer system and to limit overflows.

Predictive control goes one-step further by incorporating weather forecast data to allow for advanced planning of control tasks and control tasks sequencing. RTC technologies are capable of reducing the frequency, duration, and volume of CSOs through optimization of sewer system operations. CSSs use RTC technology to control system regulator elements such as weirs, gates, dams, valves and pumps in a real-time environment.

RTC may be more effective in areas with excess capacity and level terrain where it is more practical to store wastewater in existing sewers. RTC has proven useful to divert flows to and from storage systems during wet weather. Some other advantages of RTC include the ability to manage storage facilities in such a way as to minimize overflows; hydraulic models can be integrated into RTC control techniques to refine operational strategies; and, system response can be predicted through use of rainfall forecast and gauge data.

While the initial costs of enhanced RTC can be significant, the monitoring costs will likely be a fraction of the cost of large capital projects that would achieve similar levels of CSO reduction. MSD completed Phase I and II of a major CSO Predictive RTC program in 2006 and 2008, respectively. Future phases of the RTC program are a significant part of the Final CSO LTCP.

3.2.3.2 In-line Storage

In-line storage is the term used to describe storage of wet weather flows within the sewer system. Taking advantage of this type of storage may reduce the frequency and volume of CSOs without a large capital investment. The amount of potential storage available in the sewer system largely depends on the available capacity of the pipes that will be used for storage, the grade of the pipes, and on the availability of suitability sites for installing regulating devices. In-line storage techniques typically use RTC to control the use of flow regulators, in-line storage units or basins, and parallel relief sewers.

Storage units and basins constructed in-line are typically governed by flow regulators which optimize in-line storage during wet weather events by damming or limiting flow in specific areas of the sewer system. Dry weather flows pass directly through in-line storage facilities. In-line storage units and basins may be either tanks or open or closed basins and may include facilities to minimize their aesthetic and environmental impact. These may include odor control systems, washdown/solids removal systems, and access for cleaning and maintenance.

Closed tanks are constructed below grade such that the surface at grade can be used for parks, playgrounds, parking or other light uses. In-line capacity can also be created by installing relief sewers parallel to existing sewers or by replacing older sewers with larger diameter pipes. One factor that may limit the applicability of in-line storage is the possible increase in basement backups and street flooding (EPA 1999).

In-line storage may also slow flow, which allows solids to settle in the sewer. If allowed to accumulate, these solids can reduce available storage and conveyance capacity. Therefore, it is important to design the facility in such a way that adequate flow velocities are provided during dry weather service to move the solids to the Water Quality Treatment Center (WQTC).

To-date, MSD has constructed and installed inflatable dams as in-line storage controls at the Sneads Branch Relief Drain and in the Southwestern Outfall. These projects have been very successful as means to reduce the volume and frequency of CSOs. Additional in-line storage is included in this Final CSO LTCP document.

3.2.3.3 Off-line Storage

Off-line storage is the term used to describe facilities that store wet weather flows adjacent to the sewer system. Off-line storage facilities have broad applicability and are adapted to site-specific conditions by changing basin shape, size, inlet or outlet type, and disinfection mechanism. Off-line storage may consist of a large single unit or several smaller units operating in an “as-needed” parallel configuration. The multiple-unit configuration allows the first unit to capture the highly polluted first flush. Diversion devices are typically used to pass flow to the other units after the first unit has reached capacity. The use of off-line storage tends to be more expensive than inline storage and is usually considered in areas where in-line storage is insufficient or unavailable. Off-line storage units are an integral part of this Final CSO LTCP. Where feasible, off-line storage units have been optimized in size based on the efficient use of in-line storage and green technologies. The off-line storage units that are included in this Final CSO LTCP are generally located in vacant lots and below grade, which reduces the potential for odors and allows the land above the unit to be utilized for low impact recreation and other uses. MSD currently operates several open basins within the CSS.

Deep tunnel storage facilities are used where large storage volumes are required and opportunities for near-surface storage are unavailable. Deep tunnels are located 100-feet to

400-feet below ground. Tunnel diameters range from 10-feet to 50-feet and many are several miles in length. During dry weather, untreated wastewater is routed around, not through, these off-line storage facilities. In contrast, during wet weather, flows are diverted from the sewer system to the off-line storage facilities by gravity drainage or with pumps. The wastewater is detained in the storage facility and returned to the sewer system once downstream conveyance and treatment capacity become available.

Overflows can occur once the capacity of off-line storage structures is exceeded. Some treatment is provided through settling; however, the primary function of such facilities is storage and the capture of peak wet weather flows. Storage tunnels were evaluated for the control of CSOs, but were found to be cost prohibitive compared to in-line or off-line storage units.

3.2.3.4 On-site Storage

On-site storage is storage developed at the WQTC. It is most applicable in systems where conveyance capacity exceeds treatment capacity. On-site storage provides operators with the ability to manage and store excess flows. The methods of on-site storage may be either new construction or rehabilitation of under-utilized or abandoned equipment. The costs associated with the development of on-site storage are typically lower than for other storage facilities built outside the bounds of the WQTC. Utilizing abandoned treatment facilities may reduce costs even more. Much of the cost savings derive from siting storage facilities on land already owned by the utility. Sewer system conveyance capacity is a limiting factor with on-site storage and should be analyzed early in the design. In addition, availability of suitable land can be a barrier to on-site storage.

3.2.4 Available Technologies - Supplemental Treatment

The recent development of wet weather treatment systems presents an alternative to storing excess flows. Supplemental treatment technologies are end-of-pipe controls used to provide some level of physical, biological, or chemical treatment to excess wet weather flows immediately prior to discharge from a CSS. This level of treatment, while less than expected from a conventional WQTC, may significantly reduce the pollutant loads from a CSO. Specific treatment technologies can address different pollutants, such as floatables, settleable solids, and pathogens. However, a major factor determining the feasibility of using treatment facilities is land availability and adjacent landuse.

3.2.4.1 Primary Clarification

The objective of clarification is to produce an effluent treated by gravitational settling of the suspended particles. Sedimentation also provides storage capacity as well as an opportunity for disinfection. Clarification is adaptable to chemical additives, such as lime, alum, ferric chloride, and polymers, which provide higher rates of suspended solids and biochemical oxygen demand, or allow “equivalent primary clarification” to occur at higher loading rates than typically used for primary clarifier sizing.

3.2.4.2 Swirl Concentrators/Vortex Separators

Vortex separators (swirl concentrators) are designed to concentrate and remove suspended solids and floatables (S&F) from wastewater or stormwater. Flow enters the unit at a controlled tangential velocity and is directed around the perimeter of a cylindrical shell, creating a swirling, vortex pattern. Vortex separators use centrifugal force, inertia, and gravity to divide combined sewage into a smaller volume of concentrated sewage, solids, and floatables; and a large volume of more diluted sewage and surface runoff. The swirling action causes solids to move to the outside wall and fall toward the bottom, where the solids concentrated flow is conveyed through a sewer line to the WQTC. The overflow is discharged over a weir at the top of the unit. Various baffle arrangements capture floatables that are subsequently carried out in the underflow. Removal effectiveness is a function of the hydraulic loading rate with better performance observed at lower loading rates. These devices may be considered "equivalent primary treatment" in some cases, but the variable performance makes this questionable in many applications. Principal attributes of the swirl concentrator are the ability to treat high flows in a very small footprint, and a lack of mechanical components and moving parts, thereby making it less operational and maintenance intensive. This technology, when coupled with disinfection, may provide an acceptable level of supplemental treatment. However, the configuration of most of the CSO outfalls in MSD's system is not conducive to the use of vortex separators, and consistent biochemical oxygen demand and total suspended solids (TSS) removals cannot be assured; therefore, they were not evaluated for selection.

3.2.4.3 High Rate Physical/Chemical Treatment

High rate physical/chemical treatment under this Final CSO LTCP considered two treatment technologies: Ballasted Flocculation and Retention Treatment Basin. Both are traditional gravity settling processes with enhanced flocculation and settling aids to increase loading rates and improve performance. The pretreatment processes for high rate physical/chemical treatment are screening and degritting.

In the first stage of ballasted flocculation a coagulant is added and rapidly mixed into solution. This is followed by a flocculation stage where polymer is added and mixed to form floc particles that will settle in the following stage. Finally, the wastewater enters the gravity settling. Sludge is collected at the bottom of the clarifier and either pumped back to the flocculation stage or removed periodically when sludge blanket depths become too high. Disinfection is applied downstream of clarification, followed by disinfectant residual neutralization. Performance varies with treatment rate and chemical dosages, but in general, removal rates of 80 - 95 percent for TSS and 60 - 80 percent for biochemical oxygen demand can be expected.

Retention treatment basin is considered equivalent primary treatment. For this treatment, polymer only is injected into the wastewater stream, followed by gravity sedimentation. Disinfection is applied downstream of clarification, followed by disinfectant residual neutralization. Performance varies with treatment rate and chemical dosages, but in general, removal rates of 50 percent of TSS and 30 percent of biochemical oxygen demand.

Removal efficiencies for each technology are also dependent on start-up time. In general, the start-up time for ballasted flocculation units, coupled with the high influent peak flow rates, require a substantial storage basin upstream of the treatment unit. There are several locations; however, where retention treatment basins could be effective due to the reduced land requirements of the technology, particularly the CSO015 and CSO191 common outfall, where substantial outfall storage is available to reduce peak inflow rate.

3.2.4.4 Disinfection

The objective of disinfection is the control of the discharge of pathogenic microorganisms into receiving waters. The disinfection methods considered for use in CSO treatment include chlorine gas, calcium or sodium hypochlorite, chloride dioxide, ozone, ultraviolet (UV) radiation, and electron beam irradiation. The chemicals are all oxidizing agents that are corrosive to equipment and in concentrated forms are highly toxic to both microorganisms and people. Each disinfection method is described below.

- Chlorine gas - Chlorine gas is effective, however, it is extremely toxic and its use and transportation are strictly controlled. In addition, it is a respiratory irritant and in high concentrations can be deadly.
- Calcium or Sodium Hypochlorite - Hypochlorite systems are common in wastewater treatment installations. For years, large, densely populated metropolitan areas have employed hypochlorite systems in lieu of chlorine gas for safety reasons. The hypochlorite system uses sodium hypochlorite in a liquid form much like household bleach and is similarly effective as chlorine gas although more expensive. It can be delivered in tanker trucks and stored on-site.
- Chlorine Dioxide - Chlorine dioxide is an unstable and explosive gas and must be generated on site. The overall system is relatively complex to operate and maintain compared to more conventional chlorination.
- Ozone - Ozone is a strong oxidizer and must be applied as a gas. Due to the instability of ozone, it must also be generated on site. Ozone disinfection is relatively expensive with high primary capital cost and high power consumption during operation. Ozonation is also relatively complex to operate and maintain compared to chlorination.
- UV Disinfection – UV disinfection uses light with wavelengths between 40 and 400 nanometers for disinfection. Light of the correct wavelength can penetrate cells of pathogenic organisms, structurally altering DNA and preventing cell function and replication. Because UV light must penetrate the water to be effective, the TSS level of CSOs can affect the disinfection ability. UV disinfection is most applicable downstream of a settling technology.
- Electron Beam Irradiation - Electron Beam Irradiation uses a stream of high-energy electrons directed into a thin film of water. The electrons break apart water molecules and produce a number of reactive chemical species, which can kill pathogenic organisms.

- Emerging Technologies – Several other disinfection systems are being developed for use in CSO disinfection applications. For example, combinations of hydrogen peroxide and peracedic acid provide effective disinfection of wastewaters with less contact time required as compared to chlorination. MSD is evaluating this technology for potential application in CSO treatment and supplemental disinfection for both chlorination and UV systems during periods of high flow. MSD will continue to monitor the application of emerging technologies as part of the “adaptive management” process. If future developments in disinfection technology indicate that a change in direction in disinfection practice is warranted, MSD will consider modifying its approach to CSO and treatment plant effluent disinfection.

Disinfection reduces potential public health impacts from CSOs however, to protect aquatic life in the receiving waters, dechlorination facilities must be installed whenever chlorination is used as a disinfectant. Dechlorination is typically accomplished by injection of sodium bisulfite in the flow stream before discharge of treated CSO flow to waterways. Dechlorination with sodium bisulfite is rapid; hence, no contact chamber is required since the reaction with chlorine is immediate.

3.2.4.5 Deep Bed Filtration

A deep bed filter system consists of a series of large tanks filled with coarse medium; typically sand or anthracite. Excess wet weather flows are directed to the top of each tank and exit at the bottom of the tank. Pollutants either may attach to the filter media or become trapped in the interstitial space of the filter; the filter is later cleaned through backwashing. Chemical additives can be used to improve removal rates.

3.2.4.6 Trickling Filters

Trickling filters are biological treatment technology for treating excess wet weather flows. In a trickling filter system, microorganisms are maintained as a biological film attached to a fixed media. Supplemental treatment facilities with any biological process must operate continuously with a minimum flow rate to maintain the biomass necessary for treatment of wet weather flows. During dry weather, effluent from biological supplemental treatment facilities is typically returned to the sewer system for further treatment and discharged at the WQTC.

3.2.4.7 Constructed Wetlands

Constructed wetlands use natural biotic systems to treat wastewater. Aquatic plants and bacteria utilize the organic wastes, nutrients, greases and bacteriological pollution found in CSOs in much the same way as in a traditional WQTC. Constructed wetlands act as both storage and treatment for CSO flows. There are two types of constructed wetlands; subsurface flow and free water surface.

Subsurface flow wetlands consist of a series of planted cells. They are two feet to three feet deep basins filled with rock or other media and vegetated with aquatic plants. These plants hide the rock and feed off the sewage flowing below the surface. These wetlands are designed to not have any exposed sewage. This reduces odor and vector problems making them more acceptable to the public. The downside is that the wholly subsurface requirement greatly reduces the volume treated or stored per acre.

Free water surface wetlands consist of two types of cells. The first type is the open water cell that contains submerged aquatic vegetation. It has a design depth of four feet and cannot tolerate floating aquatic vegetation. The large air to water contact area and penetrating sunlight raise dissolved oxygen and allow for the release of nitrogen gas to the atmosphere. This cell has a high rate physical/chemical treatment of two - three days. Extending the high rate physical/chemical treatment beyond three days, especially in sunny conditions, may cause an algae bloom that would blanket the cell and prevent gas exchange.

The second cell type in a free water surface wetland is the fully vegetated cells. It is heavily vegetated with aquatic plants that either float or grow from the bed and break the surface of the water. Fully vegetated cells are approximately two feet deep. Up to 30 percent of the cell volume is taken up by the flora planted in it. The purpose of the vegetated cell is to prohibit sunlight, drop the dissolved oxygen level, allow anaerobic processes, and kill the algae.

Typically, free water surface wetlands are constructed as alternating open-water and vegetated cells with the first cell being vegetated to trap S&F and enhance settling. The high rate physical/chemical treatment for each cell is two - three days. The process is primarily settling in the first cell with nitrification-denitrification cycle processes beginning as well. The second cell is an open-water cell, which allows for sunlight, algae, and release of nitrogen gas. The cells continue in an alternating series to the point at which the design goals are met. The last cell will always be vegetated to kill any algae. Aeration and disinfection may be added prior to the outfall.

Little energy is required to maintain treatment processes. Typically, energy consumption is limited to pumping if required to deliver CSOs to the wetland area and clear water recirculation pumping during periods of low flow to maintain the health of the facility. Additionally, wetlands provide a storage component with the treatment component. A wetland will typically provide one-million gallons (MG) of storage per acre of wetland. They also provide sanctuary for aquatic flora and fauna. Drawbacks with constructed wetlands are (1) they require relatively large areas of land; (2) treatment processes are slow (especially in cold winter environments); and (3) CSO effluent is left open to the environment.

3.2.4.8 WQTC Modification

Excess wet weather flows cause sudden changes in the hydraulic and pollutant loads impacting the WQTC. Modifications to existing wastewater treatment facilities can increase their ability to handle wet weather flows. Modifications may involve changes to the physical configuration of various treatment processes and/or the operation of specific plant processes during wet weather. Most modifications require the active involvement of the treatment plant operator to ensure effective implementation. Example modifications that maximize the treatment of wet weather flows include:

- Baffles to protect clarifiers from hydraulic surges and ensure the even distribution of flow
- Using metal salts and polymers to increase suspended solids removal
- Switching the mode of delivering flow from the primary to the secondary treatment units
- Switching from "series" operation to "parallel" operation during wet weather flows

Performance evaluations are required to determine whether additional capacity can be obtained from existing facilities. While facility modifications are generally more cost effective than new construction, some modifications that improve wet weather performance may result in increased concentrations of pollutants in treatment plant effluent during dry weather. For example, if not properly designed, a clarifier modified for wet weather flows may have inadequate settling characteristics during dry weather (Metcalf and Eddy 2003). Further, modifications that require operator attention before and after a wet weather event may interrupt regular dry weather operations and potentially compromise the quality of treated wastewater during dry weather.

MSD has made a significant investment in various unit processes to maximize the treatment capacity of the Morris Forman WQTC to make the best use of the asset that exists and to make the process as effective as possible.

3.2.4.9 Interaction with Other Collection and Treatment System Objectives

The Final CSO LTCP developed is based on a "system-wide, annual average basis" in accordance with EPA's CSO Control Policy (1994) using system characterization model (i.e. CSS model) with watershed approach. The CSS model was utilized to explore the following elements, which affects baseline flows and loads:

- Interaction with upstream separate sewer systems
- Integration of current CSO control efforts
- Incorporation of Green Demonstration Projects and Green Infrastructure Program
- Morris Forman WQTC wet weather treatment capacity
- Integration with NMC Program

The CSS provides approximately 45 percent of the total sanitary flow conveyed to Morris Forman WQTC. The remaining flow is contributed by upstream separate sanitary sewer systems (SSS). There are six boundary points in the CSS model where SSS flows contribute to the CSS. The details on model development and location of these boundary points are in Chapter 2, Section 2.4.6.3.

The existing SSSs upstream of the CSS are susceptible to significant wet weather inflow and infiltration. Therefore the quantities of flow entering the CSS from the SSSs are substantially greater during wet weather periods than during dry weather periods. IOAP Volume 3, the Final Sanitary Sewer Discharge Plan (SSDP), addresses the excessive rainfall-derived infiltration and inflow (RDI/I) in the SSS upstream of CSS.

Because of the interaction between SSSs and CSS within Morris Forman WQTC service area, both LTCP and SSDP controls were developed with the understanding that selected controls for one program will likely affect the other program. Sewer models for both LTCP and SSDP were developed with defined boundary points where information such as flows and level were exchanged to establish the appropriate boundary conditions for various alternatives.

One example of the coordination between the CSS and the SSSs upstream is the incorporation of Interim Sanitary Sewer Discharge Plan (Interim SSDP) projects into the separate sewer system model to redefine the inflow contributed to the CSS system. Projects defined in the Interim SSDP reduce the significant amount of wet weather inflow contribution to CSS system by reducing RDI/I within the new sewer system and diverting more wet weather flow to Derek R. Guthrie WQTC. Another example was during alternative evaluation phase for SSO controls in the Beargrass Creek Middle Fork watershed. The hydraulic gradeline in the upper reach of the CSS was analyzed to determine the maximum water surface elevation and peak flow rate required from the upstream SSS to reduce surcharging and eliminate SSOs near a boundary point.

To establish the “baseline” condition prior to implementation of the Final CSO LTCP, current CSS operating parameters were determined by the hydraulic model to provide a reference for evaluating proposed controls. Current CSO control efforts such as RTC Phase II projects, CSO206 (Cherokee Park) sewer separation project, and other CSO elimination projects that are scheduled are incorporated in the baseline model. More details are documented in the 2008 CSO LTCP System Hydraulic Modeling Condition Technical Memo in Appendix 3.2.1.

For the Final CSO LTCP, the watershed approach is multi-scale, ranging from a site-specific solution, to a regional program and it incorporates both “gray” and “green infrastructure” solutions. System-wide green infrastructure opportunity evaluations were performed and a set of specific green projects as well as the Green Infrastructure Program components were identified. The CSS model incorporated the elements of a Green Infrastructure Program such as downspout disconnection, rain gardens, bio-swale, green roof, porous pavement, and dry wells to simulate the reduced stormwater runoff to the CSS. The wet weather treatment capacity at Morris Forman WQTC was confirmed to be 350 MG per day (mgd) peak, and 325 mgd sustainable through stress tests of total plant flows. Expansion of the Nightingale Pump Station and redirecting wet weather flow to Derek R. Guthrie WQTC was evaluated to increase CSO wet weather flow to the Morris Forman WQTC and reduce CSO to the Beargrass Creek.

3.2.5 Approach to Green Infrastructure

The purpose of MSD's green infrastructure initiative is to develop a program that reduces CSO frequency, duration and volume utilizing environmentally sensitive techniques that more closely mimic natural hydrologic processes when compared to more traditional engineering solutions or "gray" infrastructure solutions that are typically employed in CSO control programs. Gray infrastructure solutions for CSO control typically consist of large pipes, storage tanks, tunnels, and high rate treatment facilities.

Green Infrastructure Projects

- Achieve multiple objectives and provide multiple benefits including:
- Reduction of sewer overflows
- Improvement in air and water quality
- Increased green space and wildlife habitat
- Reduced heat island effect in the urban core
- Additional overflow volume reduction by capture of the initial rainfall
- Community beautification

Although conventional engineering alternatives such as high rate treatment, sewer separation, tunnels, and remote storage facilities represent the core elements of MSD's wet weather control program, the opportunities to supplement these conventional engineering solutions with green infrastructure are abundant.

A fundamental principle of the MSD approach is that, while green infrastructure best management practices (BMP) on individual sites are a step in the right direction, a green infrastructure plan that establishes connectivity between neighborhoods, watersheds and ultimately the entire MSD service area results in far greater benefits to the community than the sum of the individual components. Additionally, when compared to gray solutions, the green infrastructure techniques have a much greater potential for leveraging funding from sources other than sanitary sewer and stormwater user fees.

3.2.5.1 Green Infrastructure Initiative

MSD's proposed green infrastructure initiative involved three main components. These components are a compilation and review of pertinent information, identification, and exploration of green infrastructure opportunities, and development of a recommended green infrastructure plan.

Major Elements of MSD's Proposed Green Infrastructure Plan

- Downspout disconnection program
- Rain barrel program
- Rain garden program
- Vegetated roof program
- Green streets
- Green parking lots
- Green alleys
- Urban reforestation

The recommended plan is the result of comprehensive evaluations of local conditions including soils, geology, hydrology, natural systems, impervious area, topography, parcel ownership, and canopy cover within the CSS area. The proposed green infrastructure plan contemplates a considerable investment by MSD in the design, construction and implementation of green techniques across the service area to achieve significant reductions in CSO activity. This investment is supported by a “business case” evaluation of the green infrastructure investments to ensure that money spent supporting the Green Infrastructure Program is cost-effective when compared to equivalent levels of CSO reduction achieved through traditional gray solutions.

Conservative estimates indicate that implementation of a long-term green infrastructure plan may remove nearly one billion gallons (BG) of stormwater runoff from the CSS annually at a cumulative cost to MSD of approximately $0.09/gallon to MSD. Preliminary reductions in stormwater volume based on the use of green infrastructure were developed using a green infrastructure costing tool developed as part of the business case evaluation. Based on assumed performance levels of green controls the cost tool takes into account the implementation of various green controls and the drainage area to the BMPs to determine a reduction in stormwater runoff for a typical year of rainfall. This is different from the CSS hydraulic model which provides a more conservative estimate of the benefit of the green infrastructure plan because the model represents a continuous simulation and accounts for antecedent moisture conditions, infiltration limitations, and pervious connectivity to storm drains. Additionally, the CSS model is utilized to predict the effects of green infrastructure implementation on the Average Annual Overflow Volumes (AAOV) for each CSO. This AAOV reduction does not match the stormwater reductions into the CSS due to specifics stated above as well as the attenuation and peak flow timing.

Partnering and working with local entities allows MSD to cost share the greater overall investment in green infrastructure lowering MSD’s effective cost per gallon. This cost per gallon estimate is comparable to and in many cases much less than, more conventional gray alternatives, such as pipes and storage facilities. In addition, this analysis is based solely on a cost/gallon basis and does not consider the many other benefits that green infrastructure provides.

3.2.5.2 Green Infrastructure Background

The terms of this Consent Decree included the requirements to eliminate SSOs and minimize CSOs. While there are no specific requirements in the Consent Decree regarding the use of green infrastructure BMPs, EPA is certainly encouraging communities to explore innovative techniques and practices such as Low Impact Development and green infrastructure to reduce CSO discharges.

At the national level, the Natural Resources Defense Council released a report titled “Rooftops to Rivers” (June 2006) which identified green infrastructure as a viable strategy for reducing the impacts of CSO discharges on the water quality of our nation’s waterways. This report provides case studies from numerous communities that have successfully incorporated green infrastructure strategies into their CSO reduction programs.

On March 5, 2007, Benjamin Grumbles, the Assistant Administrator of Water for the EPA released a memorandum to the EPA Regional Administrators regarding "Using Green Infrastructure to Protect Water Quality in Stormwater, CSO, Nonpoint Source and other water programs."

In this memorandum, Mr. Grumbles stated:

> *"Green infrastructure can be both a cost effective and environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions."*

Mr. Grumbles went on to say:

> *"I strongly support the use of green infrastructure approaches described in the Natural Resource Defense Council report…"*

As MSD initiated the development of the Interim CSO LTCP, a decision was made to aggressively explore green infrastructure opportunities within the CSS area with the goal of developing a comprehensive Green Infrastructure Program that would be integrated into the Final CSO LTCP. While it is recognized that traditional gray solutions will play a major role in the Final CSO LTCP, MSD is committed to maximizing the use of green infrastructure elements in the overall solution matrix. The following is a description of this green infrastructure planning effort and the recommended green infrastructure components.

3.2.5.3 Green Infrastructure Philosophy

Estimates indicate that the CSS discharges approximately 2.8 per year of untreated flow to local waterways. As plans were developed to minimize these discharges and comply with the terms of the Consent Decree, MSD realized that a considerable amount of local ratepayers' dollars was going to be invested in pipes, storage, and treatment facilities throughout the community. While these traditional engineering solutions are effective at reducing the volume of untreated flow discharging to local streams, these techniques may not provide benefits in other important areas such as air quality, wildlife habitat, or urban beautification. Considering the significant community resources that will be directed toward CSO mitigation, it seemed logical to explore innovative approaches that would maximize the benefits to the community for the dollars invested.

The WWT Stakeholder Group assisted MSD in the development of the Final CSO LTCP, supporting and encouraging the development of a Green Infrastructure Program as part of the Final CSO LTCP. Based on a review of local conditions, feedback from the WWT and a review of green infrastructure case study information, MSD identified four principles to guide the development of the Final CSO LTCP Green Infrastructure Program:

- Enhance and preserve natural systems
- Implement green roadways, rooftops and parking lots
- Foster strategic partnerships
- Connect green infrastructure systems to other community assets

3.2.5.4 Strategy

With the guiding principles established, MSD created a strategic approach for the development of the Green Infrastructure Program. MSD recognized that while many communities had successfully implemented green infrastructure elements targeting CSO control, few, if any, had developed comprehensive Green Infrastructure Programs during the initial phases of their LTCPs. MSD viewed this as an opportunity to maximize the role of green infrastructure and the associated benefits to the community.

MSD emphasized the importance in evaluating and integrating green infrastructure opportunities at a variety of physical scales including sites, neighborhoods, sewersheds and regions in order to establish a connected network of green components that merge into a single regional vision. See Figure 3.2.1 located at the end of this chapter for a graphical depiction of the vision that emerged from this effort.

MSD used this regional vision to develop a Green Infrastructure Program in order to reduce the amount of stormwater entering the CSS. For the purpose of evaluating the potential stormwater reductions achievable through the use of green infrastructure, the regional evaluation used a 15-year planning horizon. However, as discussed later in the chapter, MSD will assess the performance of green infrastructure demonstration projects and programs during the first six years of implementation with the goal of evaluating and adjusting financial allocations for particular programs based on a benefit-cost analysis. While green infrastructure is an important component of the Final CSO LTCP, MSD's long range commitment to this program will be based on how green technologies perform in comparison to more traditional gray solutions.

Developing a comprehensive, regional Green Infrastructure Program at the front end of a LTCP effort is an innovative and progressive approach to CSO mitigation and one that is consistent with the recommendations of the Natural Resource Defense Council and EPA.

3.2.5.5 Regional Evaluation

The regional evaluation process is relatively complex and involves a thorough understanding of site-specific issues within the community including physical, political, financial, and technical parameters. The following section provides a discussion of the eight key steps in completing this process.

Regional Evaluation Step 1 – Identification of Existing Green Infrastructure Programs

The regional evaluations began with a compilation of existing information on current green infrastructure projects and programs throughout Louisville Metro. Numerous green infrastructure activities already underway provide an important stepping-stone for the implementation of MSD's green infrastructure initiative.

Following is an explanation of some of the existing initiatives in Louisville Metro.

1. Kentucky Green and Healthy Schools

   According to the Kentucky Green and Healthy School's website, "The Kentucky Green and Healthy Schools Program is a new, voluntary effort to empower students and staff with the tools needed to take action and make their school operate at peak efficiency." Kentucky Green and Healthy Schools incorporates a two-pronged approach as follows:

   - New or renovated schools may include a "green and healthy" design from the start.
   - Existing schools allow students to inventory current school operations and environments in an effort to implement action plans that will improve school health and sustainability."

2. City of Parks

   According to www.LouisvilleKy.gov the City of Parks is a visionary and aggressive expansion of Louisville's Metro's park system, adding thousands of acres of green space, a 100-mile paved trail encircling the city, and improvement projects at hundreds of existing parks all over the Metro area.

3. Partnership for a Green City

   According to the Jefferson County Public School (JCPS) Center for Environmental Education, "the Partnership for a Green City began in August 2004, as a major step toward overcoming challenges to Louisville's environmental practices. The Partnership represents a collaborative effort to improve environmental education, environmental health, and environmental management by three of Louisville's largest public entities: Louisville Metro Government, the University of Louisville, and the JCPS. Most recently, the Partnership, and the three agencies have adopted a *Statement of Environmental Principles*. The *Principles* will be used to guide policy, budget, and program decisions being made by the Partners to incorporate sustainable ideas."

4. 21st Century Parks

   According to its website, 21st Century Parks was "founded in 2005, and is a Kentucky-based, private, non-profit corporation, created to bring a fresh vision to the preservation and development of new public parklands. Their current project is *The Fork*; planned for eastern and southern Louisville Metro, it will be one section of a new 100-mile loop creating one of the largest new urban park systems in the nation. Building on the visionary effort of former Lt. Governor Steve Henry and The Future Fund, Inc. and joining in partnership with Louisville Metro Government and Louisville Metro Parks; *The Fork* encompasses over 3,000 acres of preserved lands in southeast Louisville."

Each of these existing initiatives has the potential to impact MSD's CSO control efforts and the green infrastructure initiative in particular. MSD will continue to explore opportunities with these key stakeholders to identify mutually beneficial partnerships. See Table 3.2.1 for a partial list of existing programs.

TABLE 3.2.1

CURRENT GREEN INFRASTRUCTURE PROGRAMS WITH MSD INVOLVEMENT

Activity	Participants
Rain Gardens	Youth Build, ACTIVE Louisville
Rain Barrels	Youth Build, Louisville Nature Center
Outdoor Classrooms	Jefferson County Public Schools (JCPS), Partnership for a Green City
Riparian Buffers	Metro Parks/Olmsted Parks Conservancy
Invasive Species Removal	Metro Parks, Olmsted Parks Conservancy, Living Lands and Waters
Stream Clean-Up	Living Lands and Waters
Litter Clean Up/Beautification	Operation Brightside
Community of Trees	Louisville Metro Council, Metro Parks, Housing Authority, Muscular Dystrophy Association, Operation Brightside

The importance of these partnerships and strategic collaboration on projects with other entities is further discussed below.

Regional Evaluation Step 2 – Establish Project Awareness and Potential Project Partners

Impervious surfaces such as streets, parking lots, and rooftops are the major source of runoff in the CSS Area. While a considerable amount of land within the CSS is publicly owned, (nine percent), MSD owns a very small percentage (0.2 percent) of this land. Therefore, in order for MSD to implement effectively a source control strategy, partnerships with local property owners are essential.

In recent years downtown Louisville Metro has been the beneficiary of considerable redevelopment activities. As the trend continues, development and re-development projects in the CSS represent opportunities for MSD to partner with both public and private entities to encourage, incentivize and/or fund the construction of green infrastructure to reduce stormwater runoff entering the CSS. Incorporating green techniques into a site plan is most effectively accomplished if the green components are developed early in the process.

A key element of MSD's overall green strategy is to identify partnership opportunities throughout the community. There are numerous public agencies in Louisville Metro with plans to invest significant amounts of money over the next decade in the construction and upgrade of public infrastructure including streets, schools, parks, highways, and public housing. Each public project represents an opportunity to incorporate green infrastructure. By coordinating the design and construction of green controls into planned public projects, MSD will realize stormwater reduction benefits at a fraction of the cost compared to retrofitting green controls after the planned projects are built.

MSD staff has put considerable effort into the development of partnerships with other local public agencies to evaluate the potential to incorporate green components into planned capital improvement projects. For example, JCPS has a five-year capital improvement plan budget of $50 million for upgrades to local schools. There are 45 public schools located in the CSS and JCPS has budgeted $5.5 million for roof and site improvements for these schools.

MSD and JCPS have agreed to work together to create "win-win" projects that meet the needs of the school district while reducing the runoff from the sites. Numerous green infrastructure concept plans have been developed, including those for Roosevelt Perry Elementary and Engelhard Elementary schools.

MSD has also initiated discussions with other agencies including Louisville Metro Housing and Metro Public Works. Both agencies have expressed considerable interest in green techniques and a willingness to incorporate green elements into planned capital projects where feasible. Other agencies MSD has met with include:

- Mayor's Office
- Economic Development
- Private Developers/Architects/Engineers/Landscape Architects

- Metro Parks/21st Century Parks/Future Fund
- City of St. Matthews
- ACTIVE Louisville
- Partnership for a Green City
- Kentucky Association of Festivals
- Neighborhood Associations

These entities are potential project partners that could become “green ambassadors” promoting the inclusion of green infrastructure throughout the community.

Regional Evaluation Step 3 – Existing Green Infrastructure Initiatives Mapping

Awareness of other activities, developments, and programs within the MSD service area will allow MSD to make informed decisions about where their green efforts should be focused and how they may incorporate green infrastructure components into others’ activities. This is an ongoing effort intended to identify opportunities for MSD to promote the incorporation of green infrastructure techniques into projects being funded by other local agencies at their earliest stages. In certain instances, MSD may decide to partner with these agencies to design and/or construct green infrastructure elements into these projects.

MSD has compiled information on existing Green Infrastructure Programs and planned projects and created Geographic Information System (GIS)-based maps to facilitate the integration of these projects into the community-wide green vision. Figure 3.2.2 located at the end of this chapter displays some of these key programs and opportunities in the community that support and augment MSD’s green vision. These include the Community of Trees planting plan, proposed urban redevelopment projects, bikeways, existing and proposed green infrastructure projects, rain barrels, and other green infrastructure initiatives.

Regional Evaluation Step 4 – Impervious Area Evaluations

MSD’s Consent Decree mandates the minimization of overflows from the CSS. Wet weather CSOs occur when too much stormwater runoff enters the CSS and the system capacity is exceeded resulting in discharges directly to local receiving streams. A root cause of the excessive stormwater runoff is impervious surfaces. As landscapes are developed and natural vegetation is replaced with pavements and rooftops, the rate and volume of stormwater runoff that occurs during precipitation events dramatically increases.

Ideally, post construction green infrastructure techniques would be designed to match the pre-development hydrology of the system in terms of infiltration, evaporation, and runoff. Obviously, this is not realistic, particularly from the perspective of retrofitting a highly urbanized environment. However, a Green Infrastructure Program designed to reduce CSOs must decrease the amount of impervious surface and/or reduce the volume of runoff entering the CSS.

A detailed impervious area evaluation was performed for the entire combined sewer area – which totals approximately 37 square miles utilizing available information in the Louisville Jefferson County Information Consortium (LOJIC) GIS database. The objective of this evaluation was to determine the distribution of impervious surfaces and their relative significance throughout the CSS. This information is critical in identifying major categories of impervious surfaces and in selecting appropriate green techniques to reduce stormwater from these sources. This evaluation was a significant factor in the development of the regional plan.

The result of this exercise revealed that the CSS contains approximately 500 million square feet (sq. ft.) of impervious area, which represents approximately 19 square miles, or 51 percent, of the combined system. This total impervious area was further divided into specific categories including rooftops, roadways, and parking lots. The area of each surface type was determined, along with the relative percentages of each, in relation to the total impervious area contained within the CSS. Roads represent 135 million square feet, buildings 187 million sq. ft. and parking, sidewalks and driveways represent another 183 million sq. ft. of hard surface.

Impervious Surfaces in the CSS

The following is a breakdown of the primary landuse types and distribution of the total impervious area throughout the CSS.

- Roads 26 percent impervious
- Single Family 27 percent impervious
- Industrial Property 17 percent impervious
- Commercial Property 13 percent impervious
- Other 17 percent impervious

Additionally, an impervious area evaluation by landuse type was performed. This evaluation showed that 36 percent of the impervious surfaces in the CSS are located on publicly owned property, including roadways. Schools account for over eight million sq. ft. of impervious surface while MSD owned property comprises only 1.2 million sq. ft. of hard surface, underscoring the importance of partnerships.

See Appendix 3.2.2 Impervious Area Evaluation for a detailed description of the impervious area distribution within the CSS. Figure 3.2.3 located at the end of this chapter is a map showing the extent of impervious surfaces within the combined system.

In summary, in order for the Green Infrastructure Program to have a major impact on CSO reduction in Louisville Metro, the program will need to target roads, residential properties, and some percentage of industrial/commercial landuses.

Regional Evaluation Step 5 – Natural Systems Evaluations

Natural systems such as stream networks (existing and historical), soils, geology and wetlands were evaluated and considered in the identification of opportunities to implement green infrastructure. With the stated goal of promoting techniques that are consistent with the natural hydrologic cycle, an important first step in the green evaluation process was to develop an understanding of natural systems. This understanding involves reviewing locations, capacities, and suitabilities to accommodate additional runoff, including historic resources that are now less visible.

Historic maps were reviewed in an effort to better understand the evolution of natural drainage systems for the CSS Area. Information was compiled showing the location of stream networks, historic wetlands and major pond features from over one hundred years ago. Many of these streams and drainage features are no longer evident. Figure 3.2.4 located at the end of this chapter is map from the Civil War era that shows where streams once existed west of downtown and how the Beargrass Creek and other features have been modified over time. Appendix 3.2.3 Historic and Natural Systems Mapping contains other historic and natural systems mapping that were compiled as part of this effort.

A general philosophy of MSD's green approach is to capitalize on these natural systems to allow them to function more as nature intended to provide beneficial functions. The urbanization of cities has involved the systematic replacement of streams and wetlands with hard surfaces and piping networks. The result has been a lower groundwater table, lower base flows in our streams, higher peak flows in the streams during wet weather and an overall change in the natural hydrologic and hydraulic cycle.

As shown in Figure 3.2.5, located at the end of this chapter, under natural conditions a large percentage of annual precipitation either infiltrates or evaporates with only approximately ten percent of rainfall resulting in runoff. Landuse changes associated with urbanization can have a dramatic effect on this overall water balance resulting in large increases in runoff volumes and corresponding decreases in infiltration and evaporation.

A key objective of MSD's green infrastructure approach is to protect this natural water balance in less developed and undeveloped areas of the community especially with anticipated landuse changes. The second half of the objective is to restore, where supported by the business case, the natural hydrologic balance that existed in the downtown area prior to major urbanization. By understanding the natural systems, specific practices can be implemented to restore or enhance the pre-developed function of the land.

The Green Infrastructure Program contemplates the use of existing natural systems and the replacement of impervious surfaces with vegetated surfaces to both minimize runoff and to convey redirected runoff from the CSS to existing natural systems. Both of these approaches should assist in reducing CSOs.

Regional Evaluation Step 6 – Tree Canopy Coverage

As discussed above, downtown Louisville Metro is comprised of significant amounts of impervious surfaces. With the increase of hard surfaces such as roads, parking lots and buildings there is usually a corresponding decrease in tree canopy cover. The loss of canopy cover can have a significant impact on stormwater runoff.

As noted on EPA's website: [See EPA fact sheets in Appendix 3.2.4].

> *"A study done by the U.S. Department of Agriculture's Center for Urban Forest Research found that a medium-sized tree can intercept 2,380 gallons of rain per year" (Center for Urban Forest Research 2002).*
>
> *"Trees also absorb carbon dioxide, decrease temperatures, and provide habitat for urban wildlife. Urban forestry also reduces noise levels and provides recreational benefits."*

With the proper tools, types of plants, planting, and maintenance, reforestation can effectively reduce both the pollutants in, and the volume of, stormwater. The nonprofit organization American Forests conducted a study in the Houston area to document urban forest covering a 3.2-million-acre area. They also analyzed 25 specific sites with aerial photography using CITYgreen software to map and measure tree cover. Study results show that trees provide significant benefits relative to the quality and quantity of stormwater runoff and energy savings. The study found that Houston's tree cover reduces the need for stormwater management by 2.4 billion cubic feet per peak storm event, saving $1.33 billion in one-time construction costs (ENN, 2001).

A CITYgreen evaluation was performed for the CSS area. CITYgreen is GIS software that analyzes the ecological and economic benefits of tree canopy and other green space. CITYgreen was developed by American Forests, a pioneer in the science and practice of urban forestry. The software works only in conjunction with analysis software from the Environmental Systems Research Institute. In addition to computing air pollution removal and carbon storage, this software application computes stormwater runoff using the Natural Resource Conservation Service model. CITYgreen software has been successfully used by major cities across the nation to implement Green Infrastructure Programs.

The results of the CITYgreen exercise, summarized in Table 3.2.2, indicate that the current canopy cover, which is only 11 percent of the CSS area (2,600 acres), represents over $30 million in onetime stormwater storage benefits to the community, in lieu of constructing stormwater detention facilities. The evaluation further indicates that by increasing canopy cover to the point where it represents 26 percent of the CSSA or 6,200 acres would provide an additional $43 million in stormwater storage benefits. For more information about the CITYgreen exercise please see Appendix 3.2.5 CITYgreen Analysis.

TABLE 3.2.2

STORMWATER STORAGE BENEFITS BASED ON AN INCREASE IN TREE CANOPY

	Tree Canopy		Onetime Stormwater Storage Benefits
	Acres	% of CSSA	CITYgreen Exercise
Existing Conditions	2,600	11%	$30,000,000
Increase Tree Canopy	6,200	26%	$73,000,000

In addition to the increase in stormwater storage benefits, other benefits associated with a 26 percent tree canopy cover include:

- Carbon stored: 266,600 tons total
- Carbon sequestered: 2,100 tons per year
- Air pollution removal: 629,700 lbs per year

The Clifton neighborhood, located on the east side of the CSS, was selected as a pilot area to conduct a more detailed and accurate CITYgreen evaluation. Canopy cover values were developed by manually digitizing aerial photographs. It was determined that approximately 45 percent of the study area has impervious surfaces and 20 percent is tree canopy. The CITYgreen analysis indicated that the current canopy represents $1.1 million in stormwater storage benefits. This benefit could be increased by $500,000 if only 15 percent or 29 acres of the existing impervious surface area were replaced with tree canopy.

As part of the evaluation, a review of Louisville Metro's Land Development Code for canopy cover requirements for various landuses were compared to target values established by American Forests, Inc. Louisville Metro's current regulations exceed recommended values for urban residential landuses but have significantly lower requirements than suggested for suburban landuses. See Figure 3.2.6 located at the end of this chapter.

Regional Evaluation Step 7 - Stormwater Redirection

Sewer separation is a common technique used to reduce CSOs. While this is an effective technique from a CSO discharge reduction perspective, it may simply move the additional stormwater runoff from one pipe system to another and can aggravate a number of other concerns associated with urbanization such as water balance, loss of habitat and low base flows in local streams.

In order for redirection of runoff from the CSS to be a viable part of the CSO control program, an alternative conveyance system to transport stormwater flows needs to be identified. The natural systems mapping exercise revealed: with the exception of the Beargrass Creek, few natural drainage features remain within the CSS. However, a number of local streams, particularly in the southwest section of Louisville Metro, are located in close proximity to the outer edge of the CSS boundary.

Figure 3.2.7, located at the end of this chapter, shows the delineation of the CSS system and the local stream networks. A review of this map indicates that there may be potential to separate stormwater from areas near the outer boundary of the CSS and redirect this flow to existing streams located outside the CSS area. This approach is referred to as “offloading.” Further evaluation of these streams will need to be performed to ensure that the additional flows do not create new, or aggravate existing problems such as hydromodification or flooding prior to actual implementation of these types of projects.

A study area, delineated by a dashed line in Figure 3.2.8 that parallels the CSS boundary but is located 1/4 mile inside the existing perimeter, was established for the purpose of further exploring this option. Figure 3.2.8 is located at the end of this chapter. This zone contains approximately 8,000 acres and generates approximately four BG of stormwater runoff annually. Successful redirection of even a small percentage of the runoff generated in this area would result in significant reductions in flow to the CSS. Several focus areas along this boundary were identified through this process and will be discussed further in Section 3.2.6.7.

Regional Evaluation Step 8 – Subsurface Evaluations

Many green infrastructure techniques rely on infiltration as the primary mechanism to achieve runoff volume reductions. Soils and geology are important components in determining if and where stormwater runoff can be infiltrated into the subsurface. Soil permeability plays a major role in the design configuration and the functionality of certain green control techniques. High permeability rates can reduce the footprint and/or profile of a proposed green component resulting in very cost effective designs. Understanding local soil characteristics is very important in the development of a recommended program. Unfortunately, adequate soils information was not readily available for the CSS area. The soil information contained in the LOJIC database for the CSS area simply showed a single polygon with the classification of “urban soils.” The Natural Resource Conservation Service database showed slightly more detail but the core downtown region of Louisville Metro was still labeled “Urban Area.”

Therefore, MSD worked with a local geotechnical engineer with years of experience in the Louisville Metro area to evaluate further the soils and geology in this region. A generalized map of soil and rock conditions was generated using a combination of published subsurface data, engineering experience, and local records of excavations and soil test borings within the CSS boundaries. This map, while somewhat coarse, provides a general guide for directing the types of green techniques that are applicable in the different regions throughout the Louisville Metro area. While this evaluation is an important tool to guide the selection of BMPs, it is only a preliminary delineation and site-specific evaluations will be necessary for final design.

Figure 3.2.9, located at the end of this chapter, is a geologic map of Kentucky, which shows that the Louisville Metro is located on the western edge of the geological formation known as the Cincinnati Arch. The eastern portion of the Louisville Metro is located in the uplifted fringe of this formation. In addition to having greater topographic relief than the western part of the City, the geologic characteristics of east Louisville Metro differ significantly from the rest of the City. The eastern portion of the CSS, particularly in the Beargrass Creek area, is dominated by bedrock forming karst uplands with sinkholes. The karst geology in this area contains limestone bedrock with sinkholes that may be considered for infiltration if supplemented with biofiltration strategies. The following is a brief description of the results of the subsurface evaluation:

- The Louisville Metro area is composed of two basic geologic settings: deposits related to past activities and alignments of the Ohio River (alluvium) and residual soils (soils weathered in place) derived from limestone and shale layers.
- The downtown area is immediately adjacent to the Ohio River and lies on deep sand and gravel layers extending down about 100 feet to limestone.
- The west part of the city also was formerly located in the riverbed but has more recently been part of backwater, or slower, depositional characteristics. These conditions produced silt and clay layers over the deeper alluvial strata.
- To the south, the depth to rock becomes much shallower, and the upper rock surface is composed of relatively impermeable shale. The combination of the fine-grained backwater soils and the impermeable rock creates very soft, poorly drained conditions. Easily weathered shales on the slopes along the southern edge of the CSS area add slope instability to the soft conditions.
- The eastern and southeastern portion of the Louisville Metro is composed mainly of fine-grained soils, but these are residual soils weathered from shale and limestone. The soils typically are moderately to highly plastic clays, low in permeability. The residual deposits are relatively thin and overlay variably solutioned limestone. Sinkhole development is common, particularly in those areas underlain by the Jeffersonville limestone formation.

Published data from the United States Geological Survey (USGS) and the Natural Resource Conservation Service were used to draw approximate boundaries between the aforementioned conditions. Experience with soil test borings and excavation was referenced to refine those boundaries and define a number of “classifications” for soil conditions within the CSS project area. Those classifications indicated that:

- Several areas in the center and the west of the CSS area would be suitable for green methodologies involving discharge of surface water runoff into the subsurface.
- Some sections in the north-central and southwest portions of the subject area were found to be suitable for shallow infiltration methods, such as bioswales, green streets, and green parking lots.

- Areas in the west and north central were identified as appropriate for applications, which discharge runoff deeper in the subgrade (dry wells) where shallow fine-grained (lower permeability) deposits overlay more permeable sands and gravels.
- The eastern and southeastern sections of the CSS area were considered to be very sensitive due to the possibility of sinkhole development with the introduction of runoff into subsurface conditions where subsidence over karst terrain is possible.
- The subsurface conditions map (see Appendix 3.2.6, Regional Soils Evaluation) divides the CSS area into six different zones based on shallow soils and geology types.

The six zone delineations are as follows:

- Zone 1 – Alluvium: shallow infiltration due to recent deposits of sand, gravel, and silt
- Zone 2 – Clay: typically 5 - 20 ft. of low permeability, risk of sinkhole activity
- Zone 3 – Clay with shallow shale: no shallow infiltration, unstable on slopes
- Zone 4 – Loess: unconsolidated silt over shallow shale
- Zone 5 – Outwash: silts and clays in the upper 15 - 20 ft., sands below grading to gravel
- Zone 6 – Terrace: silts and clays in upper 15 - 20 ft., over shale

Special conditions, such as second- or third-generation redevelopment and old underground utilities, were noted as being pertinent with regard to the suitability of subsurface discharge methods and the possible corresponding problems. These conditions were identified as being characteristic of particular areas so that they became considerations when green methods were suggested for specific sites. Most of the northern part of downtown Louisville Metro is second- or third-generation construction, and past demolition methods involved razing old buildings and pushing the debris into the subsurface on the site. Typically, fine-grained fill soils, such as silty clays, have been compacted over the debris-filled layers to create building pads. The resulting subsurface conditions include large voids. Runoff flowing down through such deposits can transport the fine-grained fill into the voids in the deeper strata, causing subsidence to occur under existing structures. In addition, numerous old utilities are present throughout downtown, most of which act as conduits for water flowing down through the soil. Increasing runoff to zones containing such utilities can cause dropouts and large volumes of subsidence. Known sites containing old debris and abandoned utilities were avoided when considering potential sites for green demonstration projects.

A number of older buildings in downtown also were constructed at a time when excessive groundwater was not considered in design. Infiltration of significant volumes of runoff into the foundation bearing soils and basement wall backfill around such buildings could cause structural problems, so the general locations of these buildings were considered when evaluating specific green application locations.

A final condition evaluated for the soils map was the presence of large contamination zones in the sand and gravels layers in the center and western portions of the combined sewer service area. Published environmental records were reviewed to identify areas of significant contamination so that green measures, such as dry wells, would not expand contamination plumes or otherwise exacerbate existing problems. Refer to Appendix 3.2.7 Contamination Regions for a map showing the contaminated regions in the CSS. See Figure 3.2.10, at the end of this chapter, showing the hydric soils result in a soil with distinctly different properties than non-hydric soils.

Regional Evaluation Summary

The eight steps in this regional evaluation process are a unique effort that was designed specifically for the MSD's green infrastructure process. By completing a comprehensive regional green infrastructure planning initiative at the front end of the Final CSO LTCP, MSD is poised to be a national model for the use of green infrastructure in the control and mitigation of combined sewer overflows. A graphical depiction summarizing the results of this complex regional evaluation has been developed and is presented in Figure 3.2.11 located at the end of this chapter. This regional plan will serve as the roadmap to guide Louisville Metro to a greener, more livable and sustainable future.

3.2.5.6 CSO Sewershed Evaluations

Much of the data generated during the regional sewershed evaluation provided valuable information that opened opportunity for detailed assessments of green opportunities at a smaller scale. The CSS area is divided into over 100 smaller sewersheds that generally represent the local drainage area to a particular permitted overflow point. These individual sewersheds provided logical study units for performing this detailed evaluation.

Each sewershed with an active overflow was reviewed for potential green opportunities. For the purpose of consistency, a standard set of criteria was developed to evaluate each sewershed basin. The following is a brief description of the criteria that were used for this exercise:

- Public alleys were considered for porous pavements.
- Publicly owned buildings were candidates for green roofs.
- Mapped sinkholes were considered for stormwater offloading.
- Publicly owned green spaces were considered for biofiltration techniques.
- Publicly owned parking lots were considered for biofiltration techniques.
- Catch basins in Zone 5 were considered for dry wells.
- Residential housing in Zone 5 was considered for downspout disconnection.

In addition to this standardized set of criteria, the following information was included on each opportunities map, to assist in with the green evaluation:

- Overflow characterization (volume, duration and frequency)
- Percent tree canopy
- Number of catch basins
- Population

The purpose of this assessment was to objectively examine each sewershed and identify the potential opportunities to implement green infrastructure within that particular study area. The result of this exercise was the generation of approximately 100 maps of individual sewersheds, each with specific green infrastructure opportunities identified. See Appendix 3.2.8 Green Opportunities Maps for Individual CSO Basins for the green infrastructure opportunities maps for each sewershed.

This assessment task was not intended to provide a detailed evaluation of each of the identified opportunities but rather to understand the various types of opportunities and their relative significance across the CSS. With this understanding, MSD identified a short list of green infrastructure techniques along with candidate locations to evaluate further for the implementation of various demonstration projects.

Information obtained from LOJIC data served as the basis for this evaluation and included the following data:

- Imperviousness
- Landuse
- Public ownership
- Single family homes
- Commercial/Industrial property

LOJIC
Louisville/Jefferson County Information Consortium

Each of these categories is described in more detail below.

Imperviousness

As discussed earlier, an impervious area is a root cause of CSOs. The result of increased impervious surface is an increase in both peak discharge rates of stormwater runoff and an increase in the overall volume of stormwater runoff. In the CSS, all this additional stormwater runoff must be conveyed by a pipe network that in some cases is over 100 years old. When the capacity of the CSS is exceeded, overflows occur. Therefore, developing a Green Infrastructure Program that emphasizes source control requires that the distribution of impervious surfaces within each sewershed be determined.

The data contained in the LOJIC database allowed for a more detailed evaluation of imperviousness for individual basins. In general, impervious areas were divided into three major categories: rooftops, roadways, and miscellaneous transportation areas such as parking lots, sidewalks and driveways.

By evaluating the impervious area distribution within each individual sewershed and evaluating this in the context of a particular CSO, MSD can begin to target particular types of impervious surface and identify effective green infrastructure techniques to reduce the associated runoff.

Landuse

Landuse is important in this process because the types of impervious surfaces are directly linked to landuse types. Landuse distribution was calculated for each sewershed based on identified categories. These categories included residential, commercial, industrial, parks and open space and public space.

This data helps determine which green infrastructure techniques may be most appropriate for a particular area. For example, in an area comprised predominantly of residential landuse, most of the impervious surface is residential rooftops and roadways. Therefore, a recommended Green Infrastructure Program targeting this area would need to identify techniques that are suitable for these types of impervious surfaces and would likely not anticipate a large benefit from a control such as a green roof program.

Public Ownership

Using data provided by LOJIC, public properties within each basin were identified and included police stations, fire stations, post offices, schools, and other government buildings. The total roof area and parking lot area associated with publicly owned lands were calculated for each sewershed basin. This determined how much public property was contributing to the imperviousness of the sewershed. Public buildings were marked as a potential for a green roof and public parking lots were marked as a potential for permeable pavement or biofiltration techniques. In order for the MSD green initiative to be successful, major property owners within the CSS will need to become partners in the implementation of green infrastructure techniques. Large land owning public agencies represent good candidates to fulfill this need.

Single Family Homes

Utilizing LOJIC data, the number of single-family homes and associated rooftop area, in each sewershed, was calculated based on the “Single Family” landuse delineation. This determined the total single-family rooftop area that contributed to the imperviousness of the basin. Based on the size of the residential parcels, the density of the homes, the percentage of the impervious area, and the subsurface conditions of the area, a ranking of good, fair, or poor was given to each basin regarding the potential effectiveness of a downspout disconnection program.

Commercial/Industrial Property

The LOJIC database contains landuse information that delineates commercial and industrial properties from other landuse types. While MSD is actively working with this sector in new and redevelopment projects to educate and incentivize green practices, MSD has opted to be very conservative in its estimates of green benefits in the context of the Final CSO LTCP and therefore has not projected CSO reductions from projects in this landuse class.

3.2.5.7 Neighborhood and Focus Area Evaluations

An important outcome of the regional evaluation was the identification of seven focus areas recommended for further evaluation. While each site has unique characteristics, they all represent opportunities to:

- Offload or remove significant amounts of stormwater runoff from the CSS
- Partner with a public agency
- Establish connectivity of green spaces

The focus areas and the associated CSO reduction projects discussed below represent conceptual solutions only. Each area will require additional study to determine the feasibility of the proposed techniques. Most of the proposed concepts involve a combination of green and gray infrastructure technologies.

Focus Area 1 – Northwest Area

Focus Area 1, located in the northwest portion of the combined sewer service area is comprised of residential and industrial landuses with a significant amount of Right of Way (ROW). A total of 272 acres have been identified within this Focus Area 1.

Based on an analysis of existing surface drainage patterns, soil characteristics and available land area the following green infrastructure opportunities exist:

- Redirect stormwater runoff from the interstate system to biofiltration facilities and dry wells located in the I-264 ROW.
- Capture, treat, and redirect runoff from rail yard to facilities in I-264 ROW.

- Construct porous alleys in local neighborhoods.
- Separate storm sewers in local neighborhoods and redirect to the biofiltration facilities and dry wells located in the I-264 ROW.

Refer to Figure 3.2.12, located at the end of this chapter, for the features and conditions of the Northwest Focus Area.

Focus Area 2 - Northeast Area

Focus Area 2, located in the northeast portion of the combined sewer area is comprised of residential, industrial, natural stream network and a significant amount of ROW. Based on an analysis of existing surface drainage patterns, soil characteristics and available land area the following green opportunities exist:

- Separate storm sewers in local neighborhoods and redirect to stream system or biofiltration, wetlands and/or sinkholes facilities along stream corridor.
- Enhance local greenway system and establish greater connectivity between neighborhoods.
- Incorporate green infrastructure controls into major planned State highway corridor reconfigurations adjacent to the Ohio River.
- Capitalize on existing neighborhood organizations and areas with public support for green infrastructure through targeted downspout disconnection programs, rain barrel distribution, and residential rain garden installations.

Refer to Figure 3.2.13, located at the end of this chapter, for the features and conditions of the Northeast Focus Area.

Focus Area 3 – South Central West Area

Focus Area 3, located in the south central west portion of the combined sewer area is primarily residential landuse along with a number of schools and some ROW. Based on an analysis of existing surface drainage patterns, soil characteristics, and available land area the following green infrastructure opportunities exist:

- Separate storm sewers in local neighborhoods and redirect to adjacent stream networks.
- Create strategic partnerships with local schools to incorporate green infrastructure components on school properties that also provide educational opportunities.

- Implement green infrastructure techniques on Louisville Metro Municipal Housing Authority property.
- Retrofit existing detention facilities to incorporate water quality-based design elements and/or infiltration components.

Refer to Figure 3.2.14, located at the end of this chapter, for the features and conditions of the South Central West Focus Area.

Focus Area 4 - South Central East Area

Focus Area 4, located in the south central east portion of the combined sewer area is comprised of residential, industrial and a significant amount of interstate ROW. This focus area has tremendous opportunity to forge valuable strategic partnerships. Key landowners in this area include Kentucky Exposition Center, Kentucky Transportation Cabinet, University of Louisville, Churchill Downs, and Louisville International Airport.

There are a relatively high percentage of pavements in this study area in the form of parking lots, roadways, and runways contributing large amounts of stormwater runoff to the CSS. Based on an analysis of existing surface drainage patterns, soil characteristics, and available land area the following green infrastructure opportunities exist:

- Redirect stormwater runoff from the interstate system to biofiltration facilities and dry wells located in the I-65 ROW.
- Install pervious pavements in large parking lot areas.
- Incorporate vegetated stormwater controls into existing large parking lot areas.
- Implement green street practices.
- Increase canopy cover.

Refer to Figure 3.2.15, located at the end of this chapter, for the features and conditions of the South Central East Focus Area.

Focus Area 5 – Southwestern Parkway Area

Focus Area 5, located in the southwestern parkway portion of the combined sewer area is comprised primarily of residential landuse along with interstate ROW. Based on an analysis of existing surface drainage patterns, soil characteristics, and available land area the following green infrastructure opportunities exist:

- Strong potential for green street techniques at multiple scales of roadway systems ranging from local, to collector to state highways.
- Potential to utilize various techniques to control roadway runoff ranging from dry wells to biofiltration to rain gardens.
- Utilize interchange area in State ROW for infiltration of runoff.
- Separate storm sewers in two local neighborhoods and discharge directly to the Ohio River.
- Utilize green streets to provide connectivity to local parks.

Refer to Figure 3.2.16 located at the end of this chapter for the features and conditions of the Southwestern Parkway Focus Area.

Focus Area 6 – Southwest Greenway and Parkway Area

Focus Area 6, located in the southwest greenway and parkway portion of the combined sewer area is comprised of residential, industrial, interstate ROW, and a utility corridor. This Focus Area includes an existing MSD detention basin and a natural stream. Based on an analysis of existing surface drainage patterns, soil characteristics, and available land area the following green infrastructure opportunities exist:

- Potential to develop a greenway connection
- Ability to enhance existing detention basins
- Opportunity to work with strategic partners
- Potential to infiltrate into glacial outwash

Refer to Figure 3.2.17, located at the end of this chapter, for the features and conditions of the Southwest Greenway and Parkway Focus Area.

Focus Area 7 – Central Business District Area

Focus Area 7, located in the Central Business District portion of the combined sewer area is comprised of mostly impervious surfaces including buildings, roadways, and large parking lots. This central downtown area provides a great opportunity to utilize green controls to capture runoff while connecting the community. The following green opportunities exist:

- Strong potential for green street techniques at multiple scales of roadway systems ranging from local to collector streets.
- Potential to retrofit existing buildings with vegetated roofs
- Opportunity to retrofit existing parking lots with biofiltration techniques or rain gardens. Refer to Figure 3.2.18, located at the end of this chapter, for the green street concept plan for the Central Business District Focus Area.

An initial test site was installed in 2007 at a parking lot for the Girl Scouts of Kentuckiana's new headquarters on Lexington Road.

As discussed, each Focus Areas will require additional evaluation to determine which, if any, of the proposed concepts are in fact feasible. Stormwater offloading, strategic partnerships and the use of natural systems are key elements to each area. Each proposed project has the potential to have a significant impact on both the green infrastructure initiative as well as MSD's overall CSO mitigation program, which may translate into the elimination and/or reduction of proposed gray controls.

Additional maps for each focus area can be found in Appendix 3.2.9 Seven Focus Areas.

3.2.5.8 Site Evaluations

As previously mentioned, MSD has worked intensely to develop effective partnerships, where multiple entities benefit from implementation of green infrastructure practices. A good example of this effort is the relationship MSD has developed with JCPS. MSD has worked with JCPS to develop green concept plans for two schools - Roosevelt Perry Elementary and Engelhard Elementary - both located within the CSS. These concept plans provide the schools with new site plans that incorporate green elements, enhance the functionality of the sites, improve aesthetics, and provide a reduction in stormwater runoff entering the CSS.

Roosevelt Perry Elementary is located on the west side of Downtown Louisville Metro. This site has approximately 2.5 acres of impervious surface. The existing site is somewhat disjointed with parking adjacent to and close to the building, while playground areas are located around the corner of an adjacent building next to a very busy road. Currently, the runoff from this site discharges directly to the CSS – approximately 2.3 MG per year. A revised site plan was developed that addresses the needs of JCPS and targets the reduction of runoff from the site. The proposed plan incorporates pervious pavements, bio-swales, a small vegetated roof, outdoor educational space, and a cistern and curbs extensions that result in an estimated 79 percent reduction (1.8 MG) of annual runoff to the CSS. Additionally, the parking was moved to the perimeter of the site, hard and soft playground areas were moved to the middle of the property, and outdoor classroom facilities were located just outside of the existing school.

The Roosevelt Perry concept plan also represents a great example of the benefits that a multi-scaled approach can achieve. Interviews with school officials determined that most of the students enrolled in this school live in the adjacent neighborhoods. The concept plan incorporates revised street designs that improve pedestrian safety through the use of vegetated curb bump outs at cross walks that serve as a traffic calming elements and also infiltrate stormwater runoff from the roadways. Simple modifications to an adjacent, underutilized park create a more valuable community asset and a badly needed functional playground for an urban school. The multi-scale site plan should serve as the catalyst for a meaningful partnership between JCPS, Metro Parks, Public Works, and MSD that collectively achieves far more community benefit by targeting limited resources at an integrated, coordinated plan.

Engelhard Elementary, the second concept plan site, is located just south of Downtown Louisville Metro. The site is comprised of one building, a parking lot, and a grass play area. Approximately 1.8 acres of impervious surface discharge approximately 1.8 MG per year directly to the combined sewer. The green concept plan incorporates pervious concrete, a bio-retention swale, reinforced turf, and curb cuts resulting in an estimated reduction of 1.4 MG per year to the CSS. In addition to the green elements, the proposed concept plan relocated the play area closer to the school, dramatically improved traffic flow through the site and provided much needed parking facilities.

According to the 2007 JCPS Facility Needs Survey, there is $75,000 worth of site and pavement work planned for Engelhard in the next five years. Discussions are currently ongoing, between MSD and JCPS to determine the benefits and logistics of implementing the proposed plan or some version of it.

Each of these schools provided an opportunity to demonstrate the importance of evaluating individual sites from a variety of perspectives. While the specific conditions of each site were improved in terms of stormwater runoff, safety, traffic flow and parking, each proposed plan stepped beyond the parcel boundaries of the individual school site to identify opportunities to effectively integrate these school sites into a larger context of the neighborhood and the sewershed. See Appendix 3.2.10 Concept Plans.

3.2.5.9 Green infrastructure Demonstration Projects

Upon completion of the green CSO sewershed evaluations, workshops were conducted to review the results of each of the basin evaluations. The result of these workshops was the identification of a subset of basins that were deemed to be candidates for more detailed evaluations with the objective of selecting 19 green infrastructure demonstration projects. Site visits were performed at each of the candidate locations and an evaluation was performed that considered numerous factors including property ownership, public visibility, soils, geology, basin size, proximity to adjacent structures and age of those structures.

The result of this effort was the selection of 19 potential locations in the CSS for the construction of green infrastructure projects that generally can be categorized into five major component types. These types are biofiltration, green alleys, green streets, dry wells, sinkholes and wetlands creation or restoration. Greater detail of each of these component types is presented in the following pages.

Biofiltration Techniques

Similar to most highly urbanized areas, downtown Louisville Metro contains a high percentage of impervious area. One of the primary objectives of the green infrastructure effort is to replace hard infrastructure with vegetation where practical. Biofiltration techniques provide a means to reduce stormwater runoff, promote groundwater recharge, maximize evapotranspiration and reduce the total impervious surface in the CSS. While biofiltration is an important component of this program, the performance of infiltration techniques in downtown areas may be negatively impacted as a result of the compaction of native soils that typically occurs in urban settings. MSD will explore techniques such as soil aeration to enhance the ability of public green spaces to infiltrate stormwater runoff.

From a geologic standpoint, several types of alluvial deposits underlie downtown Louisville Metro. Some areas contain fine-grained layers near the ground surface, but silty sands and sands at depths of less than five to seven feet underlie many portions of central and south central downtown. Such relatively permeable conditions are conducive to effective installation and function of bioswales.

Parking lots provide ample opportunity to cost effectively utilize biofiltration techniques. Based on the impervious area evaluation, parking lots represent a significant portion of the impervious area within the CSS. Retrofitting existing parking lots and redirecting runoff to vegetated perimeters and medians will effectively and efficiently reduce the volume of water entering the combined system. Five parking lots were identified as candidates for demonstration projects. These sites were selected based on the presence of relatively permeable stratigraphic conditions in the subsurface and the absence of any indication of leaking or malfunctioning infrastructure or sensitive building foundations in the immediate vicinities of the chosen sites. If properly designed these systems will reduce the runoff from the site and provide needed green space to these large impervious areas. Appendix 3.2.11 Biofiltration Technique Cross Sections provides some cross-sectional details for this type of green infrastructure technique. Parking lots were identified as candidates for demonstration projects at the following locations:

- CSO053 – MSD Main Office Parking Lot Biofiltration Swale
- CSO053 – Seventh and Cedar Green Parking Lot
- CSO181 – Second and Broadway Green Parking Lot
- CSO198 – Third and West Ormsby Biofiltration Swales
- CSO022 – Sixth Street and Muhammad Ali Green Parking Lot

Rain Gardens

Rain gardens are vegetative systems used to intercept runoff from relatively small drainage areas. Runoff directed to rain gardens is reduced through infiltration and evapotranspiration practices. MSD has been implementing a residential rain garden program for many years. See Section 3.2.5.10.

In an effort to expand the application of this technique to the urban setting, MSD has identified one site downtown to construct a rain garden. The site is within the sewershed of CSO028 and located at Sixth Street and Broadway. Additionally, MSD is committed to identifying four additional sites within the first year of the program to more fully evaluate the applicability of rain gardens to reduce CSOs in the downtown area.

Green Alleys

The transportation network in downtown Louisville Metro includes a large number of alleys - over 500 in the CSS area. A partnership between MSD and Louisville Metro Public Works would facilitate the utilization of porous pavement technology during the alley renovation process and could prove to be a cost effective technique for CSO control.

As stated previously, many portions of downtown Louisville Metro are underlain by silty sand and sand deposits that allow infiltration rates suitable for the installation of porous pavements. Many portions of west Louisville also include similar subsurface conditions, and alleys were included in almost all of the original road construction in that area. A limiting factor, however, is the widespread presence of old, leaking infrastructure under and in close proximity to many alleys. Increased infiltration into the subgrade around these compromised pipes and associated structures could lead to subsidence under the alleys and surrounding structures. Therefore, green alleys were chosen with special consideration of available information on the existing active and inactive infrastructure.

While there are numerous porous pavement technologies available including porous asphalt, porous pavers, bricks with spacers, etc., the technology selected for these demonstration projects is pervious concrete. Two types of alley configurations were selected for these demonstration projects. The first configuration assumes that the entire alley surface would be replaced with a pervious concrete surface. The other configuration assumes that only a 4-foot wide center strip of porous concrete will be constructed. Appendix 3.2.12 Porous Concrete Cross Sections provides typical details for pervious concrete.

Pervious concrete contains less lime and finer particles than ordinary concrete.

The following three alleys were identified as candidate demonstration projects:

- CSO015 – Seventeenth and W Hill Permeable Alley
- CSO053 – Seventh and Market Permeable Alley
- CSO121 – Campbell and Main Permeable Alley

Green Streets

A large percentage (27 percent) of the impervious surfaces in the CSS is associated with roadways. Green street techniques have the potential to play a significant role in MSD's Green Infrastructure Program. While numerous configurations ranging from street edge alternatives, to sidewalk planters, to porous pavements are all components of green streets, this evaluation did not identify the specific techniques to be used in the demonstration project, but rather recognized that each street will require a site-specific design.

Stratigraphy suitable for the green street application is similar to that of green alleys, so the same areas of downtown were evaluated for potential candidates. Some green street techniques allow a slightly deeper discharge depth, such as street edge solutions, but for the purposes of this part of the project, areas with relatively shallow (five feet to seven feet deep) silty sands and sands were considered. Many of the possible green street locations included open space on adjacent parcels to minimize the risk of destabilization of shallow, soil-bearing foundations by saturation of the bearing soils.

One location - Housing Authority Property: Beecher Terrace in CSO208 was identified for a green street demonstration project. This location includes shallow foundations at a distance of at least 40 feet from the nearest infiltration point. This distance was considered to be sufficient to minimize the chances of saturating the foundation bearing soils. General assumptions for cost and performance were utilized for the evaluation with the understanding that these values would need to be refined once a final concept plan was developed for the site.

Dry wells

Dry well construction was considered to have a high potential for offloading surface water runoff from the CSS in the central and western portions of the CSS area. Dry wells can have a relatively high capacity compared to other green infrastructure techniques, and they typically are used in areas where surficial fine-grained clays and silts reduce shallow infiltration rates and prohibit the effective use of methods like bioswales and green streets.

A dry well typically consists of a concrete pipe section that is inserted into the ground and transports runoff from an existing stormwater sewer line to permeable layers in the subsurface. The dry well system can include any number of filtration devices to prevent contaminants from being discharged into the aquifer. The number and type of such devices depends on the origin of the runoff and the presence of other filters prior to the runoff entering the sewer system.

To develop a dry well properly, a soil test boring should be advanced at the location of the proposed dry well. The stratigraphy revealed by the boring should be evaluated to determine at what depth soil permeability will permit infiltration rates that will allow rapid discharge of surface water runoff into the subsurface. The boring information also should be used to characterize groundwater levels in order to define boundaries between saturated and unsaturated zones. After permeability and groundwater conditions have been established, the structure can be sized assuming an infiltration rate at a given discharge depth.

Dry wells proposed to be used in the MSD project likely will be constructed to discharge at depths of 15 to 25 feet below the ground surface into fine- to medium-grained sands. Groundwater levels in the target zones in the western and north central portions of the CSO area have been recorded to be between 30 feet and 65 feet below the ground surface causing the proposed dry wells to discharge in the unsaturated zone. As a result, infiltration rates will be required to be estimated, and conservative estimates will be used.

A number of potential dry well locations were identified on publicly owned parcels where soil test borings on nearby sites indicated sands and gravels at depths of 15 to 20 feet below the existing ground surface. Several public agencies, including the Louisville Metro Housing Authority and the JCPS expressed their willingness to allow dry well construction on their properties in order to further the green initiative. See Appendix 3.2.13 for a standard drywell cross-section.

The construction of dry wells will most likely require obtaining an Underground Injection Control permit. In Kentucky, the Underground Injection Control permitting process is administered through EPA - Region 4 in Atlanta. The agency requires that a form be completed detailing the location of the proposed dry well, the type of construction and documentation on any known sources of contamination in the area, or any vicinity-wide plumes of contamination. The data is reviewed to determine if the feature will be introducing any new contaminants into the aquifer or will be attenuating any existing plumes of contamination. If the EPA does not believe the dry well poses a significant risk to the quality of the aquifer, a rule authorization is granted. See Appendix 3.2.14 Drywell Rule Authorization Form for a copy of the required form.

Five candidate locations were selected for the construction of dry wells.

- CSO189 – I-264 Off-Ramp Dry Well
- CSO019 – I-264 On-Ramp Dry Well
- CSO191 – I-264 and Gibson Dry Well
- CSO191 – Russell Lee Drive Dry Well
- CSO191 – JFK Montessori Area Dry Well

Sinkholes and Wetlands

There is a possibility that sinkholes with well-defined throats could be used as dry wells. Dry well installation is common in the karst terrain in southern Indiana and central Kentucky. Solution features in the calcareous rock layers (usually limestone) were formed by groundwater flow, so a discharge capacity of some volume typically is present in the rock layers beneath a sinkhole of substantial size. The difficult part of developing a dry well in a sinkhole is evaluating the capacity and determining whether the solution features in the immediate zone beneath the upper rock surface are clogged with soil fines and may be flushed out with hydrostatic pressure. Specific geotechnical evaluations will be necessary before discharging any additional runoff to the subsurface in the eastern portion of the CSO area, due to the potential of causing karst-related subsidence.

A dry well in a sinkhole is constructed in much the same manner as a dry well in an alluvial stratigraphy. The most significant difference is that considerable work must be completed to identify the throat, which is the opening in the upper rock surface into the network of solution features.

Placement of dry wells in sinkholes is difficult because there is no order or regularity to the location of such features. The probability of a sinkhole with adequate capacity to receive runoff being located on accessible property near sewer structures with significant flow is low. However, several closed contour depressions were identified in areas where stormwater runoff could be offloaded from the CSO system. One such location is in close proximity to a delineated wetland adjacent to the Beargrass Creek. Preliminary plans have been discussed to separate nearby sewers and discharge the flow to the existing wetland area. The wetland would need to be expanded and enhanced and reconfigured to allow large flows to discharge directly to a very large existing sinkhole feature.

Exploration of the sinkhole for capacity should be performed by exposing the throat and doing a series of pump tests in which water is discharged into the feature in several manners. One test should include a large volume of water in a short flow duration, to simulate a brief, intense precipitation event. At least one other test should be conducted by discharging a steady flow into the feature for an extended time to explore constant flow capacity, intermediate storage, and possible silting in.

This project represents an opportunity to utilize a natural system for stormwater control, improve an existing resource, and potentially reduce and/or eliminate a gray control. Due to the unique nature of this project, a more detailed preliminary evaluation can be found in Appendix 3.2.15 Wetland/Sinkhole Preliminary Evaluation.

The 19 proposed demonstration projects will cost approximately $1.5 million to implement and will remove an estimated 10 MG of stormwater from the CSS annually. But more importantly, these projects represent an opportunity to demonstrate various green techniques, develop more accurate and locally based cost information and monitor their performance.

3.2.5.10 Green Program Development

In addition to the 19 demonstration projects, MSD's recommended green infrastructure plan includes six programs elements. These program elements are downspout disconnection, rain barrel program, residential rain gardens, green roof incentives, urban reforestation, and dry wells.

These programs will be implemented on a regional level by MSD in an effort to reduce CSOs, as well as to raise public awareness of the responsibility that individuals have in protecting and enhancing our local water resources. Each of the green programs, and costs associated with their implementation, is described in more detail below.

It is important to note that for the purpose of evaluating the potential stormwater reductions achievable through the use of green infrastructure, the regional evaluation used a 15-year planning horizon. However, as will be discussed later in the document, MSD plans on assessing the performance of green infrastructure demonstration projects and programs during the first six years of implementation with the goal of evaluating and adjusting financial allocations for particular programs based on a benefit-cost analysis. By July 2010 MSD will finalize the details for a regional downspout disconnect and rain barrel programs. In addition, MSD will define a more formal strategy for developing programs, such as a vegetative roof incentive or urban reforestation program, that deal with public and private partners by July 2010.

Concurrent with the development of the green programs, MSD plans to begin design and construction of several of the green demonstration projects in July 2009 and estimates that all 19 demonstration projects will be constructed by December 2011. The completion of these demonstration projects will allow for the development of more formal partnership arrangements with other local agencies such as Metro Housing Authority, Public Works, and JCPS. Successful implementation of the demonstration projects should provide a level of confidence in the community to more readily commit to widespread application of specific techniques on public property outside the control of MSD that can then be translated into formal green programs, including budgets and implementation levels, for elements such as green streets, permeable alleys, and green parking lots.

Once the demonstration projects have been completed and proven successful to allow for widespread implementation, MSD will work with the necessary entities to develop other formal programs for green controls such as porous alleys, rain gardens and green streets. MSD will define the strategy for the development of additional green projects by the end of 2013. Therefore, while green infrastructure is envisioned to be an important component to the overall Final CSO LTCP, MSD's long range commitment to this program will be based on how green performs in comparison to more traditional gray solutions.

Downspout Disconnection

Single-family rooftops account for 18 percent of the impervious area within the CSS area. By disconnecting roof downspouts, a significant portion of this impervious area can be removed from the combined system. MSD will develop an incentive-based Downspout Disconnection Program to target the stormwater entering the CSS from residential landuse.

The proposed program will offer homeowners financial incentives per disconnected downspout. The financial incentive will motivate homeowners to participate in the program and should result in higher participation rates.

Utilizing LOJIC data the total square footage of single-family rooftops was calculated for each basin. Field surveys of approximately 30 basins were conducted in an effort to determine the percentage of single-family homes with downspouts that are directly connected to the CSS. The results of this effort indicated that, on average, approximately 65 percent of parcels have downspouts that were directly connected to the combined sewer. In estimating the potential benefits of the downspout disconnection program in basins that were not field surveyed, it was assumed that 65 percent of the total residential rooftop area was available for disconnection. For those sewersheds where field surveys were conducted the actual percent of downspouts connected was utilized in the evaluation.

In estimating the potential stormwater reduction from this program, each basin was given a rating of high, medium, or low for both effectiveness and participation. The "effectiveness" rating was based on criteria such as soil conditions, lot size and density of the homes. This variable is intended to provide an estimate of the percentage of the stormwater removed during the disconnection that somehow flows back into the CSS through either direct or indirect means. Even if a downspout is disconnected from the CSS, some of the redirected runoff still have the potential to re-enter the CSS.

The "participation" rating was based on local knowledge of the neighborhoods and types of residents within the area. A 10 percent participation rate implies that 10 percent of the homes will participate in the program. However, note that based on assumptions stated above, even if a homeowner agrees to participate, for the purposes of this evaluation, stormwater reduction estimates only assume that 50 percent of the roof is disconnected.

Furthermore, because of the potential for sinkhole creation, green components that require shallow infiltration will not be recommended on the eastside of the CSS area without further geotechnical investigation. Therefore, basins that were tagged as not suitable for infiltration, based on the regional soils evaluation, discussed in Section 3.2.6.4, were automatically given an implementation rate of zero. After further investigation, certain areas in this region will be eligible for a downspout disconnection program, thus increasing the benefit of the program.

Utilizing the matrix in Table 3.2.3 an estimate of the stormwater removal effectiveness was determined for each sewershed. For example, if for a particular sewershed the participation rate is estimated to be low, but the effectiveness of disconnected water remaining out of the CSS is medium, then the matrix indicates that the program will in effect, removing 10 percent of the roof area from the CSS.

TABLE 3.2.3

DOWNSPOUT DISCONNECTION STORMWATER REDUCTION MATRIX

PARTICIPATION		EFFECTIVENESS: LOW	EFFECTIVENESS: MEDIUM	EFFECTIVENESS: HIGH
	HIGH	15%	35%	40%
	MEDIUM	10%	25%	35%
	LOW	5%	10%	15%

The results of each sewershed evaluation were combined and totaled. Using conservative estimates for each program variable, it has been estimated that once fully implemented the downspout disconnection program will remove approximately seven percent of connected single-family roof area from the CSS that translates into the removal of 134 MG of stormwater annually. To see specific reductions for each basin and a program flowchart please see Appendix 3.2.16 Downspout Disconnection Reductions and Program Flowchart.

Based on an evaluation of anticipated administrative and reimbursement costs, $250 per downspout was used to establish a program budget. The cost for program management and marketing costs was derived from data provided by the City of Portland, Oregon Stormwater Retrofit Program Manager.

The program participation estimates assume that 1,545 downspouts will be disconnected annually, which equates to approximately $0.05 per gallon removed. MSD will strategically perform geotechnical evaluations for basins originally marked as unsuitable for downspout disconnection in order to increase the overall effectiveness of this program.

TABLE 3.2.4

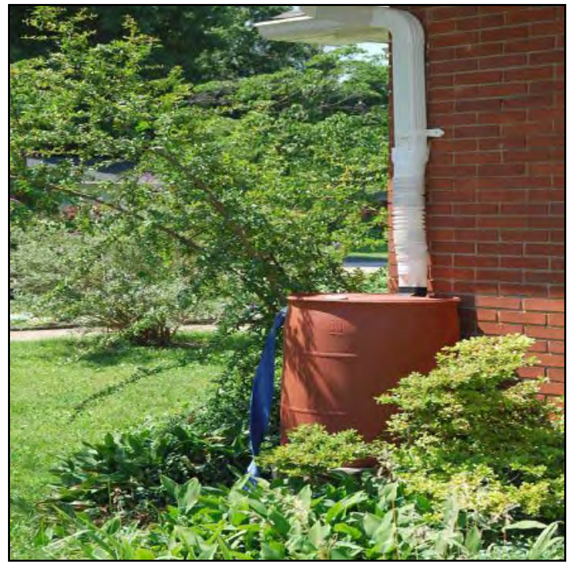
DOWNSPOUT DISCONNECTION PROGRAM COSTS

Downspout Disconnect Program Costs	
Estimated Program Cost per Downspout	$250
Estimated Downspouts Disconnected	1,545
TOTAL	$386,000

As stated earlier, the 15-year timeframe is used for planning purposes only to estimate potential long-term reductions in stormwater runoff to the CSS. Many assumptions have been made regarding the performance of this program that will need to be evaluated during the first six years of implementation. Therefore, while downspout disconnection is envisioned to be an important component to the Final CSO LTCP, MSD's long range commitment to this program will be based on the cost effectiveness of this technique in comparison to more traditional gray solutions.

Rain Barrel Program

Rain barrels are an effective way to educate the public about CSOs and provide an opportunity for homeowners to actively participate in the reduction of overflows. MSD currently has a rain barrel program in place, and has distributed rain barrels to over 350 residents within the MSD service area. The current program is being performed in partnership with Youth Build and the Louisville Nature Center. However, MSD will continue to explore other opportunities to increase overall distribution and use of rain barrels throughout the CSS area.



Rain barrels collect and store rainwater from the roof to use later for watering. Each barrel provides storage for 58 gallons of water.

Because MSD cannot control rain barrel use and maintenance, the potential reductions of stormwater runoff provided by rain barrels will not be included in the Final CSO LTCP, in terms of downsizing proposed gray controls. As the number of rain barrel installations increase, MSD may begin to realize volume reduction benefits of this program. If monitoring suggests a measurable decrease in the stormwater entering the CSS as a result of this program, MSD will re-evaluate how this program can be incorporated into the Final CSO LTCP. See Appendix 3.2.17 Rain Barrel Program Flow Chart for a program flowchart.

MSD's program will develop and distribute annual brochures to homeowners with rain barrel tips and information on proper operation and maintenance. In addition, MSD will continue to distribute marketing information and pamphlets, make presentations at public meetings, and use other techniques to encourage and educate homeowners throughout the community to participate in the rain barrel program.

TABLE 3.2.5

RAIN BARREL PROGRAM COSTS

Annual Rain Barrel Program Costs	
Estimated Program Cost per Rain Barrel	$165
Estimated Rain Barrel Target	1,000
TOTAL	**$165,000**

For budgeting purposes, MSD assumes 1,000 rain barrels will be distributed annually. This will result in an annual program cost of approximately $165,000. See Table 3.2.5 for a more detailed breakdown of annual costs.

Private Property Rain Garden Program

A residential rain garden program provides MSD with an opportunity to enhance the downspout disconnection program. By assisting homeowners with the proper redirection of downspouts to an appropriately sized rain garden, both MSD and homeowners benefit.

TABLE 3.2.6

PRIVATE PROPERTY RAIN GARDEN PROGRAM COST

Annual Rain Garden Program Costs	
Estimated Program Cost per Rain Garden	$1,300
Estimated Rain Garden Installation Target	24
TOTAL	$31,000

MSD has developed an educational manual, *A How-To Guide for Building Your Own Rain Garden*, to assist homeowners with the design and implementation of a residential rain garden. Interested homeowners are encouraged to contact MSD for information about installing a rain garden on their property. The residential rain garden program requires that homeowner's actively participate in the planning and construction phases. If desired by the homeowner, MSD staff will assist with plant selection, design calculations, and construction. Appendix 3.2.18 Residential Rain Garden Program Flowchart shows the MSD flowchart for program implementation.

Rain Garden on Harvard Street

Based on MSD's experience, the costs to construct residential rain gardens, including plants, range from $1,000 to $2,500. The actual costs are affected by the size of the garden and level of participation by the homeowner with construction and plant selection activities. For budgeting purposes, MSD assumes design and construction of 24 rain gardens per year.

Green Roof Incentive Program

Vegetated roofs, or green roofs, are vegetated areas that are designed as part of a roof system. While this technology has been used in Europe for many years, it is only in recent years that vegetated roof systems have become an accepted practice in the U. S. These systems can be utilized on commercial, industrial or residential roofs. Data from monitored vegetated roof systems indicate a significant reduction in annual runoff from these systems when compared to more traditional metal or asphalt roofs.

The following information, taken from the EPA fact sheet on green roofs (See Appendix 3.2.4) presents the results of a green roof performance study:

> *Penn State Green Roof Research Center has also noted a decrease in both total stormwater runoff and peak flow discharge. […] In this 1+ inch storm event, the green roofs captured approximately 25% of total runoff compared to the conventional roofs. Over the period from May 23, 2003 to June 1, 2003, 2.21 inches of rain fell, of which the green roof detained 1.05 inches (~47 %). The center noted that the spring of 2003 was wet and cool.*

A number of both public and private entities involved in new development and re-development activities in the MSD service area have been considering the installation of vegetated roofs. MSD has performed evaluations at a number of MSD owned buildings regarding the structural suitability of existing facilities to be retrofitted with vegetated roofs. MSD is committed to demonstrating this technology and an appropriate site will be identified to install a vegetated roof.

However, MSD recognizes the potential benefits that green roofs represent in terms of stormwater reductions to the CSS and has evaluated approaches to encourage or incentivize more widespread application of this technique throughout Louisville Metro. An evaluation of the potential benefits that MSD would realize from the installation of a green roof indicated that a square foot of a typical vegetated green roof ranges from $3.00 - $5.00 in equivalent "gray" CSO control.

A number of details associated with this program still need to be finalized. Issues such as design and performance standards, reimbursement levels for different types of vegetated systems, stormwater credits, plan review and approvals, inspections and maintenance issues still need to be finalized. However, MSD is committed to this program and has developed a budget for implementation.

TABLE 3.2.7

GREEN ROOF PROGRAM COSTS

Annual Green Roof Program Costs	
Estimated Program Cost per Square Foot of Green Roof	$4.00
Estimated Square Foot of Green Roof Installed	222,900
TOTAL	**$892,000**

MSD estimates that the average stormwater benefit for installation of a vegetated roof is $4 per square foot. For budgeting purposes, the following assumptions have been made:

- Ten percent of public buildings will install vegetated roofs (1.8 million sq ft)
- Two percent of commercial buildings will install vegetated roofs (504,000 sq ft)
- Two percent of industrial buildings will install vegetated roofs (753,000 sq ft)

Based on these assumptions, over three million sq. ft. of vegetated roofs will be constructed in Louisville Metro over the next 15 years. At an average of $4 per square foot, this equates to $13.4 Million.

As stated earlier, the 15-year timeframe is used for planning purposes only to estimate potential long-term reductions in stormwater runoff to the CSS. Many assumptions have been made regarding the performance of this program that will need to be evaluated during the first six years of implementation. Therefore, while a green roof incentive program is envisioned to be an important component to the Final CSO LTCP, MSD's long range commitment to this program will be based on the cost effectiveness of this technique in comparison to more traditional gray solutions.

Urban Reforestation Program

Urban reforestation is the practice of enhancing and restoring vegetative cover in urban areas. Trees provide natural control of stormwater runoff as well as other benefits such as improved air quality, increased wildlife habitat, and cooler temperatures.

A number of studies have been completed to evaluate the annual stormwater runoff reductions that a single urban tree can achieve. According to an article from *Stormwater: The Journal for Surface Water Quality Professionals:*

> *"Horticulturists note that trees' weekly water needs equal 5 gal. plus 5 gal. per caliper inch. For example, a 2-caliper-inch tree needs 15 gal. (5 + [5 x 2] = 15) weekly. This calculation, of course, is for minimum needs; many trees can take in more water."*

Based on this information, a 2-inch caliper tree would require at a minimum 780 gallons per year. According to the New York City (NYC) Department of Parks and Recreation, the average NYC tree captures 1,432 gallons of stormwater each year. Research published in June 2005 and conducted in the city of Minneapolis by the Center for Urban Forest Research indicated that a tree could soak up to 2,000 gallons annually.

An evaluation of the system-wide unit cost ($/gallon) of gray solutions determined the marginal unit cost of gray controls (based on the unit cost per gallon to go from eight to four overflows per year) is approximately $0.30 per gallon. Using $0.30 per gallon as a basis, MSD could justify spending up to $240/tree (medium sized) based on the reduction in stormwater entering the CSS. However, MSD is committed to this program and has developed a preliminary budget for implementation.

The cost of trees varies substantially depending on the size and type of tree and the location for the proposed planting. Section 3.2.5.5 suggested that existing canopy cover in the CSS be increased by approximately 2,000 acres. Assuming that a medium sized tree has a 20-foot canopy, approximately 139 trees would be required to provide an acre of canopy cover and 278,000 trees to achieve the recommended goal. MSD can play a subordinate yet important role in this effort.

Based on the estimated benefits that trees provide to MSD and the community, the Green Infrastructure Program recommends that MSD allocate funds annually to promote and enhance tree planting programs throughout the City. The program will include financial assistance to a variety of programs including sapling give-aways and cost sharing in urban streetscape programs.

Based on the results of this evaluation, MSD will explore opportunities to work with other public and private entities within the Louisville Metro area to increase the current tree canopy by at eight percent over the duration of the Consent Decree. See Table 3.2.8 for program costs.

TABLE 3.2.8

URBAN REFORESTATION PROGRAM COST

Annual Urban Reforestation Program Costs	
Estimated Program Cost per Tree	$240
Estimated Trees Planted	933
TOTAL	$224,000

Dry Wells

The geology of the west side of Louisville Metro – Zone 5 on the soil map (Appendix 3.2.6) – is suitable for deep infiltration techniques. The recommended green program suggest evaluating the feasibility of utilizing dry wells throughout this area as a mechanism to off load flow from street inlets into the subsurface. This approach has been successfully employed in other CSO communities, most notably in Portland, Oregon.

MSD owns approximately 18,000 inlets in Zone 5. For the purpose of estimating potential benefits from this program, assume that 50 percent of these street inlets will be directed to a dry well system. The estimation also assumes that each inlet has a drainage area of approximately 7,500 sq. ft. and that each dry well will receive flow from two existing inlet structures. If fully implemented, this program could remove 1.4 BG of stormwater from the CSS annually.

The most significant concern regarding dry wells is the potential challenge the permitting of these facilities presents. EPA Region 4 administers the Underground Injection Control Program in Kentucky. A dialogue needs to occur between EPA Region 4 and MSD to gain a better understanding of the extent of these requirements.

Because of the highly permeable soils present in the CSS area, MSD has elected to pursue the use of dry well technologies as part of the Final CSO LTCP. The purpose of the demonstration project is to evaluate the feasibility of permitting dry wells as a stormwater control technique and to obtain a better understanding of the cost implications of complying with the permitting requirements. Based on the results of the demonstration projects, MSD will determine if it is appropriate to include dry wells as a component of its regional green infrastructure Programs.

Dry well costs vary significantly based on type of construction, size, and depth. Dry wells installed in other communities with average diameters of four feet to six feet and average depths ranging from 15 feet – 25 feet have had costs of $15,000 to $40,000, including exploratory costs and engineering evaluation.

Because of the significant impact on stormwater flows that this program represents, MSD is committed to exploring the feasibility of this technique for LTCP compliance. However, until the permitting issues are resolved, MSD will not assume any benefits from this program in the context of the LTCP, and has not established program budget for dry wells.

3.2.5.11 Green Cost Tool

To ensure that the proposed Green Infrastructure Program is in fact cost effective, a green infrastructure cost/performance tool was developed. The two primary components of the MSD green plan include both programs and projects. Programmatic elements include such items as downspout disconnection and rain barrel distribution while the project components include items such as green streets and green alleys.

The differentiating factor between the two components is that programs will be implemented across large portions of the CSS area, while projects will be more localized and site specific. The green infrastructure cost/performance tool is a spreadsheet that computes costs and benefits (in terms of stormwater reduction) for both elements - programs and projects. This planning level tool integrates assumptions ranging from implementation levels, to costs, and stormwater reductions.

The purpose of the demonstration projects is to evaluate many of the assumptions that were used in the development of the cost tool. However, it is important to note that while MSD is committed to implementing an aggressive Green Infrastructure Program, MSD will direct appropriate resources toward those green components that are demonstrating the most benefit for the money invested. Therefore, the cost tool will likely be frequently updated to reflect actual cost and performance data and provide MSD with a mechanism to readily adjust program and project allocations in an effort to maximize the benefits achieved through implementation of the Green Infrastructure Program.

The components evaluated in the green cost tool include:

Programs

- downspout disconnection
- rain barrels
- vegetated roof
- urban reforestation

Projects

- green parking lots
- dry wells
- green streets
- green alleys
- biofiltration

For each component, the costing model considers a projected implementation rate and an estimated effectiveness. In some instances, for example downspout disconnection, these values are derived on a sewershed-specific basis and then summarized to produce an overall result.

For other components such as green alleys, benefits are derived by taking a standard performance value (gallons removed per year) and typical unit costs and applying these values to an estimated number of green alley projects expected to be constructed. This results in projected benefits of the program in terms of cost per gallon of stormwater removed on an annual basis.

This green cost tool allows MSD to compare proposed green infrastructure components to alternative gray controls by sewershed, or on a regional level. In situations where gray controls are relatively expensive, it may make sense to pursue more aggressively green controls. In other instances, green techniques may not be part of the recommended solution.

The results of the regional evaluation indicate that when implemented, the recommended green plan may remove nearly one BG of stormwater from the CSS at a cost of approximately $0.09/gallon to MSD. Preliminary assumed reductions in stormwater volume based on the use of green infrastructure were developed using the green costing tool developed as part of the business case evaluation, as previously discussed. This is different from the CSS hydraulic model which provides a more conservative estimate of the benefit of green because the model represents a continuous simulation and accounts for antecedent moisture conditions, infiltration limitations, and pervious connectivity to storm drains. Additionally, the CSS model is utilized to predict the effects of green infrastructure implementation on the AAOV for each CSO. This AAOV reduction does not match the stormwater reductions into the CSS due to attenuation and peak flow timing. This evaluation, which is intentionally conservative in terms of estimating green performance, reveals that green infrastructure can be a very cost competitive solution, with successful partnerships and cost sharing, when compared to more traditional gray controls. Based on this evaluation, MSD is committing to a green program with an annual budget in excess of $6 million/year, for the first six years. For a more detailed breakdown of the green plan, see Chapter 4, Section 4.1.2.1.

3.2.5.12 Integrating Green with Gray

The integration of the green infrastructure efforts and the gray infrastructure controls is a critical component of the successful implementation of Final CSO LTCP. Planned green controls were translated into an estimated reduction in impervious surface for each basin. Inputs to the collection system model will be revised to reflect these changes and the model will be run to determine the potential decrease in CSO activity and the corresponding reduction of proposed gray controls that may result from the implementation of green components. See Appendix 3.2.19: Green Infrastructure AAOV Impact Assessment and Modeling for details of the modeling approach used to estimate the overflow volume and frequency reduction. As the first sets of green infrastructure demonstration projects are built, the controls will be monitored and data on the effectiveness in reducing stormwater runoff will be generated and analyzed. Based on the results of the post construction monitoring of the green controls, MSD will re-evaluate and adjust the size of planned gray projects to provide the target level of CSO control.

Once MSD has selected a location for a green best management practice (BMP) and has identified and worked with potential partners, MSD will begin the design phase of the project. During the design phase, MSD and the project partner will establish an O&M agreement for the specific green control. After the project has been constructed, the location will be entered in MSD's Hansen tracking system. This will allow for data on the location, size, construction cost, and inspection results to be readily available in a GIS format.

Each green control will be inspected on a regular basis to gather information on performance and maintenance routines. System monitoring will be evaluated and the performance information will be used within the collection system model to perform typical year model simulations. The impacts of green infrastructure on AAOV and peak flow rates will be used to adjust the size of the planned gray projects. Figure 3.2.19, located at the end of this chapter, is an implementation diagram of the Green Infrastructure Program, inclusive of the process for constructing, inspecting, and monitoring a green project in order to assess impact on the size a gray control.

Additionally, MSD will use the schedule developed for the design and construction of gray projects to assist in targeting green demonstration projects. At this time MSD estimates that green demonstration projects will be constructed by December 2011. MSD will conduct performance monitoring and/or CSS modeling before any modification to the gray projects are recommended. Therefore, gray projects scheduled for implementation after this timeframe will be targeted as priority areas to implement green components in order to evaluate the possibility of resizing gray controls due to the impact of the green infrastructure.

3.2.6 Definition of Water Quality and CSO Controls

The ultimate goal of the CSO Policy is to bring CSO communities into compliance with requirements of the Clean Water Act (CWA) (59 CFR 18688). This includes meeting the technology-based requirements (through NMC) and the water quality-based requirements through development of the Final CSO LTCP. MSD established initial CSO control goals based on a review of the recreational and aquatic life use impairments in Beargrass Creek and the Ohio River. The initial water quality and CSO control goals were established by evaluating the relative impact of CSOs on fecal coliform bacteria and dissolved oxygen with water quality models.

Beargrass Creek and the Ohio River are highly urbanized systems, which have been affected by hydromodifications such as construction of channels for flood control and locks and dams for navigation. Water quality modeling showed that attainment of the bacteria criteria in both water bodies, and dissolved oxygen criteria in Beargrass Creek, was not possible under all conditions even with complete elimination of CSOs. MSD programmatically decided to evaluate the Green Infrastructure Program and therefore evaluated a range of gray CSO control alternatives as defined in the CSO Policy (specifically zero, two, four, and eight overflows per typical year). These alternatives were then simulated with the water quality models to generate a knee of the curve for locations along the Ohio River and Beargrass Creek. The knee of the curve was used to determine where the increment of water quality benefit gained (in terms of compliance with the water quality criteria) diminishes compared to the increased costs, in accordance with the CSO Policy (59 CFR 18688). A description of knee of the curve is provided in Chapter 4.

The EPA recognizes that this analysis may result in a community establishing goals for CSO control where water quality standards are met with the exception of a few remaining overflow events (EPA, 1995, pgs. 3-21). In these instances, the CSO community needs to work with the regulatory agencies to identify mechanisms to reduce other pollutant sources, obtain a variance, partial use designation, or a revision to water quality standards as outlined in the CSO Policy. MSD intends to monitor the reduction in other sources as part of its post-construction compliance monitoring program. If necessary, MSD will work with ORSANCO and the Kentucky Department of Environmental Protection (KDEP) to provide that the Final CSO LTCP will conform to the CWA, either through identifying additional CSO control after implementation of the Final CSO LTCP or revision of the water quality standards or both.

3.2.7 Approaches to Structuring Cost Control Alternatives

The initial step in deriving gray infrastructure CSO control alternatives was to list location of CSOs (See Figure 3.2.20, located at the end of this chapter); identify viable technologies; determine single versus multiple CSO solutions; and assess siting issues.

MSD's CSS contains 106 CSOs discharging to four receiving waters:

- Ohio River
- Beargrass Creek Muddy Fork
- Beargrass Creek Middle Fork
- Beargrass Creek South Fork

Five CSO control technologies were initially considered, consisting of the following:

- Sewer Separation
- In-line Storage
- Off-line Storage (Figures 3.2.21 and 3.2.22, located at the end of the Chapter)
- Treatment (two processes, Figures 3.2.23 and 3.2.24, located at the end of the Chapter)
- Hybrid Technologies (RTC with storage; RTC with treatment, Figures 3.2.25, 3.2.26, and 3.2.27 located at the end of the Chapter)

During the development of project alternatives, a sixth technology, Pump Station Expansion, was added. As discussed in Section 3.1.2, initial CSO control alternatives were identified jointly by MSD and IOAP program consultants, taking under consideration factors such as regulatory compliance, implementability, operations and maintenance, public acceptance, etc. Typically using geographic criteria, CSO control projects were established either as individual or as groups, with numerous permutations of groupings, with multiple technologies to provide a broad array of projects for evaluation of the best CSO control solution for a given CSO/location.

The original project list provided 198 initial project alternatives. Due to an initial screening, the original list was reduced to 136 projects, distributed as shown in Table 3.2.9 across the various technologies.

TABLE 3.2.9

CSO CONTROL TECHNOLOGY ALTERNATIVES

Project Type	Project Identification Code (Used in the project tracking database)	Number of Projects Evaluated
Pump Station Expansion	03	1
Sewer Separation	08	49
Off-line Storage	09B	49
Treatment	10	17
Hybrid Technologies	13	20

Tables 3.2.10 through 3.2.14, located at the end of this chapter, list the initial 136 projects by receiving stream. Those projects which are highlighted indicate the preferred solution for the given watershed. These projects were later subject to further optimization.

The criteria for the initial screening included technology viability and performance, neighborhood impact, professional assessment of groupings, etc. An example of the initial project screening is in-line storage technology; this was deleted as a stand-alone solution as previous CSS capacity studies indicated this technology, alone, would not achieve goals set for CSS performance.

Appendices 3.2.22 through 3.2.26 list details of the following data associated with initial solutions:

- Appendix 3.2.22 Initial Project Fact Sheets
- Appendix 3.2.23 Initial Project Location Maps
- Appendix 3.2.24 Initial Project Cost Summary
- Appendix 3.2.25 Initial Project Benefit Summary
- Appendix 3.2.26 Initial Project Ground Truthing Documents

3.2.7.1 Projects Common to All Alternatives

Projects that are termed, "Common to All Alternatives" are those that have a system-wide impact. These include projects implemented under NMC, the Green Infrastructure Program, which provides source control/reduction (reducing CSO frequency and volume), the RTC Program, which is designed to maximize system storage, and Pump Station Expansion, which re-directs flow within the CSS to different watersheds. NMC and the Green Infrastructure Program are described extensively in other sections of the IOAP; RTC and the Pump Station projects will be discussed in following sections.

3.2.7.2 Outfall-Specific Solutions

Outfall-specific solutions are considered where multiple CSOs share a common outfall; where a CSO is remote and cost-prohibitive to convey to a CSO control group; or where the disruption caused by constructing conveyance (such as dense urbanization, heavy traffic corridor, etc.) is deemed too significant.

The MSD CSS includes several CSOs that fall under these categories. Several common outfalls convey discharge to the receiving stream from two-to-three individual CSOs. However, two major collectors/outfalls convey a significant number of CSOs: Sneads Branch Relief Drain, which collects discharge from 11 CSOs with a single discharge point to Beargrass Creek South Fork, and Central Relief Drain, which collects discharge from 22 CSOs into a common outfall to the Ohio River. Of the 136 projects evaluated, 83 were outfall-specific solutions.

3.2.7.3 Localized Consolidation of Outfalls

The geographic distribution of MSD CSOs provides excellent opportunity for consolidation of CSO controls, primarily in the Central Business District and the three Beargrass Creek Forks. Unfortunately, these regions are highly urbanized, limiting the number of available facility locations. Fifty-seven consolidated projects were evaluated during development of the Final CSO LTCP. The localized consolidations grouped from as few as three to as many as 32 CSOs into a single control location.

3.2.7.4 Regional Consolidation

The localized consolidation concept was expanded to an evaluation of two regional consolidation configurations. Both of these involved the use of a single CSO control technology, specifically large diameter off-line tunnels with an appropriately-sized dewatering pump station, to capture CSO for storage and subsequent conveyance to and treatment at the Morris Forman WQTC. The facilities included 35 CSOs in one configuration and the 106 CSOs in the second configuration.

3.2.7.5 Utilization of Morris Forman WQTC Capacity

The Final CSO LTCP evaluates off-line system storage with pump-back into the CSS as interceptor and treatment capacity becomes available following a wet weather event. As such, evaluation of the sustained wet weather treatment capacity of the CSS receiving treatment facility, Morris Forman WQTC, was warranted. Note that the Morris Forman WQTC is the only treatment facility in the MSD system that receives combined sewage.

MSD prepared a hydraulic model of the Morris Forman process train, and conducted process stress tests in October 2002. These tests are documented in a report from CH2M HILL dated March 23, 2003. The results of the hydraulic modeling and stress testing were used to prepare the “MFWTP - Wet Weather Standard Operating Procedure” dated May 25, 2004 and included in Appendix 3.2.20. This document includes the first version of a “capacity calculator” that is still used today, with minor modifications.

The calculator considers the number of process units available for use, from bar screens through chlorine contact basins. It also considers the depth of the sludge blankets in the primary sedimentation basins and the secondary clarifiers, since sludge blanket depth impacts the amount of flow that can be treated through the units without washing out solids.

With all process units on-line, and primary sedimentation basin and secondary clarifier sludge blankets at optimum levels, the peak flow capacity of the Morris Forman WQTC is 350 mgd. Attempting to take more than 350 mgd through the primary sedimentation basins will flood the effluent weirs and wash out solids regardless of blanket depth. If some treatment units are out of service, the peak capacity will be less, proportional to the capacity of the treatment units not in service.

Operating experience shows that the peak capacity of 350 mgd cannot be sustained for long periods of time without loss of process efficiency or washing out of solids. The maximum sustained capacity of the Morris Forman WQTC has been determined to be 325 mgd if all process units are in service and sludge blankets are at optimal levels.

While the peak hydraulic capacity of the plant is 350 mgd not all of that flow can pass through the secondary treatment process. With all units in service, and secondary clarifier sludge blankets at optimal level, the maximum capacity of the secondary treatment system is 140 mgd. The portions of the flow that do not receive secondary treatment do receive screening, grit removal, primary sedimentation, and disinfection.

In addition to evaluating the current capacity of the Morris Forman WQTC, MSD also conducted a study to evaluate the potential for plant expansion on the current site. This evaluation is documented in the "Morris Forman WWTP Expansion" Technical Memo, Appendix 3.2.21. The conclusion of this evaluation was that the existing site was fully developed, and constrained from expanding due to topography. The study evaluated satellite treatment at two nearby sites, and using two different treatment technologies. These evaluations are also included in the technical memorandum.

The result of these evaluations was the establishment of standard operating procedures (SOP) to maximize treatment at the Morris Forman WQTC, and confirmation that expansion of the treatment plant on the existing site is not practical. If additional treatment capacity is needed to achieve the objectives of the Final CSO LTCP, off-site satellite treatment will be necessary. A further discussion of treatment alternatives and evaluation is provided in Section 3.3.

3.2.7.6 Consideration of Sensitive and Priority Areas

EPA's "Combined Sewer Overflows Guidance for Long-Term Control Plan" expects that a LTCP will give the highest priority to controlling overflows to sensitive areas, defined in other Chapters of Volume 2. According to the CSO Control Policy sensitive area criteria, all waters of the Ohio River through Jefferson County and all waters of Beargrass Creek within the CSS are categorized as sensitive areas.

As described in Chapter 1, Section 1.6.7.1 and Chapter 2, Section 2.8, a study was completed within the three Forks of Beargrass Creek to segment and rank stream reaches based on their ecological sensitivity. These results determined which reaches would realize greater benefit from water quality improvements and should be given higher priority consideration during the CSO control and implementation decision process. The results of this prioritization process and ecological reach ranking are not the sole determining factor; however, it is one of several variables integrated into the Final CSO LTCP CSO control projects selection process and implementation schedule discussed in detail in Chapter 4.

Individual stream segments have an ecological rating derived from the sum of its weighted parameter points, discussed in detail in Chapter 2.8. Stream segment scores and their priority rankings are shown in Table 3.2.15.

For a preferred control alternative, ratings for the individual CSO reaches involved in the project were summed and averaged. This numerical average score was assigned a priority level using the priority delineations discussed in Chapter 2.8 to give the project an appropriate ecological rating. Averaging reach scores versus summing reach scores reduces the bias that would be created by assuming ecological improvement potential is higher for projects that group a large number of CSOs into a single control. In the case of the MSD CSS, the highest priority projects, per summing ecological reach ratings, would be those overflowing into the concrete-lined improved channel of Beargrass Creek South Fork, shown in Figure 3.2.8. Of the 42 CSOs discharging into Beargrass Creek South Fork, 32 discharge to the concrete-lined improved channel. The ratings calculated by summing reach scores, would imply that there is potential for significant improvement in the concrete-lined channel, which is not the case.

FIGURE 3.2.8 LOW PRIORITY REACH (SOUTH FORK BEARGRASS CREEK CSO081 AND CSO118)

This resulting rating was used in conjunction with other selection criteria in order to determine the order of implementation of recommended projects. Other factors that affect the schedule include, but are not limited to, benefit-cost ratio, coordination with proposed development projects, site availability, costs, and cash flow.

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

TABLE 3.2.15
STREAM SEGMENT PRIORITY SCORES AND RATINGS

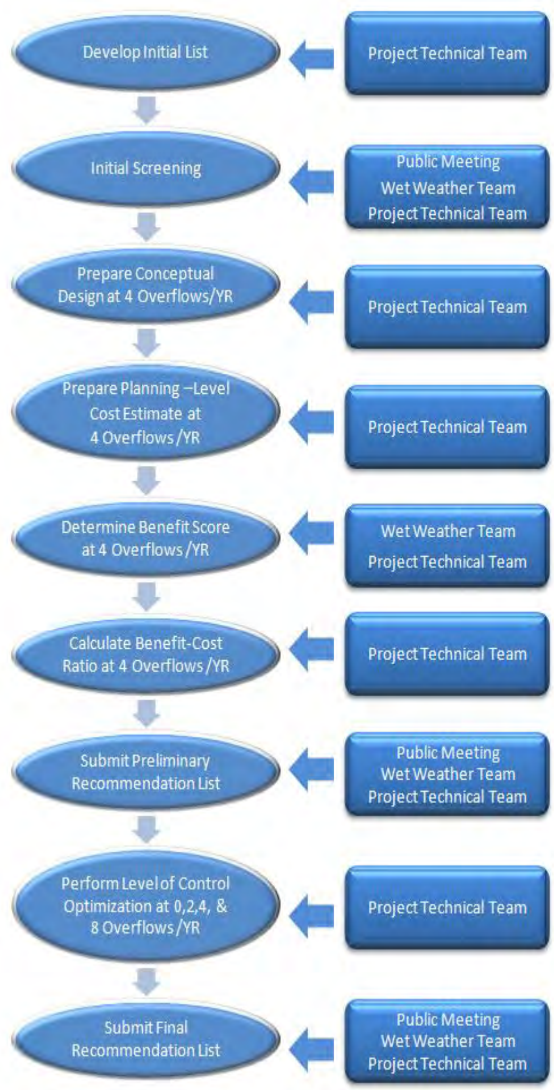
Reach Name	Accessibility	Threatened /Endangered Species or their Habit	Stream Rapid Bioassessment Protocol	Bank Erosion Hazard Index	Index of Biotic Integrity	CSO Average Annual Overflow Volume (AAOV)	Landuse	Land Cover	Restoration Potential	Reach Length	Score	Priority Rating Category
MI206	10	9	9	5	10	2	10	7	10	10	110	Highest
S109	4	4	9	7	10	7	10	10	8	10	102	Highest
S108	7	5	9	8	10	2	10	10	7	9	101	Highest
S018	5	4	9	6	10	8	10	10	7	8	100	Highest
S137	4	4	8	9	10	8	10	10	8	1	94	High/Medium
S097	7	5	8	10	10	2	7	7	8	6	93	High/Medium
S106	4	4	5	9	10	9	10	10	8	1	89	High/Medium
S081/088	6	4	10	7	1	10	8	8	8	10	87	High/Medium
MI126	9	5	3	4	5	9	10	10	10	4	82	High/Medium
MI144	6	5	7	4	5	8	5	5	9	9	80	High/Medium
MI127	9	5	7	3	5	3	5	8	10	7	79	Medium
MI166	9	5	3	7	5	3	10	7	10	7	79	Medium
MI125	9	5	4	4	5	3	10	9	10	3	76	Medium
S093	3	3	9	7	1	10	3	7	8	6	70	Medium
S130	3	3	10	7	1	5	1	7	8	5	64	Medium
S087/131	1	2	9	7	1	9	2	5	8	5	61	Medium
MI140	2	3	4	5	5	5	1	6	5	9	57	Medium
MI086	1	2	2	6	5	10	1	4	5	2	47	Medium
MU132/154/167	2	1	1	7	1	1	8	8	8	4	44	Medium/Low
S091	1	1	1	1	5	10	4	5	1	7	43	Medium/Low
S092	1	1	1	1	5	10	4	5	1	5	41	Medium/Low
S111/148	1	1	1	1	5	3	5	6	1	8	39	Medium/Low
S113	1	1	1	1	5	4	5	6	1	5	37	Medium/Low
S151	1	1	1	1	5	1	5	8	1	6	37	Medium/Low
S152	4	1	1	1	5	3	3	6	1	4	36	Lowest
S110	4	1	1	1	5	6	5	4	1	1	36	Lowest
S142	1	1	1	1	5	10	2	2	1	2	33	Lowest
S119	1	1	1	1	5	7	1	1	1	7	33	Lowest
S082	2	1	1	1	1	9	1	4	1	8	32	Lowest
S153	1	1	1	1	5	4	1	5	1	5	32	Lowest
S141	1	1	1	1	5	10	1	3	1	1	32	Lowest
S121	1	1	1	1	5	6	1	5	1	2	31	Lowest
S117/149/179	1	1	1	1	5	2	1	1	1	9	30	Lowest
S084	1	1	1	1	5	7	1	1	1	1	27	Lowest
S120	1	1	1	1	5	5	1	1	1	2	26	Lowest
S146/147	1	1	1	1	5	1	1	2	1	2	23	Lowest
S083/118	1	1	1	1	5	1	1	1	1	1	21	Lowest

Range:	**95-130**	Highest Priority
	80-94	High / Medium Priority
	46-79	Medium Priority
	37-45	Medium / Low Priority
	13-36	Lowest Priority

3.3 EVALUATION OF CSO CONTROL ALTERNATIVES

In this section, the process of designing and estimating costs for the initial CSO control alternatives presented in Section 3.2.7 is discussed. Furthermore, the methodology for selecting and optimizing control alternatives, including the preferred solutions, is presented. Figure 3.3.1, summarizes the CSO controls alternative process.

FIGURE 3.3.1 CSO CONTROL ALTERNATIVE PROCESS



3.3.1 CSO Controls Sizing and Conceptual Design

The initial step in developing CSO control projects was determination of CSO frequency, flow rate, and volume. As discussed in Chapter 2.4, Jefferson County, Kentucky 2001 rainfall data was established as the yearly rainfall data to be used for sizing. A series of InfoWorks CS model runs were performed under varying CSS configurations, applying the 2001 rainfall data modes. The eventual CSS model conditions for sizing gray infrastructure alternatives were defined to include the following:

- Green Infrastructure Program build-out
- RTC program implementation
- Flow re-direction from Beargrass Creek South Fork watershed to the Ohio River watershed
- Reduced inflow contribution from the separate sewer system based on flow re-direction projects planned for the sanitary sewer system

The CSS hydraulic model output produced a list that included the number of overflows predicted for each CSO in the CSS for the 2001 annual rainfall. Each overflow or event was defined by volume, flow rate, and duration. This data was then used to size conveyance and volume required to achieve a performance goal. The performance goal or target for the initial suite of 136 projects was set at a level of four overflows per year, per the presumptive approach. Per this goal, the conveyance rate design basis was set at the fifth highest flow rate, providing that only the four higher flows would exceed the hydraulic capacity of the collection system and associated overflow control. Likewise, the volumetric design basis was set at the fifth highest overflow volume, providing capture of overflows that are lesser in volume than the largest four events. Note that the conveyance rate and volumetric design parameters are independent since model results indicated different storms produced overflow volumes and rates that are precipitation simulation-driven, not event-driven. Thus, the fifth highest overflow may not necessarily occur at the fifth highest conveyance rate.

For conceptual design of sewer separation projects, pipe diameters were set equal to the diameter of the existing combined conveyance pipe. For nearly all separation projects, a new stormwater system, or modifications to the existing system for conversion to stormwater only, was considered. Of 49 sewer separation projects evaluated, 44 were storm sewers only, two were sanitary only, and three were a mix of systems.

In executing conceptual design of the storage and treatment projects, the Project Cost Estimating Document, MSD's Design Manual, MSD Record Drawings, LOJIC and GIS data were the primary guides and data sources. Conveyance piping was sized using the minimum pipe slope set by MSD guidelines. Basin storage depths were set at 15 feet, with an additional two feet freeboard, in an effort to minimize excavation costs. However, to offset the cost of large pump stations required by the high flow rates predicted by the model, basins were typically set at a depth that allowed gravity in – pump out operation (24-hour return for conceptual sizing), resulting in some basins to be up to 40~50 feet below grade. It is expected that pump station sizing and basin depth will be optimized as part of the final design process.

In regard to the regional storage facilities (tunnels) considered, two configurations, the Ohio River drainage basin, as depicted in Figure 3.3.2 and the entire CSS as depicted in Figure 3.3.3, that are located at the end of the chapter are inclusive of the Ohio River and Beargrass Creek drainage basins, were conceptually laid out. The Ohio River facility encompassed 35 CSOs and the CSS facility encompassed all 106 CSOs. Both configurations envisioned storage per the CSO controls sizing parameters discussed above, and included 48-hour pump-back stations. The average depth of each facility was assumed to be 100 feet. As such, a “mixed face” was assumed, versus a rock face, based on anecdotal information as to subsurface soil conditions along the proposed alignment.

As discussed in Section 3.2.7, satellite treatment considered two treatment processes: ballasted flocculation and retention treatment basin. The criterion for selection of treatment was the modeled treatment rate; five mgd for ballasted flocculation and 0.5 mgd for retention treatment basin. Of the 17 treatment plants evaluated, seven were ballasted flocculation and 10 were retention treatment basin.

The RTC program has been under consideration by MSD since 1999. Several inflatable dams are in operation to maximize storage in the Southwest Outfall and Sneads Branch Relief Drain. However, no RTC project alone is predicted by the model to provide sufficient storage to achieve the CSO target of four overflows per year. Hybrid projects are RTC projects paired with either storage or treatment, to take advantage of maximum in-line storage, thus reducing the size of the CSO control. Of the 20 hybrid technology projects evaluated, 19 were RTC-storage and one was RTC-treatment.

Also inclusive of the design process was identification of potential sites for construction of control alternatives. Most alternatives considered more than one location. In order to evaluate the feasibility of a site, a ground-truthing exercise was performed. This exercise reviewed the following parameters:

- Property Use Classification
- Utility Conflicts
- Site Constructability
- Adjacent Transportation Corridors
- Adjacent Property Use Classification

3.3.2 Project Costs

The Project Cost Estimating Document was utilized to determine estimated costs for CSO control alternatives. The tool served to generate consistent conceptual/planning level costs for technology solutions being analyzed for each respective scenario. The costing platform (data workbook) utilized by the tool to generate these planning level costs was built from a database of costing and construction data compiled from a variety of sources associated with similar construction projects. The tool also institutes planning level contingencies for the uncertainties encountered with each respective project. The planning level costs generated by the tool may vary +50 percent to -30 percent from a detailed cost for a specific project. As such, the main focus of the tool is to compare (not develop) planning level estimates for the projects being evaluated while taking into account each site's individual constraints.

The tool is used to evaluate a multitude of project approaches/technologies that could be utilized for addressing CSO controls. Specific to this Final CSO LTCP, these approaches/technologies are as follows:

- Flow Redirection
- RTC Flow Control
- Sewer Separation
- Storage
- Satellite Treatment

The tool is populated with individual construction costing modules/worksheets that correspond to the construction aspects that are relative to each of the above overflow reduction approaches/technologies. The costing modules/worksheets incorporated with the tool cover:

- Conveyance/In-line Storage – planning level cost development for open-cut, auger bored, micro-tunneled, or open-faced tunnel-boring machine sewers.
- Pump Stations – planning level cost development for pump stations with below ground wet wells, bar screens, a super structure, submersible pumps, piping, controls, and a backup generator.
- Force Mains – planning level cost development for the trench installation of ductile iron force mains utilizing the same costing methodology as open-cut sewers.
- Flow Control – planning level cost development for the installation of either inflatable dams (in pipeline or channels) or an RTC adjustable sluice gate.

- Off-line Storage – planning level cost development either covered or uncovered storage, concrete or earthen structure, with facilities consisting of a diversion structure, grit pit, coarse screening, flushing, instrumentation, standby generator, sump pumps and tankage.
- Satellite Treatment – planning level cost development for either ballasted flocculation or retention treatment basin facilities, including screening and disinfection.

These modules also have parameters associated with them that consider the constraints and conditions of the respective project site / tract being evaluated.

In addition, the tool also possesses ancillary costing modules that generate additional non-construction costs that include: program management costs, administration costs, real estate costs, contingency costs, engineering and inspection costs, planning and preliminary design costs, design services costs, interest costs, and costs for performance bonds.

3.3.3 Performance

The performance of CSO controls is difficult to predict precisely. As noted in earlier sections of this chapter, the target goal for the initial control alternatives was four overflows per year, which established the sizing of control projects. Different technologies provide different water quality outcomes even as they eliminate or reduce CSO overflow volume and frequency. Future conditions or regulations may require a higher level of CSO control than is provided for in this Final CSO LTCP. Higher levels of control may be obtained through expansion of existing controls (where space allows), addition of facilities such as supplemental storage in other locations, or retrofitting modifications to existing facilities (such as making process additions, for example, coagulant addition and disinfection to convert storage basins to discharging equivalent primary treatment under some flow conditions). Other opportunities to modify the level of CSO controls may include enhancement or expansion of the Green Infrastructure Program should monitoring indicate cost-effective source runoff reduction.

The five technologies evaluated, listed in Section 3.2.7, include the following:

- Pump Station Expansion
- Sewer Separation
- Off-line Storage
- Treatment
- Hybrid Technologies

Sewer separation, which separates sanitary sewage and stormwater into distinct, respective piping systems, can potentially result in continued discharge of poor water quality to a receiving stream (depending on pollutant load). In applying the benefit tool described in Section 3.1.2.2, this potential is factored into project scoring by assigning no improvement to the public health value, although technically the CSO overflow/volume is eliminated by sewer separation.

Reduction of CSO to a receiving stream by utilizing off-line storage can have a wide range of volumetric performance based on the hydraulic characteristics of the CSS. The percent capture is dependent on the distribution of the overflow event volumes; the remaining overflows of the preferred performance level (zero-12 overflows per year) could comprise a significant portion of the annual overflow volume generated by a respective CSO or group of CSOs. The project technologies and associated level of CSO control recommended, discussed in Chapter 4, are eventually input into the CSS model to determine system-wide CSO capture.

The two high rate physical-chemical treatment equivalent primary technologies evaluated, retention treatment basin (and ballasted flocculation produce different levels of effluent water quality. Retention treatment facilities are essentially settling basins with enhanced settling created by chemical (coagulant) addition. Settling is followed by addition of disinfectant, typically chlorine, followed by a de-chlorination agent. Overflow rates are typically several thousand gallons per day per square foot (gpd/sq ft), allowing the facility footprint to be minimal compared to conventional treatment. Treatment is only initiated once the volume of the basin is exceeded; otherwise the stored sewer overflow is pumped back to the CSS once capacity is available following the wet weather event.

Ballasted flocculation is a higher level of treatment than retention treatment basin, primarily resulting from higher clarification performance. Higher mixing energies, coupled with a ballasted settling material (for example, microsand) and significantly higher surface overflow rates (several orders of magnitude higher) result in higher quality effluent. Similar to retention treatment basin, chlorination-dechlorination is applied to reduce pathogen counts to within regulatory limits. UV or oxidants may also be used for pathogen inactivation. Due to operating requirements, and unlike retention treatment basin, a storage basin is added at the head of the plant to allow operator travel time and plant start-up. Also similar to retention treatment basin, treatment is only initiated once the volume of the tank is exceeded; otherwise the stored overflow is pumped back to the CSS.

Capital costs for construction of the treatment facilities (excluding pump stations and tanks) vary significantly: approximately \$0.13 - \$0.15 per gallon of treatment rate for retention treatment basin vs. approximately \$0.45 - \$0.50 per gallon for of ballasted flocculation treatment rate. Ballasted flocculation costs would actually be higher because a storage tank is required at the head of the facility. Operating costs, such as chemicals, power, maintenance, etc., are similarly higher for retention treatment basin vs. ballasted flocculation: \$0.007 per gallon vs. \$0.019 per gallon.

The treatment facility surface overflow design rates of 6,000 gpd/sq ft and 60 gpm/sq ft for retention treatment basin and ballasted flocculation respectively (per the Project Cost Estimating Document) will reduce pollutants and pathogen counts to the levels found in Table 3.3.1.

TABLE 3.3.1

SATELLITE TREATMENT PERFORMANCE

Parameter/Treatment Process	Ballasted Flocculation	Retention Treatment Basin
Total Suspended Solids (TSS)	80%-95% removal	50% removal
Biochemical Oxygen Demand (BOD)	60%-80% removal	30% removal
Pathogen Count	126 E. Coli/100 ml	126 E. Coli/100 ml

It is important to note that the CSO Control Policy permits treatment of CSO discharge to the following minimum levels of treatment:

- Primary clarification
- Solids and floatable removal and disposal
- Disinfection and removal of disinfectant residuals

The conceptual design elements and criteria of both processes listed above comply with these requirements. Whereas ballasted flocculation treatment exceeds the requirements dictated by the CSO Control Policy (hence the higher costs), retention treatment complies with the stated minimum requirements.

Performances of hybrid technologies are dependent on the types of systems merged into the control facility(s). The majority of hybrid projects evaluated were RTC with off-line storage, therefore performance of these controls would mirror that of off-line storage: determined by hydraulics of the respective CSOs. Where RTC is paired with treatment, the effluent quality of the treatment selected would determine the impact to the receiving stream.

The Pump Station Expansion project is utilized to re-direct flow within the CSS; the controls installed in the receiving sewershed will determine the performance of CSO control applied to that diverted volume of combined sewage.

3.3.4 Cost/Performance Evaluations

The benefit-cost ratio data generated by the benefit scoring and conceptual/planning-level cost estimates of the initial project list of 136 control alternatives was ultimately screened to a group of 19 preferred CSO control projects that were modeled to achieve the initial target overflow goal of four per year. While benefit-cost evaluations were the primary method to determine alternative selection, it was not the only factor considered in the decision process. Operational considerations, primarily the conveyance and treatment capacity available to empty the in-line and off-line storage basins, plus ecological reach ratings, described in Section 3.2.7.6, were also taken into consideration. As a result, two projects that were not the best-ranked benefit-cost ratio were recommended for the next step in the process (level of control optimization): one satellite treatment project, and one pump station expansion project.

Following the preliminary recommendation preferred of CSO control projects to MSD and the WWT, the preferred CSO control projects were subject to an optimization process level of control performance of zero, two, and eight overflows per year, to complement the initial performance sizing of four overflows per year. The benefit-cost calculations were also developed for the zero, two, and eight overflows per year, with the optimal benefit-cost ratio level of control recommended in the Final CSO LTCP.

This set of data for the various level of control projects was then plotted against performance targets to develop knee of the curve graphs. The graphs presented to the WWT included the following:

- Cost versus wet weather capture percentage
- Wet weather capture versus fecal coliform model predictions for both Ohio River and Beargrass Creek watersheds

The outcome of these CSO control project recommendations are presented in Chapter 4.

3.3.5 Rating and Ranking of Alternatives

At the completion of this evaluation process, the CSO projects were ranked by benefit-cost ratio. Outfall-specific solutions with one technology were compared technology versus technology. Localized consolidation projects grouped different combinations of CSOs in different geographic locations with competing control technologies. Typically, projects were selected by the highest benefit-cost ratio. Exceptions were made on ease of implementation per geographic requirements (available land area). In addition, CSS operation improvement opportunities, (basically reduction in pumping, or the need to add wet weather treatment capacity to the system) were included in the decision process.

Specific to Beargrass Creek South Fork, as a result of the significant number of CSOs (42), 34 permutations of CSO projects were evaluated. In addition, projects that were obvious geographic groupings were considered (see Figure 3.3.4, located at the end of this Chapter). Table 3.3.2 (also located at the end of this chapter), is a matrix comparing CSOs versus alternative-specific benefit-cost ratios which assisted in selection of the best localized consolidation project. This matrix served as a tool that could be used with other variables, primarily limited geographic sites to select a preferred alternative. The objective was to compare the benefit-cost ratios for the various clustered projects against obvious geographic clustering for any fatal flaw.

Following selection of preferred alternatives (the highlighted projects on Table 3.3.2); modifications to the operation of the CSS in the upper reach of Beargrass Creek South Fork were evaluated by MSD. This resulted in modifying the selected project, L_SO_MF_097_M_09B_B_D, shown on Figure 3.3.5 located at the end of this Chapter. These modifications include upgrading a pump station to divert flow from the Beargrass Creek South Fork watershed to the Ohio River watershed. This resulted in two CSOs (CSO018 and CSO108) from the original consolidated solution to become outfall specific solutions, shown on Figure 3.3.6 at the end of this Chapter. In addition, the overflow frequency of one CSO (CSO109) was reduced to two overflows per year, within the presumptive approach of no more than four overflows per year.

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO015	SOUTHWESTERN PS	OR	7,441.3		X	X	X		X	X	
CSO016	MILES PARK BYPASS	OR	0.0		X				X	X	
CSO018	NIGHTINGALE PS	BGCSF	0.0						X	X	
CSO019	34th STREET PS	OR	1,192.4		X	X			X	X	
CSO020	BUCHANAN PS	OR	86.6				X				
CSO022	FOURTH ST PS	OR	95.2		X					X	
CSO023	ORI @ 4th ST PS	OR	--		X					X	
CSO026	CRD 6th & BROADWAY	OR	8.4	X	X	X				X	
CSO027	CRD 7th & BROADWAY	OR	10.1	X	X	X				X	
CSO028	CRD 6th & YORK	OR	6.1	X	X	X				X	
CSO029	CRD 8th & YORK	OR	0.0	X	X	X				X	
CSO030	CRD 9th & YORK "A"	OR	Eliminated								
CSO031	CRD 6th & BRECKINRIDGE	OR	3.8	X	X	X				X	
CSO032	CRD 4th & BRECKINRIDGE	OR	Eliminated								
CSO033	CRD ON YORK E OF 4th	OR	Eliminated								
CSO034	CRD 4th & YORK	OR	5.1	X	X	X				X	
CSO035	CRD 2nd & BROADWAY NO 1	OR	0.0	X	X	X				X	
CSO036	CRD 3rd & BROADWAY	OR	20.0	X	X	X				X	
CSO038	CRD 5th & BROADWAY	OR	9.5	X	X	X				X	
CSO049-SM	PRESTON ST	OR	Eliminated								
CSO050	12th STREET	OR	36.3	X	X						
CSO051	11th STREET	OR	6.3	X	X						

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO052	10th STREET	OR	8.7	X	X						
CSO053	8th STREET	OR	34.1	X							
CSO054	7th STREET	OR	7.1	X	X						
CSO055	6th STREET	OR	18.0	X	X						
CSO056	5th STREET	OR	22.0	X	X						
CSO057	FIRST STREET OVERFLOW WEIR	OR	--		X						
CSO058	PRESTON ST OVERFLOW WEIR	OR	105.4	X	X						
CSO062	LOGAN COMPANY	OR	--				X				
CSO065	LAMPTON ST	BGCSF	Eliminated								
CSO080	PAYNE ST	BGCMF	Eliminated								
CSO081	LETTERLE	BGCSF	Eliminated								
CSO082	BGI AT BGC	BGCSF	16.0		X			X	X	X	
CSO083	BRENT ST & BROADWAY CONNECT	BGCSF	45.7		X			X	X	X	
CSO084	BRENT ST @ BGC	BGCSF	125.1		X				X	X	
CSO086	PAYNE AT SPRING	BGCMF	6.1	X	X					X	
CSO087	BLUEHORSE	BGCSF	Eliminated								
CSO088	MELLWOOD AVE INT	BGCSF									
CSO091	SCHILLER AVE OVERFLOW	BGCSF	15.0	X				X	X	X	
CSO092	ST CATHERINE @ BGC	BGCSF	7.7	X	X			X	X	X	
CSO093	SPRING STREET	BGCSF	20.8	X							
CSO097	CANTONMENT SIPHON NO 2	BGCSF	--		X				X	X	

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO104	SW PKWY SEWER @ BROADWAY	OR	62.0		X	X	X		X	X	
CSO105	WESTERN OUTFALL @ BROADWAY	OR	1,893.0		X	X	X		X	X	
CSO106	ROYAL - NEFF	BGCSF	11.8	X	X				X	X	
CSO108	REG N0 1 - NEWBURG	BGCSF	485.2		X	X				X	
CSO109	REG NO 2 - DEER PARK	BGCSF	95.4		X				X	X	
CSO110	REG NO 3 - GOSS AVE	BGCSF	73.0		X			X	X	X	
CSO111	EMERSON STREET SEWER	BGCSF	99.4		X			X	X	X	
CSO113	ELLISON AVENUE SEWER	BGCSF	67.6		X			X	X	X	
CSO117	REG NO 11 - DRY RUN	BGCSF	74.2		X	X		X	X	X	
CSO118	REG NO 15 - E BROADWAY	BGCSF	354.1		X	X		X	X	X	
CSO119	BRENT STREET SEWER	BGCSF	--		X			X	X	X	
CSO120	PHOENIX HILL SEWER	BGCSF	7.7	X	X			X	X	X	
CSO121	REG NO 18 - GREEN ST	BGCSF	107.2		X			X	X	X	
CSO123	REG NO 20 – RUTH-SLUGRV	BGCMF	Eliminated								
CSO125	REG NO 24 - GRINSTEAD DR	BGCMF	391.0		X					X	X
CSO126	REG NO 26 - RAYMOND AVE	BGCMF	35.3		X					X	X
CSO127	ETLEY AVENUE	BGCMF	192.3		X					X	X
CSO130	WEBSTER STREET	BGCSF	28.4	X	X						
CSO131	REG NO 33 - MELLWOOD & FRANKFORT	BGCSF	50.3	X							
CSO132	REG NO 35 - BROWNSBORO	BGCMF	674.0		X	X			X	X	
CSO137	CALVARY CEMETERY	BGCSF	26.7		X				X	X	

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO140	LOCUST STREET	BGCMF	75.5	X	X					X	
CSO141	BAXTER AVE @ BGC	BGCSF	16.5	X	X			X	X	X	
CSO142	SBR LOGAN ST @ ST CATHERINE	BGCSF	[illegible]		X				X	X	
CSO144	VANCE ST REGULATOR	BGCMF	16.4	X	X					X	X
CSO145	POINT PUMP STATION	BGCSF	Eliminated								
CSO146	SNEADS BRANCH DIVERSION	BGCSF	724.6		X			X	X	X	
CSO147	SWAN STREET DIVERSION	BGCSF	Eliminated								
CSO148	EASTERN PKWY DIVERSION	BGCSF	24.9		X			X	X	X	
CSO149	DRY RUN DIVERSION	BGCSF	225.8		X			X	X	X	
CSO150	8th ST @ COMMON PLACE	OR	1.8	X	X						
CSO151	REG NO 5 - CASTLEWOOD	BGCSF	232.5		X			X	X	X	
CSO152	REG NO 7 - SOUTHEASTERN	BGCSF	260.6		X			X	X	X	
CSO153	COOPER STREET	BGCSF	41.7		X			X	X	X	
CSO154	MELLWOOD @ SCHOEFFEL	BGCMU	31.0		X				X	X	
CSO155	ROWAN ST @ 12th ST	OR	11.9	X	X						
CSO156	6th & WASHINGTON SAN DIV	OR	--	X	X						
CSO160	SEWER IN ALLEY SAN DIV	OR	2.0	X	X						
CSO161	MARKET ST SAN DIV	OR	2.5	X	X						
CSO162	BEALS BRANCH HW REG	BGCMF	Eliminated								
CSO166	BEALS BRANCH SAN DIV	BGCMF	681.1		X	X				X	X
CSO167	BROWNSBORO LAT NO 2	BGCMF	11.0		X				X	X	
CSO172	ADAMS STREET	OR	13.7	X	X				X	X	

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO174	SBR GOSS & BOYLE	BGCSF	169.6		X	X			X	X	
CSO178	CRD 9th & YORK "B"	OR	29.7	X	X	X				X	
CSO179	KENTUCKY ST SEWER OVERFLOW	BGCSF	461.8		X	X		X	X	X	
CSO180	SBR ORMSBY AVE RELIEF	BGCSF	2.8		X					X	
CSO181	CRD 2nd & BROADWAY NO 2	OR	22.6	X	X	X				X	
CSO182	SBR SHELBY & BURNETT	BGCSF	147.3		X				X	X	
CSO183	SBR ALEXANDER & KESWICK	BGCSF	3.2		X				X	X	
CSO184	SBR FETTER & ALEXANDER	BGCSF	109.3		X				X	X	
CSO185	SBR SHELBY & KESWICK	BGCSF	145.8		X				X	X	
CSO186	SBR LOGAN & OAK	BGCSF	0.0		X				X	X	
CSO187	SBR SHELBY & CAMP	BGCSF	5.2		X				X	X	
CSO188	SBR SHELBY & CLAY	BGCSF	14.7		X				X	X	
CSO189	NORTHWESTERN SAN DIV	OR	1,148.7		X	X	X		X	X	
CSO190	SEVENTEENTH ST SAN DIV	OR	145.4		X					X	
CSO191	ALGONQUIN PKWY SAN DIV	OR	339.8		X	X			X	X	
CSO192	CRD S 6th & GARLAND	OR	9.0	X	X	X				X	
CSO193	CRD S 6th & KENTUCKY	OR	22.7	X	X	X				X	
CSO194	CRD S OAK W of 4th	OR	Eliminated								
CSO195	CRD S 4th & OAK	OR	7.3	X	X	X				X	
CSO196	CRD S 3rd & OAK	OR	--	X	X	X				X	
CSO197	CRD S 3rd S OF OAK	OR	--	X	X	X				X	
CSO198	CRD S 3rd & ORMSBY	OR	13.0	X	X	X				X	

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.1.1
CONTROL TECHNOLOGIES BY CSO

CSO No.	CSO Name	Receiving Stream	Drainage Area (ac.)	Sewer Separation	Off-Line Storage	In-Line Storage	Flow Control	Flow Diversion	Ballasted Flocculation Treatment	Retention Treatment Basin	Hybrid
CSO199	CRD S 3rd N OF MAGNOLIA	OR	--	X	X	X				X	
CSO200	CRD S 3rd & MAGNOLIA	OR	10.3	X	X	X				X	
CSO201	CRD S 5th & KENTUCKY	OR	[illegible]	X	X	X				X	
CSO202	CRD S ORMSBY W of 3rd	OR	5.32	X	X					X	
CSO203	CRD S 4th & ORMSBY	OR	14.2	X	X	X				X	
CSO204	CRD S 5th & BRECKINRIDGE	OR	Eliminated								
CSO205	SBR MORGAN STREET RELIEF	BGCSF	9.5		X				X	X	
CSO206	CHEROKEE PARK @ SPRING DR	BGCMF	Being Separated								
CSO207	2nd & JEFFERSON	OR	2.5								
CSO208	12th & JEFFERSON	OR	11.2	X	X						
CSO209	CHEROKEE PARK @ PARK BD RD	BGCMF	Eliminated								
CSO210	45th STREET-GREENWOOD	OR	166.7		X				X	X	
CSO211	MAIN DIVERSION STRUCTURE	OR	3,620.3		X		X		X	X	

Legend: BGCMU – Beargrass Creek Muddy Fork; BGCMI - Beargrass Creek Middle Fork; BGCSF - Beargrass Creek South Fork; OR – Ohio River; CRD-Central Relief Drain; SBR-Sneads Branch Relief; BGI - Beargrass Interceptor;

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.10

BEARGRASS CREEK MUDDY FORK (BGCMU) INITIAL SOLUTIONS

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_MU_MF_154_M_09B_B_A	**Off-Line Storage**	CSO132, CSO154, CSO167	This project includes a 7.95 MG underground covered storage basin for CSOs 132, 154 and 167. The facility will require a 7.95 mgd PS to return the stored flow back to the interceptor.	24.36
L_MU_MF_154_S_09B_B_A	**Off-Line Storage**	CSO154	This project includes a 0.17 MG underground covered storage basin for CSO 154. The facility will require a 0.17 mgd PS to return the stored flow to the interceptor.	45.73
L_MU_MF_154_M_13_B_A	**RTC with Storage**	CSO132, CSO154, CSO167	This project includes a 7.45 MG underground covered storage basin for CSOs 132, 154 and 167. The facility requires a 7.45 mgd PS to return stored flow back to interceptor and a 0.5 MG RTC in-line storage using an inflatable gate in the Brownsboro Road Trunk Sewer.	21.56
L_MU_MF_132_M_09B_B_A	**Off-Line Storage**	CSO132, CSO167	This project includes a 7.78 MG underground covered storage basin for CSOs 132 and 167. The facility will require a 7.78 mgd PS to return the stored flow back to the interceptor.	20.38
L_MU_MF_132_M_13_B_A	**RTC with Storage**	CSO132, CSO167	This project includes a 7.19 MG underground covered storage basin for CSOs 132 and 167. The facility will require a 7.19 mgd PS to return stored flow back to interceptor and a 0.5 MG RTC in-line storage using an inflatable gate in the Brownsboro Road Trunk Sewer.	18.17
L_MU_MF_154_M_10_B_A	**Treatment Facility**	CSO132, CSO154, CSO167	This project is to provide a 81 mgd RTB High Rate Treatment Facility for CSOs 132, 154 and 167. Annual volume stored is approximately 153 MG, operated 58 times per year.	17.19
L_MU_MF_132_M_10_B_A	**Treatment Facility**	CSO132, CSO167	This project is to provide a 78 mgd RTB High Rate Treatment Facility for CSO 132 and 167. Annual volume stored is approximately 58 MG, operated 58 times per year.	14.85

Legend: ILS- In-Line Storage; LF- Linear Feet, RTB –Retention Treatment Basin,
Selected Projects are in Yellow

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.11

BEARGRASS CREEK MIDDLE FORK (BGCMI) INITIAL SOLUTIONS

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_MI_MF_127_M_09B_B_A	**Off-Line Storage**	CSO125, CSO126, CSO127, CSO166	This project is to provide a 4.13 off-line storage facility consisting of a covered concrete basin for CSOs 125, 126, 127 & 166. Annual volume stored is approximately 59.79 MG, operated 54 times per year.	40.63
L_MI_MF_144_M_09B_B_A	**Off-Line Storage**	CSO125, CSO126, CSO127, CSO144, CSO166	This project is to provide a 4.13 off-line storage facility consisting of a small uncovered concrete basin followed by a large earthen storage basin for CSOs 125, 126, 127, 144 (zero AAOV) & 166. Annual volume stored is approximately 59.79 MG.	60.03
L_MI_MF_144_M_09B_B_B	**Off-Line Storage**	CSO086, CSO125, CSO126, CSO127, CSO140, CSO144, CSO166	This project is to provide a 5.11 MG off-line storage facility consisting of a small uncovered concrete basin & a large earthen storage basin for CSOs 086, 125, 126, 127, 140, 144 (zero AAOV) & 166. Annual volume stored is approximately 76.32 MG.	60.01
L_MI_MF_144_M_13_B_A	**RTC with Storage**	CSO086, CSO125, CSO126, CSO127, CSO140, CSO144, CSO166	This project is to provide a 4.6 MG off-line storage facility consisting of a small uncovered concrete basin & a large earthen storage basin for CSOs 086, 125, 126, 127, 140, 144 (zero AAOV) & 166 and 0.5 MG of RTC-ILS at CSO 166 using an inflatable gate.	46.35
L_MI_MF_144_M_13_B_B	**RTC with Storage**	CSO125, CSO126, CSO127, CSO144, CSO166	This project is to provide a 3.63 off-line storage facility consisting of a small uncovered concrete basin followed by a large earthen storage basin for CSOs 125, 126, 127, 144 (zero AAOV) & 166 and 0.5 MG of RTC-ILS at CSO 166 using an inflatable gate.	44.10

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.11

BEARGRASS CREEK MIDDLE FORK (BGCMI) INITIAL SOLUTIONS

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_MI_MF_166_M_09B_B_A	**Off-Line Storage**	CSO086, CSO125, CSO126, CSO127, CSO140, CSO144, CSO166	This project will provide a 5.11 MG off-line storage facility with a covered concrete off-line storage facility for CSOs 086(zero AAOV), 125, 126, 127, 140, 144 (zero AAOV) & 166. Annual volume stored is approximately 76.32 MG. Facility will require a 5.1 mgd PS	39.71
L_MI_MF_126_M_09B_B_A	**Off-Line Storage**	CSO125, CSO126, CSO127, CSO166	This project is to provide a 4.13 off-line storage facility consisting of a covered concrete basin for CSOs 125, 126, 127 & 166. Annual volume stored is approximately 59.79 MG, operated 54 times per year.	35.82
L_MI_MF_166_M_13_B_A	**RTC with Storage**	CSO086, CSO125, CSO126, CSO127, CSO140, CSO144, CSO166	This project is to provide a 4.6 MG off-line storage facility with a covered concrete basin for CSOs 086 (zero AAOV), 125, 126, 127, 140, 144 (zero AAOV) & 166 & 0.5 MG of RTC-ILS at CSO166. Annual volume stored is appr. 69.42 MG. Facility requires a 4.6 mgd PS.	34.02
L_MI_MF_127_M_13_B_A	**RTC with Storage**	CSO125, CSO126, CSO127, CSO166	This project is to provide a 3.63 off-line storage facility consisting of a covered concrete basin for CSOs 125, 126, 127 & 166 and 0.5 MG of RTC-ILS at CSO 166. Annual volume stored is approximately 53 MG, operated 54 times per year.	33.85
L_MI_MF_126_M_13_B_A	**RTC with Storage**	CSO125, CSO126, CSO127, CSO166	This project is to provide a 3.63 MG off-line storage facility consisting of a covered concrete basin for CSOs 125, 126, 127 & 166 and 0.5 MG of RTC-ILS at CSO 166 using an inflatable gate. The basin is located just north of I-64 adjacent to CSO 126.	28.93
L_MI_MF_144_S_08_A_A	**Sewer Separation**	CSO144	This project includes the construction of a new water storm system consisting of 2,560 LF of 12" pipe in street, 2,060 LF of 15" pipe in street, 355 LF of 15" pipe out of street and 780 LF of 36" pipe in street.	-38.19

L_MI_MF_140_S_08_A_A	**Sewer Separation**	CSO140	This project includes the construction of a new storm sewer system consisting of [illegible] LF of pipe in street & [illegible] LF of pipe out of street.	26.24
L_MI_MF_140_M_09B_B_A	**Off-Line Storage**	CSO086, CSO140	This project is to provide a 0.97 MG underground covered concrete storage basin for CSOs 86 (zero AAOV) and 140 to reduce overflows to no more than 4 per year. Annual stored volume is approximately 16.53 MG; 54 operations per year.	30.85
L_MI_MF_086_S_08_A_A	**Sewer Separation**	CSO086	This project includes the construction of a new storm sewer system consisting of 390 LF of 12" pipe in street, 145 LF of 15" pipe in street, 1,205 LF of 18" pipe in street and 460 LF of 21" pipe in street.	-72.51
Legend: ILS- In-Line Storage; LF- Linear Feet, RTB –Retention Treatment Basin, Selected Projects are in Yellow				

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

CSO Data Outdated

Refer to Chapter 5

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_097_M_09B_B_D	**Off-Line Storage**	CSO018, CSO097, CSO106, CSO108, CSO109, CSO110, CSO111, CSO137, CSO148, CSO151	This project includes an 8.63 MG underground covered storage basin for CSOs 018, 97, 106, 108, 109, 110, 111, 137, 148, and 151. The facility will require an 8.63 mgd PS to return flow to the interceptor. (CSO 111 (zero AAOV) and CSO [illegible] has 3 CF per year)	35.79
L_SO_MF_106_S_08_A_A	**Sewer Separation**	CSO106	This project includes the construction of a new storm sewer system consisting of 60 LF of 12" pipe in street and 20 LF of 27" pipe in street; plus 20 LF of 12" pipe out of street, 555 LF of 24" pipe out of street, and 390 LF of 27" pipe out of street.	194.69
L_SO_MF_097_M_09B_B_A	**Off-Line Storage**	CSO097, CSO106, CSO137	This project includes the construction of a 0.98 MG off-line underground covered storage basin for CSOs 097, CSOs 097, 106 & 137. The facility will require 0.98 mgd effluent PS to return the stored flow to the interceptor over a 24 hour time period.	53.19
L_SO_MF_111_M_09B_B_A	**Off-Line Storage**	CSO097, CSO106, CSO110, CSO111, CSO137, CSO148,	This project includes a 2.64 MG underground covered storage basin for CSOs 097, CSOs 097, 106, 110, 111 (zero AAOV), 137 & 148. The basin will have an effluent PS sized to empty the basin within a 24 hour period.	51.83
L_SO_MF_113_M_09B_B_A	**Off-Line Storage**	CSO097, CSO106, CSO110, CSO111, CSO113, CSO137, CSO148, CSO151	This project includes a 6.64 MG underground covered storage basin for CSOs 097, CSOs 097, 106, 110, 111 (zero AAOV), 113, 137, 148 and 151. The facility will require a 6.64 mgd PS to return flow over a 24 hour period.	41.18
L_SO_MF_151_M_09B_B_A	**Off-Line Storage**	CSO097, CSO106, CSO110, CSO111, CSO137, CSO148, CSO151	This project includes a 6.21 MG underground covered storage basin for CSOs 097, CSOs 097, 106, 110, 111 (zero AAOV), 137, 148, and 151. The facility will require a 6.21 mgd PS to return stored flow to the interceptor over a 24 hour period.	36.64
L_SO_MF_110_M_09B_B_A	**Off-Line Storage**	CSO110, CSO111, CSO148	This project includes a 1.66 MG underground covered storage basin for CSOs 110, 111 (zero AAOV) & 148. The basin is adjacent to CSO 110, BGC and a cemetery south of Eastern Parkway. The basin will have a PS to empty it within a 24 hour period.	35.52
L_SO_MF_097_M_09B_B_B	**Off-Line Storage**	CSO097, CSO108, CSO109, CSO110, CSO111, CSO148, CSO151	This project includes the construction of an 6.73 MG off-line underground storage basin for CSOs 097, 108, 109, 110, 111 (zero AAOV), 148 & 151. The facility will require a 6.73 mgd effluent PS to return the stored flow over a 24-hour period.	34.06

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_097_M_09B_B_C	**Off-Line Storage**	CSO097, CSO110, CSO151	This project includes the construction of a 5.85 MG off-line underground storage basin for CSOs 097, 110, & 151. The facility will require a 5.85 mgd effluent PS to return the stored flow to the interceptor over a 24-hour period.	31.34
L_SO_MF_097_M_10_B_A	**Treatment Facility**	CSO097, CSO106, CSO137	This project is to provide a 9.6 mgd RTB High Rate Treatment Facility for CSOs 097, CSOs 097, 106 & 137. The basin is located on undeveloped property between CSOs 97 & 106 near the SFBGC. Annual volume stored is approximately 16.61 MG, operated 48 times per year.	28.30
L_SO_MF_151_M_09B_B_B	**Off-Line Storage**	CSO110, CSO111, CSO148, CSO151	This project includes the construction of a 5.23 MG off-line underground storage basin for CSOs 110, 111 (zero AAOV), 148 & 151. The facility will require a 5.23 mgd effluent PS to return the stored flow to the interceptor over a 24-hour period.	27.97
L_SO_MF_151_M_09B_B_C	**Off-Line Storage**	CSO110, CSO111, CSO151	This project includes the construction of a 5.14 MG off-line underground storage basin for CSOs 110, 111 (zero AAOV), & 151. The facility will require a 5.14 mgd effluent PS to return the stored flow to the interceptor over a 24-hour period.	25.15
L_SO_MF_018_M_09B_B_A	**Off-Line Storage**	CSO018, CSO108	This proposed project includes a 2.42 MG underground closed off-line storage basin for CSO's 018 and 108. The basin will be fed by gravity and have a small PS and FM to empty the basin over a 24-HR period.	23.88
L_SO_MF_097_M_10_B_B	**Treatment Facility**	CSO018, CSO097, CSO106, CSO108, CSO109, CSO110, CSO111, CSO137, CSO148, CSO151	This project is to provide a 79.3 mgd RTB High Rate Treatment Facility for CSOs 018, 097, 106, 108, 109, 110, 111, 137, 148 & 151. Annual volume stored is approximately 155 MG, operated 59 times per year.	21.18
L_SO_MF_108_S_09B_B_A	**Off-Line Storage**	CSO108	This project includes an underground covered off-line storage basin to reduce overflows at CSO 108. Assumes 300' of gravity line to a 0.79 MG basin and includes a new PS and FM to empty the basin and return flows to the interceptor.	14.69
L_SO_MF_018_S_09B_B_A	**Off-Line Storage**	CSO018	This proposed project includes a 1.63 MG underground closed off-line storage basin. The basin will be feed by gravity and have a small PS and FM to empty the basin over a 24-HR period.	13.42

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_018_M_10_B_A	**Treatment Facility**	CSO018, CSO108	This project is to provide an above-grade 21 mgd BF High Rate Treatment Facility and a below-grade 2.5 MG off-line concrete storage basin for CSOs 018 and 108. Average annual volume of captured CSO is ~30 MG.	6.58
L_SO_MF_092_M_09B_B_D	**Off-Line Storage**	CSO091, CSO092, CSO113, CSO117, CSO146, CSO149, CSO152, CSO179, & SBR	This project includes a 17.65 MG underground covered storage basin for CSOs 113, 152, 091, 092, 146, 179, 149, 117, & the 11 SBR CSOs. The facility will require a 17.65 mgd PS to return stored flow to the BGI after the event. (CSOs 92 & 179 have zero AAOV).	32.99
L_SO_MF_092_M_09B_B_B	**Off-Line Storage**	CSO092, CSO113, CSO152	This project includes a 4.42 MG underground covered storage basin for CSOs 113 and 152. The facility will require a 4.42 mgd PS to return stored flow to the BGI over a 24 hour period. (CSO 92 has zero AAOV)	32.74
L_SO_MF_092_M_09B_B_C	**Off-Line Storage**	CS0113, CSO117, CSO149, CSO152	This project includes a 13.09 MG underground covered storage basin for CSOs 113, 152 149, & 117. The facility will require a 13.09 mgd PS to return stored flow to the BGI over a 24 hour period. (CSOs 92 & 179 have zero AAOV)	32.61
L_SO_MF_152_M_09B_B_A	**Off-Line Storage**	CSO091, CSO092, CSO113, CSO152	This project includes a 4.5 MG underground covered storage basin for CSOs 091, 092, 113, & 152. The facility will require a 4.5 mgd PS to return stored flow to the BGI over a 24 hour period.	31.58
L_SO_MF_152_M_09B_B_B	**Off-Line Storage**	CSO091, CSO092, CSO113, CSO146, CSO152	This project includes a 7.65 MG underground covered storage basin for CSOs 113, 146, 091, 092 & 152. The facility will require a 7.65 mgd PS to return stored flow to the interceptor.	30.42
L_SO_MF_117_M_13_B_A	**RTC with Storage**	CSO117, CSO149, CSO179	This project includes a 5.47 MG underground covered storage basin for CSOs 117, 149, & 179 and 3.2 MG of RTC-ILS for the CSO group using inflatable and adjustable gates. The facility will require a 5.47 mgd PS to return stored flow back to the interceptor.	26.56
L_SO_MF_117_M_09B_B_B	**Off-Line Storage**	CSO117, CSO146, CSO149, CSO179	This project includes a 11.82 MG underground covered storage basin for CSOs 117, 146, 149 and 179. The facility will require a 11.82 mgd PS to pump stored flow back to the interceptor. (CSO 179 had zero AAOV)	26.50
L_SO_MF_117_M_10_B_B	**Treatment Facility**	CSO117, CSO146, CSO149	This project is to provide an above-grade 37.5 mgd BF High Rate Treatment Facility and a below-grade 2 MG off-line storage basin for CSOs 117, 146 and 149. AAOV of captured CSO is ~225 MG.	17.63

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_117_M_10_B_A	**Treatment Facility**	CSO117, CSO149, CSO179	This project is to provide a 94.5 mgd RTB High Rate Treatment Facility for CSOs 117, 149, & 179. Annual volume stored is approximately 578 MG, operated 11 times per year.	16.53
L_SO_MF_091_S_08_A_A	**Sewer Separation**	CSO091	This project includes the construction of a new storm sewer system consisting of 580 LF of 12" pipe in street, 1,100 LF of 12" pipe out of street and 20 LF of 24" pipe in street.	-62.64
L_SO_MF_092_S_08_A_A	**Sewer Separation**	CSO092	This project includes the construction of a new storm sewer system consisting of 970 LF of 12" pipe in street plus 665 LF of 12" pipe out of street.	-106.15
L_SO_MF_083_M_09B_B_A	**Off-Line Storage**	CSO082, CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	This project includes a 9.46 MG off-line covered storage basin for CSOs 082, 083 (zero AAOV), 084, 118, 119, 120, 121, 141 and 153 to reduce overflows to no more than 4 per year. The basin will require an 9.46 mgd PS.	40.31
L_SO_MF_141_S_08_A_A	**Sewer Separation**	CSO141	This project includes the construction of a new storm sewer system consisting of 515 LF of 12" pipe in street plus 1,920 LF of 15" pipe in street.	74.97
L_SO_MF_153_M_09B_B_B	**Off-Line Storage**	CSO082, CSO120, CSO121, CSO141, CSO153	This project includes a 2.35 MG underground covered storage basin for CSOs 082,120, 121, 141 and 153. The facility will require a 2.35 mgd pump station to return the stored flow to the interceptor over a 24 hour period.	53.26
L_SO_MF_153_M_09B_B_A	**Off-Line Storage**	CSO120, CSO121, CSO141, CSO153	This project includes a 2.25 MG underground covered storage basin for CSOs 120, 121, 141 and 153. The facility will require a 2.25 mgd pump station to return the stored flow to the interceptor over a 24 hour period.	50.09
L_SO_MF_082_M_09B_B_B	**Off-Line Storage**	CSO082, CSO120, CSO121, CSO153	This project includes a 2.04 MG underground covered storage basin for CSOs 082, 120, 121 and 153. The facility will require a 2.04 mgd pump station to return the stored flow to the interceptor over a 24 hour period.	45.82
L_SO_MF_120_S_08_A_A	**Sewer Separation**	CSO120	This project includes the construction of a new storm sewer system consisting of 4,035 LF of 15" pipe in street, 180 LF of 18" pipe in street, 285 LF of 30" pipe in street and 245 LF of 30" pipe out of street.	43.80

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_083_M_13_B_A	**RTC with Storage**	CSO082, CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	This project includes an 8.66 MG off-line covered storage basin for CSOs 082, 083 (zero AAOV), 084, 118, 119, 120, 121, 141 and 153 and 0.8 MG of RTC-ILS at CSO 118. The basin will require an 8.66 mgd PS to return the stored flow after the event.	38.12
L_SO_MF_082_M_09B_B_A	**Off-Line Storage**	CSO082, CSO083, CSO084, CSO091, CSO092, CSO110, CSO111, CSO113, CSO117, CSO118, CSO119, CSO120, CSO121, CSO141, CSO146, CSO148, CSO149, CSO151, CSO152, CSO153, CSO179	This project includes a 32.65 MG off-line covered storage basin for CSOs 082, 083 (zero AAOV), 84, 091, 092, 110, 111 (zero AAOV), 113, 117, 118, 119, 120, 121, 141, 146, 148, 149, 151, 152, 153, 179. The basin will require a 32.65 mgd PS.	27.81
L_SO_MF_118_M_09B_B_A	**Off-Line Storage**	CSO083, CSO084, CSO118, CSO119	This project includes a 7.42 MG off-line covered storage basin for CSOs 083 (zero AAOV), 084, 118 & 119 to reduce overflows to no more than 4 per year. The basin will require a 7.42 mgd PS to return the stored flow to the interceptor after the event.	23.40
L_SO_MF_118_M_13_B_A	**RTC with Storage**	CSO083, CSO084, CSO118, CSO119	This project includes a 6.62 MG off-line covered storage basin for CSOs 083 (zero AAOV), 84, 118 & 119 and 0.8 MG of RTC-ILS at CSO 118. The basin will require a 6.62 mgd PS to return the stored flow to the interceptor after the event.	21.73
L_SO_MF_083_M_10_B_A	**Treatment Facility**	CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	This project is to provide an above-grade 8.5 mgd BF High Rate Treatment Facility and a below-grade 11.5 MG off-line storage basin CSOs 084, 118, 119, 120, 121, 141, 153. The BF AAOV of captured CSO is ~171 MG.	19.45
L_SO_MF_118_S_09B_B_A	**Off-Line Storage**	CSO118	This project includes a 5.79 MG off-line covered storage basin for CSO 118 to reduce overflows to no more than 4 per year. The basin will require an effluent pump station to return stored flow to the interceptor.	14.65
L_SO_MF_118_M_10_B_A	**Treatment Facility**	CSO083, CSO084, CSO118, CSO119	This project is to provide a 89.2 mgd RTB High Rate Treatment Facility for CSOs 083 (zero AAOV), 084, 118 & 119. Annual volume stored is approximately 130 MG, operated 40 times per year.	14.27

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.12

BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit Cost Ratio (Present Worth)
L_SO_MF_118_S_13_B_A	**RTC with Storage**	CSO118	This project includes a 4.99 MG off-line covered storage basin for CSO 118 and 0.8 MG of RTC-ILS at CSO 118 to reduce overflows to no more than 4 per year. The basin will require an effluent pump station to return stored flow to the interceptor.	13.45
L_SO_MF_093_S_08_A_A	**Sewer Separation**	CSO093	This project includes the construction of a new storm sewer system consisting of 2,975 LF of 12" pipe in street plus 350 LF of 12" out of street.	46.32
L_SO_MF_130_S_09B_B_A	**Off-Line Storage**	CSO130	This project includes the construction of a 0.1 MG off-line underground covered storage basin for CSO 130. The facility will require a small pump station to return the stored flow to the interceptor following the wet weather event.	40.48
L_SO_MF_130_M_09B_B_A	**Off-Line Storage**	CSO093, CSO130	This project includes the construction of a 0.2 MG off-line underground covered storage basin for CSOs 093 and 130. The facility will require a small pump station to return the stored flow to the interceptor following the wet weather event.	40.39
L_SO_MF_130_S_10_B_A	**Treatment Facility**	CSO130	This project is to provide a 2 mgd RTB High Rate Treatment Facility for CSO 130. Annual volume stored is approximately 1 MG, operated 9 times per year.	20.96
L_SO_MF_130_S_08_A_A	**Sewer Separation**	CSO130	Project includes construction of new storm sewer system consisting of 2,610 LF of 12" pipe in street,10 LF of 12" pipe out of street, 985 LF of 18" pipe in street, 360 LF of 30" pipe in street, 35 LF of 48" pipe in street, 440 LF of 48" pipe out of street	-18.17

Legend: ILS- In-Line Storage; LF- Linear Feet, RTB –Retention Treatment Basin, Selected Projects are in Yellow

TABLE 3.2.13

INITIAL PROJECT LIST FOR OHIO RIVER WEST REGION

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_015_M_13_B_B	**ILS with Treatment**	CSO015, CSO191	This project is to provide a 110 mgd RTB High Rate Treatment Facility for CSOs 015 and 191. Annual volume treated is approximately 527.41 MG, operated 64 times per year.	7.59
L_OR_MF_015_M_13_B_A	**ILS with Storage**	CSO015, CSO191	This project includes a 25.6 MG open concrete basin for CSOs 015 and 191, incorporating 20 MG RTC-ILS between PRFPS and SGC in SWO. The basin is located east of I-264 adjacent to MSD property. The facility is gravity in-gravity out operation.	8.46
L_OR_MF_015_M_09B_B_A	**Off-Line Storage**	CSO015, CSO191	This project includes a 45.61 MG open concrete basin for CSOs 015 and 191. The basin is located on adjacent MSD property. The facility will require a 45 mgd PS to return the stored flow back to the interceptor.	6.74
L_OR_MF_015_M_13_B_C	**ILS with Storage**	CSO015, CSO191	This project includes a 25.6 MG covered concrete basin for CSOs 015 and 191, incorporating 20 MG RTC-ILS between Paddy's Run FPS and Sluice gates in Southwestern Outfall. The basin is located east of I-264 adjacent to MSD property. The facility is gravity in-gravity out.	4.75
L_OR_MF_015_M_09B_B_B	**Off-Line Storage**	CSO015, CSO191	This project includes a 45.61 MG covered concrete basin for CSOs 015 and 191. The basin is located on adjacent MSD property. The facility will require a 45 mgd PS to return the stored flow back to the interceptor.	3.06
L_OR_MF_015_M_10_B_A	**Treatment Facility**	CSO015, CSO191	This project is to provide a 671.1 mgd RTB High Rate Treatment Facility for CSOs 015 and 191. Annual volume stored is approximately 527.41 MG, operated 64 times per year. The basin is located on adjacent MSD property.	1.78
L_OR_MF_211_M_13_B_A	**ILS with Storage**	CSO016, CSO210, CSO211	This project includes a 23.97 MG underground open concrete basin for CSOs 016, 210, and 211. The facility will be a gravity in-gravity out operation. Project also includes RTC-ILS at two locations within the SO for a total of 16.1 MG of storage.	15.17
L_OR_MF_211_M_09B_B_A	**Off-Line Storage**	CSO016, CSO210, CSO211	This project includes a 40.07 MG underground open concrete basin for CSOs 016, 210, and 211. The basin is located on MSD property near I-264. The facility will be a gravity in-gravity out operation.	15.03

TABLE 3.2.13

INITIAL PROJECT LIST FOR OHIO RIVER WEST REGION

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_211_M_10_B_A	**Treatment Facility**	CSO016, CSO210, CSO211	This project is to provide an above-grade 60 mgd Ballasted Flocculation High Rate Treatment Facility. A below-grade 31 MG off-line concrete storage basin will provide the required volume of storage for CSOs 016, 210, and 211 prior to activation of the BF process.	7.29
L_OR_MF_211_M_13_B_B	**ILS with Storage**	CSO016, CSO210, CSO211	This project includes a 23.97 MG underground covered concrete basin for CSOs 016, 210, and 211. The facility will be a gravity in-gravity out operation. Project also includes RTC-ILS at two locations within the SO for a total of 16.1 MG of storage.	8.38
L_OR_MF_211_M_09B_B_B	**Off-Line Storage**	CSO016, CSO210, CSO211	This project includes a 40.07 MG underground covered concrete basin for CSOs 016, 210, and 211. The basin is located on MSD property near I-264. The facility will be a gravity in-gravity out operation.	6.13
L_OR_MF_105_M_13_B_A	**ILS with Storage**	CSO104, CSO105,CSO189	This project includes a 4.26 MG underground covered concrete basin for CSOs 104, 105, and 189 and RTC-ILS in the Western Outfall and the Northwestern Interceptor for a total of 8.8 MG using adjustable gates. The facility will be filled and emptied by gravity. Project includes park improvements.	20.51
L_OR_MF_105_M_09B_B_A	**Off-Line Storage**	CSO104, CSO105	This project is to provide a 1.84 MG, underground, off-line, covered storage basin to reduce overflows at CSOs 104 and 105 to no more than 4 per year. Annual volume stored is approximately 19 MG. Project includes park improvements.	17.31
L_OR_MF_104_M_13_B_A	**ILS with Storage**	CSO104, CSO105, CSO189	This project includes a 4.26 MG underground covered concrete basin for CSO s 104, 105, and 189 and 8.8 MG of RTC-ILS using adjustable gates in the Northwestern Interceptor, the Western Interceptor, and Western Outfall. The project includes a 4.26 mgd pump out facility. Project includes park improvements.	15.04
L_OR_MF_189_S_13_B_A	**ILS with Storage**	CSO189	This project includes a 6.22 MG underground covered concrete basin for CSO 189 and 5.0 MG of RTC-ILS using an inflatable gate in the Northwestern Interceptor. The project includes a 6.25 mgd pump out facility. Project includes park improvements.	9.97
L_OR_MF_104_M_09B_B_A	**Off-Line Storage**	CSO104, CSO105, CSO189	This project includes a 13.06 MG underground covered concrete basin for CSOs 104, 105, and 189. The facility will require a 13 mgd PS to return the stored flow back to the interceptor. Project includes park improvements.	8.74

TABLE 3.2.13

INITIAL PROJECT LIST FOR OHIO RIVER WEST REGION

Project ID	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_189_S_09B_B_A	**Off-Line Storage**	CSO189	This project includes a 11.22 MG underground covered concrete basin for CSO 189. The basin is located in Shawnee Park. The project includes an 11.25 mgd pump out facility. Project includes park improvements.	5.97
L_OR_MF_105_M_10_B_A	**Treatment Facility**	CSO104, CSO105	This project is to provide a 23.1 mgd RTB High Rate Treatment Facility for CSOs 104 & 105 in Shawnee Park. Annual volume stored is approximately 21.63 MG, operated 19 times per year. Project includes park improvements.	5.45
L_OR_MF_104_M_10_B_A	**Treatment Facility**	CSO104, CSO105, CSO189	This project includes a 126.9 RTB treatment plant for CSOs 104, 105, and 189. The basin is located in Shawnee Park. Project includes park improvements. The plant is operated 39 times per year treating 197.42 MG.	4.99
L_OR_MF_189_S_10_B_A	**Treatment Facility**	CSO189	This project includes a 110 mgd Retention Treatment Basin plant for CSO 189 based on the 5th highest flow rate. The facility will require a 110 mgd PS to pump into the RTB plant. Project includes park improvements.	3.60

Legend: ILS- In-Line Storage; LF- Linear Feet, RTB –Retention Treatment Basin

Selected Projects are in Yellow

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.14 INITIAL PROJECT LIST FOR OHIO RIVER NORTH REGION				
Project or Cost Sheet Name	**Solution Technology Details**	**CSOs Addressed**	**Project Description**	**Benefit /Cost Ratio (Present Worth)**
L_OR_MF_019_S_13_B_A	**ILS with Storage**	CSO019	This project includes a 12.7 MG underground covered concrete basin for CSO 019. The facility will require a 12.7 mgd PS to return the stored flow back to the interceptor. Project also includes 1.8 MG of RTC-ILS using an inflatable gate. Project includes park improvements.	7.41
L_OR_MF_019_S_09B_B_A	**Off-Line Storage**	CSO019	This project includes a 14.54 MG underground covered concrete basin for CSO 019. The facility will require a 14.5 mgd PS to return the stored flow back to the interceptor. Project includes park improvements.	6.83
L_OR_MF_019_S_10_B_A	**Treatment Facility**	CSO019	This project is to provide an above-grade 108 mgd Treatment Facility and a below-grade 10 MG off-line concrete storage. The average annual volume of captured CSO is ~298 MG. Project includes park improvements.	2.24
L_OR_MF_190_S_09B_B_A	**Off-Line Storage**	CSO190	This project includes a 1.95 MG underground covered concrete basin for CSO 190. The basin is located in a vacant lot near I-64. The project includes a 2 mgd pump out facility.	26.85
L_OR_MF_190_S_10_B_A	**Treatment Facility**	CSO190	This project is to provide a 27 mgd RTB High Rate Treatment Facility for CSO 190. The basin is located in a vacant lot near I-64. Annual volume stored is approximately 36 MG, operated 50 times per year.	17.60
L_OR_MF_199_S_08_A_A	**Sewer Separation**	CSO199	This project includes the construction of a new storm sewer system consisting of 410 LF of 15" pipe in street.	151.32
L_OR_MF_053_S_08_A_A	**Sewer Separation**	CSO053	This project includes the construction of both a new sanitary sewer system and a new storm sewer system. The sanitary system consists of 15 LF of 36" pipe in street. The storm system consists of 10 LF of 36" pipe in street.	144.44
L_OR_MF_027_M_09B_B_A	**Off-Line Storage**	CSO026, CSO027, CSO028, CSO029, CSO031, CSO034, CSO035, CSO036, CSO038, CSO178, CSO181, CSO192, CSO193, CSO195, CSO196, CSO197, CSO198, CSO199, CSO200, CSO201, CSO202, CSO203	This project includes a 1.21 MG underground covered concrete basin for Central Relief Drain CSOs. The basin is located beneath MSD HQ parking lot. The facility will require a 1.2 mgd PS to return the stored flow back to the interceptor.	83.52

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.14

INITIAL PROJECT LIST FOR OHIO RIVER NORTH REGION

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_035_S_08_A_A	**Sewer Separation**	CSO035	This project includes the construction of a new storm sewer system consisting of 1,875 LF of 15" pipe in street plus 985 LF of 15" pipe out of street.	80.62
L_OR_MF_201_S_08_A_A	**Sewer Separation**	CSO201	This project includes the construction of a new storm sewer system consisting of 630 LF of 15" pipe in street and 830 LF of 15" pipe out of street.	52.72
L_OR_MF_050_S_08_A_A	**Sewer Separation**	CSO050	This project includes the construction of a new storm sewer system consisting of 4,715 LF of 15" pipe in street plus 475 LF of 15" pipe out of street.	44.31
L_OR_MF_193_S_08_A_A	**Sewer Separation**	CSO193	This project includes the construction of a new storm sewer system consisting of 2,920 LF of 15" pipe in street.	39.04
L_OR_MF_203_S_08_A_A	**Sewer Separation**	CSO203	This project includes the construction of a new storm sewer system consisting of 545 LF of 15" pipe in street and 1,450 LF of 15" pipe out of street.	37.31
L_OR_MF_178_S_08_A_A	**Sewer Separation**	CSO178	This project includes the construction of a new storm sewer system consisting of 2,050 LF of 12" pipe in street, 95 LF of 12" pipe out of street, 2,660 LF of 15" pipe in street and 475 LF of 18" pipe in street.	11.54
L_OR_MF_029_S_08_A_A	**Sewer Separation**	CSO029	This project includes the construction of a new storm sewer system consisting of 1,675 LF of 15" pipe in street plus 2,110 LF of 15" pipe out of street. It also consists of 925 LF of 21" pipe in street.	-6.18
L_OR_MF_181_S_08_A_A	**Sewer Separation**	CSO181	This project includes the construction of a new storm sewer system consisting of 2,425 LF of 12" pipe in street, 15 LF of 12" pipe out of street, 845 LF of 15" pipe in street, 1,035 LF of 27" pipe in street and 75 LF of 72" pipe in street.	-33.73
L_OR_MF_054_S_08_A_A	**Sewer Separation**	CSO054	This project includes the construction of a new storm sewer system consisting of 340 LF of 15" pipe in street plus 1,135 LF of 15" pipe out of street.	-37.99
L_OR_MF_156_S_08_A_A	**Sewer Separation**	CSO156	This project includes the construction of a new storm sewer system consisting of 2,925 of 12" pipe in street and 75 LF of 15" pipe in street.	-55.84

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.14

INITIAL PROJECT LIST FOR OHIO RIVER NORTH REGION

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_052_S_08_A_A	**Sewer Separation**	CSO052	Project includes construction of a new sanitary and storm sewer system. The sanitary system consists of 170 LF of 6" pipe in street plus 490 LF of 15" pipe in street. The storm system consists of 360 LF of 15" pipe in street plus 190 LF of 15" pipe out of street	-56.99
L_OR_MF_036_S_08_A_A	**Sewer Separation**	CSO036	This project includes the construction of a new storm sewer system consisting of 1,870 LF of 15" pipe in street, 450 LF of 15" pipe out of street, 1,030 LF of 18" pipe in street and 735 LF of 21" pipe in street.	-69.06
L_OR_MF_150_S_08_A_A	**Sewer Separation**	CSO150	This project includes the construction of a new storm sewer system consisting of 80 LF of 12" pipe in street, 175 LF of 12" pipe out of street and 405 LF of 30" pipe in street.	-94.22
L_OR_MF_056_S_08_A_A	**Sewer Separation**	CSO056	This project includes the construction of a new sanitary sewer system consisting of 130 LF of 10" pipe in street, 780 LF of 10" pipe out of street, 385 LF of 12" pipe in street and 325 LF of 12" pipe out of street.	-98.05
L_OR_MF_038_S_08_A_A	**Sewer Separation**	CSO038	This project includes the construction of a new storm sewer system consisting of 1,235 LF of 15" pipe in street plus 905 LF of 18" pipe in street.	-100.42
L_OR_MF_195_S_08_A_A	**Sewer Separation**	CSO195	This project includes the construction of a new storm sewer system consisting of 800 LF of 15" pipe in street.	-124.10
L_OR_MF_200_S_08_A_A	**Sewer Separation**	CSO200	This project includes the construction of a new storm sewer system consisting of 595 LF of 15" pipe in street.	-162.30
L_OR_MF_192_S_08_A_A	**Sewer Separation**	CSO192	This project includes the construction of a new storm sewer system consisting of 75 LF of 12" pipe in street, 35 LF of 12" pipe out of street, and 550 LF of 15" pipe in street.	-214.39
L_OR_MF_034_S_08_A_A	**Sewer Separation**	CSO034	This project includes the construction of a new storm sewer system consisting of 735 LF of 15" pipe in street plus 15 LF of 15" pipe out of street.	-247.05
L_OR_MF_198_S_08_A_A	**Sewer Separation**	CSO198	This project includes the construction of a new storm sewer system consisting of 145 LF 15" pipe in street.	-254.50
L_OR_MF_197_S_08_A_A	**Sewer Separation**	CSO197	This project includes the construction of a new storm sewer system consisting of 30 LF of 15" pipe in street.	-292.68

CSO Data Outdated

Refer to Chapter 5

TABLE 3.2.14

INITIAL PROJECT LIST FOR OHIO RIVER NORTH REGION

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_051_S_08_A_A	**Sewer Separation**	CSO051	Project includes construction of a new sanitary & storm sewer system. The sanitary system consists of 30 LF of 8" pipe in street plus 195 LF of 8" pipe out of street. The storm system consists of 120 LF of 12" pipe in St plus [illegible] LF of 12" pipe out of St	-331.37
L_OR_MF_026_S_08_A_A	**Sewer Separation**	CSO026	This project include construction of a new storm sewer system consisting of 300 LF of 15" pipe in street plus 20 LF of 30" pipe in street.	-483.97
L_OR_MF_055_S_08_A_A	**Sewer Separation**	CSO055	This project includes the construction of a new sanitary sewer system consisting of 55 LF of 15" pipe in street.	-514.92
L_OR_MF_028_S_08_A_A	**Sewer Separation**	CSO028	This project includes the construction of a new storm sewer system consisting of 180 LF of 15" pipe in street plus 490 LF of 15" pipe out of street.	-534.34
L_OR_MF_027_S_08_A_A	**Sewer Separation**	CSO027	This project includes construction of a new storm sewer system consisting of 135 LF of 15" pipe in street plus 70 LF of 30" pipe in street.	-618.43
L_OR_MF_031_S_08_A_A	**Sewer Separation**	CSO031	This project includes the construction of a new storm sewer system consisting of 140 LF of 15" pipe in street.	-641.79
L_OR_MF_196_S_08_A_A	**Sewer Separation**	CSO196	This project includes the construction of a new storm sewer system consisting of 45 LF of 15" pipe in street.	-844.76
L_OR_MF_155_M_09B_B_B	**Off-Line Storage**	CSO022, CSO023, CSO050, CS0051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO155, CSO156, CSO208, CRD CSOs (27 individual CSOs)	This project includes a 66" collector and 11.83 MG underground covered concrete basin for CSOs 022, 023, 050, 051, 052, 053, 054, 055, 056, 150, 155, 156, 208 and CRD. The facility requires a 11.83 mgd PS.	30.13
L_OR_MF_208_S_08_A_A	**Sewer Separation**	CSO208	This project includes the construction of a new storm sewer system consisting of 270 LF of 12" pipe in street.	163.03
L_OR_MF_155_M_09B_B_A	**Off-Line Storage**	CSO022, CSO023, CSO050, CS0051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO155, CSO156, CSO208	This project includes a 66" collector and 10.57 MG underground covered concrete basin for CSOs 022, 023, 050, 051, 052, 053, 054, 055, 056, 150, 155, 156, and 208. The facility requires a 10.5 mgd PS.	26.87

TABLE 3.2.14

INITIAL PROJECT LIST FOR OHIO RIVER NORTH REGION

Project or Cost Sheet Name	Solution Technology Details	CSOs Addressed	Project Description	Benefit /Cost Ratio (Present Worth)
L_OR_MF_058_S_08_A_A	**Sewer Separation**	CSO058	This project is a complete sewer separation project for the CSO 58 service area. The project will consist of the construction of 2,000 LF of new storm sewers and the conversion of the ex. combined sewer to a sanitary sewer with elimination of the CSO.	87.57
L_OR_MF_058_S_09B_B_A	**Off-Line Storage**	CSO058	This project includes a 5.22 MG covered concrete basin for CSO 058. The basin is located near Slugger Field. The facility will be gravity in-gravity out operation.	7.88
L_OR_MF_160_S_08_A_A	**Sewer Separation**	CSO160	This project includes the construction of a new storm sewer system consisting of 425 LF of 15" pipe in street.	-233.49
L_OR_MF_057_M_09B_B_A	**Off-Line Storage**	CSO057, CSO160, CSO161	This project includes a 0.02 MG underground covered concrete basin for CSOs 057 (zero AAOV), 160, and 161. The basin is located beneath a parking lot on 1st St between Market and Main Streets.	140.62
L_OR_MF_161_S_08_A_A	**Sewer Separation**	CSO161	This project includes the construction of a new storm sewer system consisting of 700 LF of a 12" pipe in street.	83.21
L_OR_MF_020_S_09B_B_A	**Off-Line Storage**	CSO020	This project includes the construction of a 0.62 MG off-line underground covered storage basin for CSO 20. The facility will require a small pump station to pump the stored flow to the Robert Starkey pump station following the wet weather event.	25.34
L_OR_MF_172_S_09B_B_A	**Off-Line Storage**	CSO172	This project includes a 0.08 MG underground covered concrete basin for CSO 172. The basin is located near River Road/CSX RR. The facility will be gravity in-gravity out operation.	111.09
L_OR_MF_172_M_09B_B_A	**Off-Line Storage**	CSO132, CSO154, CSO167, CSO172	This project includes a 8.36 MG underground covered concrete basin for CSOs 132, 154, 167, and 172. The basin is located near Mellwood Avenue. The facility will be gravity in-gravity out operation.	21.84
L_OR_MF_172_S_08_A_A	**Sewer Separation**	CSO172	This project includes the construction of a new storm sewer system consisting of 695 LF of 12" pipe in street, 155 LF of 12" pipe out of street, 1,110 LF of 18" pipe in street and 795 LF of 54" pipe in street.	-94.95

Legend: ILS- In-Line Storage; LF- Linear Feet, RTB –Retention Treatment Basin, CRD- Central Relief Drain, PS – pump station
Selected Projects are in Yellow

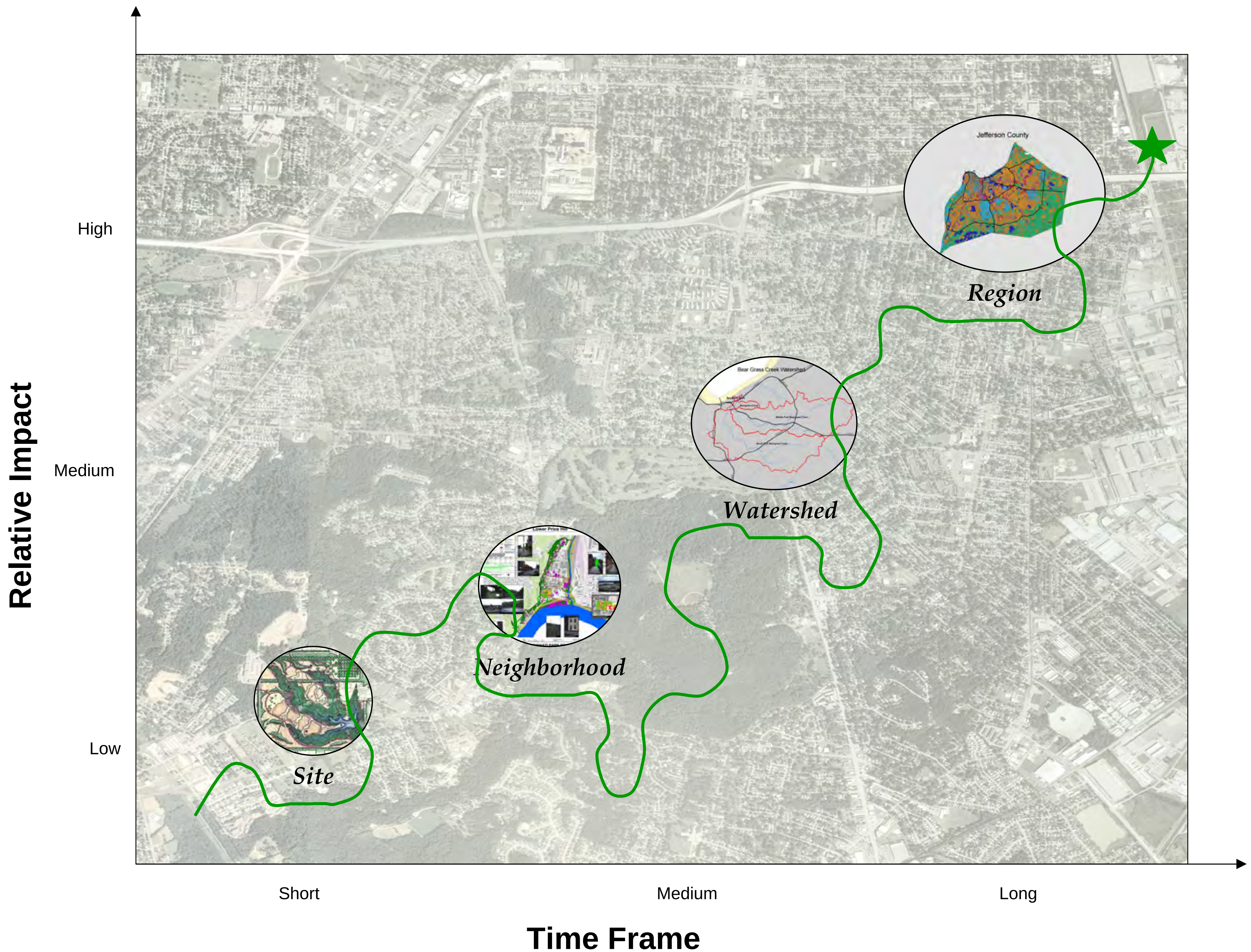
TABLE 3.3.2
BEARGRASS CREEK SOUTH FORK (BGCSF) INITIAL SOLUTIONS CSO BENEFIT-COST RATIO MATRIX

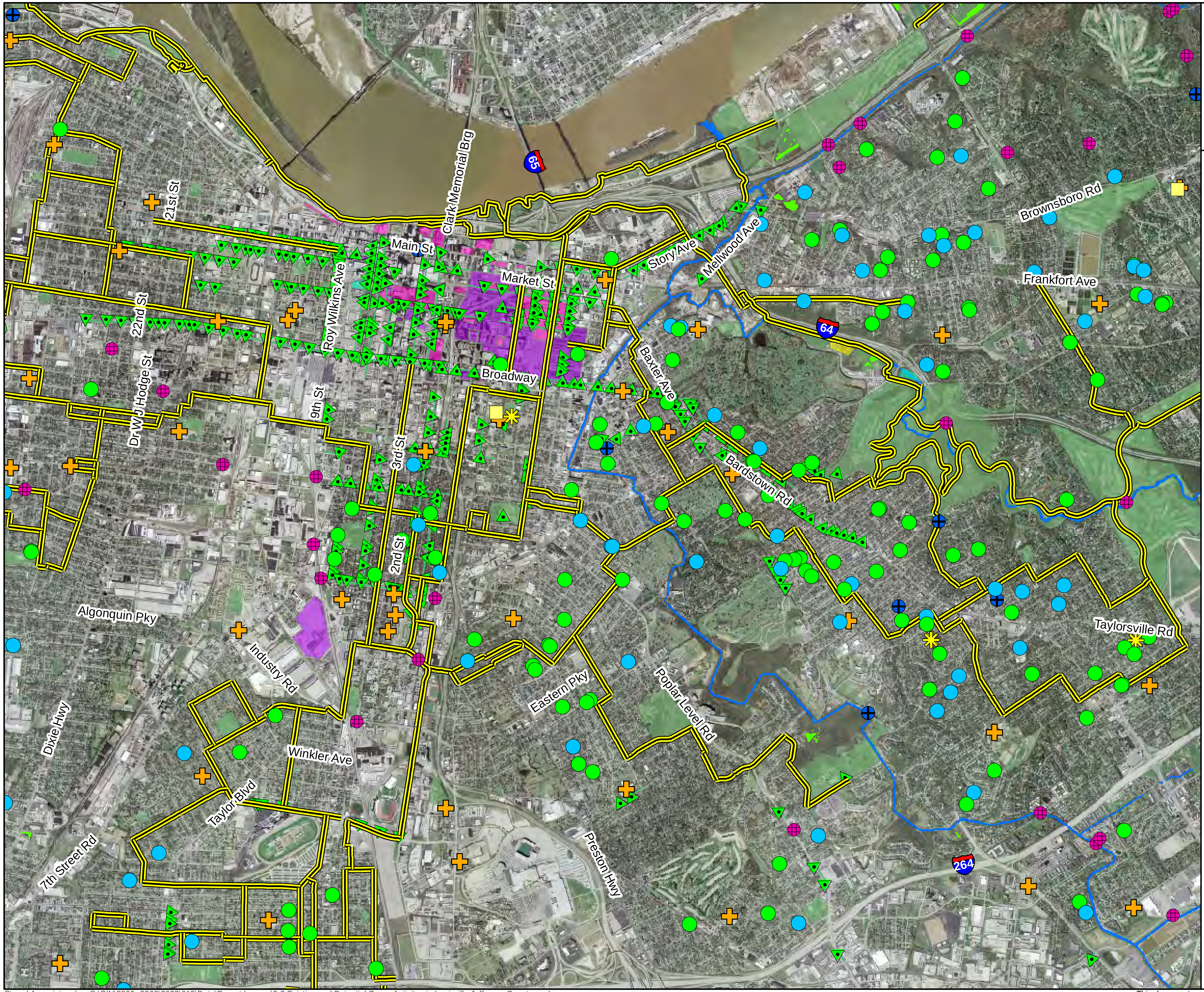
Project ID	108	018	109	137	106	97	148	110	151	113	152	91	146	117	149	SBR	118	84	119	120	141	121	153	82	130	93
L_SO_MF_097_M_09B_B_D	**35.79**	**35.79**	**35.79**	**35.79**	**35.79**	**35.79**	**35.79**	**35.79**	**35.79**																	
L_SO_MF_097_M_09B_B_B	34.06		34.06			34.06	34.06	34.06	34.06																	
L_SO_MF_018_M_09B_B_A	23.88	23.88																								
L_SO_MF_097_M_10_B_B	21.18	21.18	21.18	21.18		21.18	21.18	21.18	21.18																	
L_SO_MF_108_S_09B_B_A	14.69																									
L_SO_MF_018_M_10_B_A	6.58	6.58	6.58																							
L_SO_MF_018_S_09B_B_A		13.42																								
L_SO_MF_097_M_09B_B_A[a]				53.19	53.19	53.19																				
L_SO_MF_111_M_09B_B_A[a]				51.83	51.83	51.83	51.83	51.83																		
L_SO_MF_113_M_09B_B_A				41.18	41.18	41.18	41.18	41.18	41.18	41.18																
L_SO_MF_151_M_09B_B_A[a]				36.64	36.64	36.64	36.64	36.64	36.64																	
L_SO_MF_097_M_10_B_A				28.3	28.3	28.3																				
L_SO_MF_097_M_09B_B_C						31.34		31.34	31.34																	
L_SO_MF_110_M_09B_B_A							35.52	35.52																		
L_SO_MF_151_M_09B_B_B							27.97	27.97	27.97																	
L_SO_MF_151_M_09B_B_C								25.15	25.15																	
L_SO_MF_092_M_09B_B_D										**32.99**	**32.99**	**32.99**	**32.99**	**32.99**	**32.99**	**32.99**										
L_SO_MF_092_M_09B_B_B										32.74	32.74															
L_SO_MF_092_M_09B_B_C										32.61	32.61			32.61	32.61	32.61										
L_SO_MF_152_M_09B_B_A										31.58	31.58	31.58														
L_SO_MF_152_M_09B_B_B										30.42	30.42	30.42	30.42													
L_SO_MF_082_M_09B_B_A							27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81	27.81		
L_SO_MF_117_M_09B_B_B													26.5	26.5	26.5											
L_SO_MF_117_M_10_B_B													17.63	17.63	17.63											
L_SO_MF_117_M_13_B_A														26.56	26.56											
L_SO_MF_117_M_10_B_A														16.53	16.53											
L_SO_MF_083_M_09B_B_A																	**40.31**	**40.31**	**40.31**	**40.31**	**40.31**	**40.31**	**40.31**	**40.31**		
L_SO_MF_083_M_13_B_A																	38.12	38.12	38.12	38.12	38.12	38.12	38.12	38.12		
L_SO_MF_118_M_09B_B_A																	23.4	23.4	23.4							
L_SO_MF_118_M_13_B_A																	21.73	21.73	21.73							
L_SO_MF_083_M_10_B_A																	19.45	19.45	19.45	19.45		19.45	19.45	19.45		
L_SO_MF_118_S_09B_B_A																	14.65									
L_SO_MF_118_M_10_B_A																	14.27	14.27	14.27							
L_SO_MF_118_S_13_B_A																	13.45									
L_SO_MF_153_M_09B_B_B[a]																				53.26	53.26	53.26	53.26	53.26		
L_SO_MF_153_M_09B_B_A																				50.09	50.09	50.09	50.09			
L_SO_MF_082_M_09B_B_B[a]																				45.82		45.82	45.82	45.82		
L_SO_MF_093_S_08_A_A																										**46.32**
L_SO_MF_130_S_09B_B_A																									**40.48**	
L_SO_MF_130_M_09B_B_A																									40.39	40.39
L_SO_MF_130_S_10_B_A																									20.96	

Footnotes: a- In several cases, highest benefit-cost ratio score not selected in order to maximize CSOs per group due to dense urbanization (site availability limitations), plus fewer facilities reduces operations and maintenance tasks following wet weather events.
b- Highlighted cells indicate preferred projects.

FIGURE 3.2.1
GRAPHICAL DEPICTION OF
GREEN INFRASTRUCTURE STRATEGY

Green Infrastructure Strategy





Integrated Overflow Abatement Plan

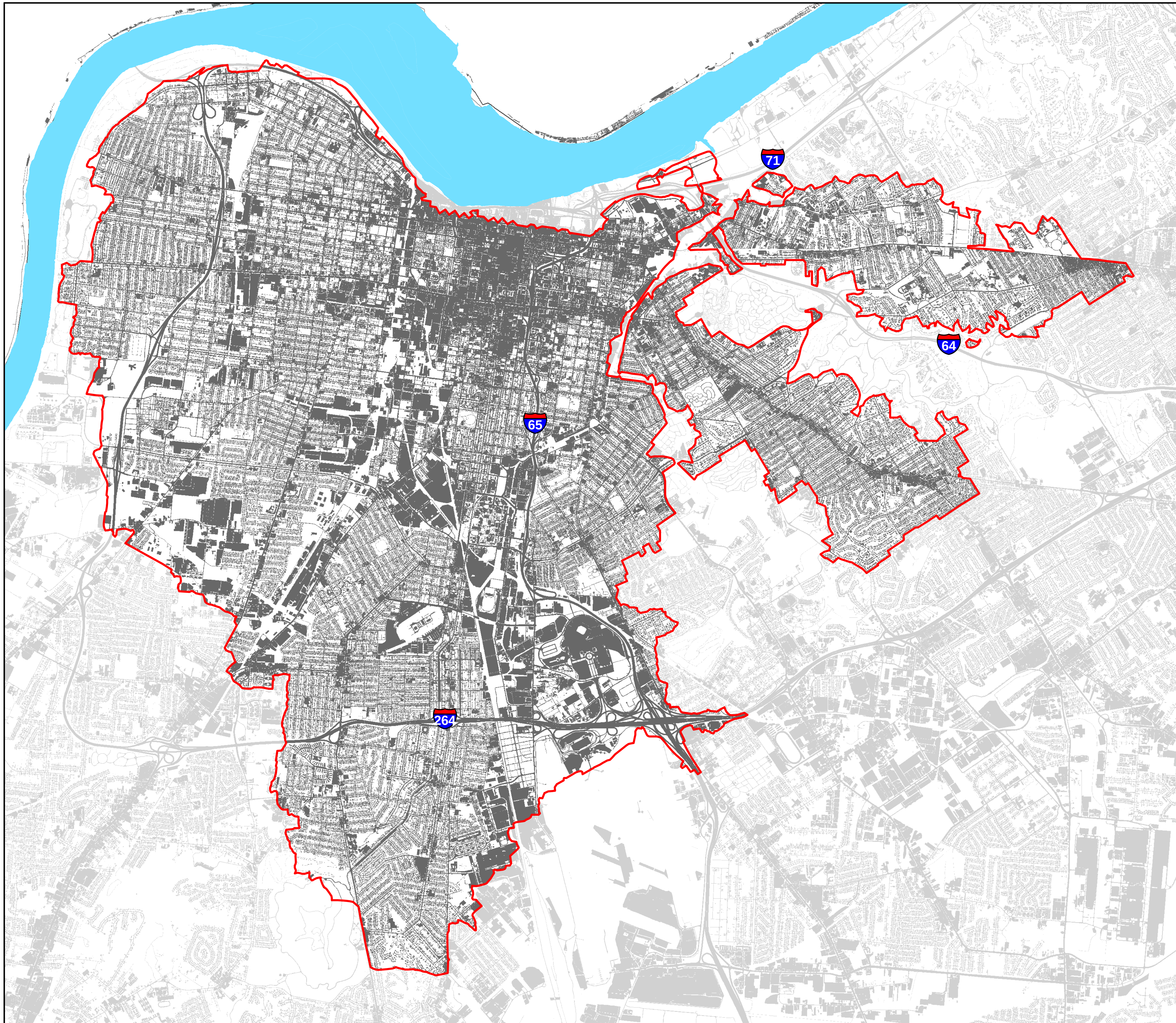
Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.2
EXISTING AND POTENTIAL GREEN ACTIVITIES IN LOUISVILLE AND JEFFERSON COUNTY AS OF AUGUST 2008

LEGEND

- Outdoor Classroom
- Rain Barrel
- Rain Garden
- Rain Barrel Request
- Drainage Hot Spots
- Consent Decree Projects
- Public Schools
- Bikeway
- Community of Trees
- Mosquito Pretreatment Zones
- Existing Green Projects
- Proposed Green Projects
- Proposed New Construction
- Proposed Renovation
- Stream
- Metro Parks

LOJIC MSD PROJECT WIN



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

FIGURE 3.2.3
IMPERVIOUS SURFACES
WITHIN THE COMBINED SYSTEM

LEGEND

- CSO Boundary
- Ohio River
- Storm Water Impervious Area

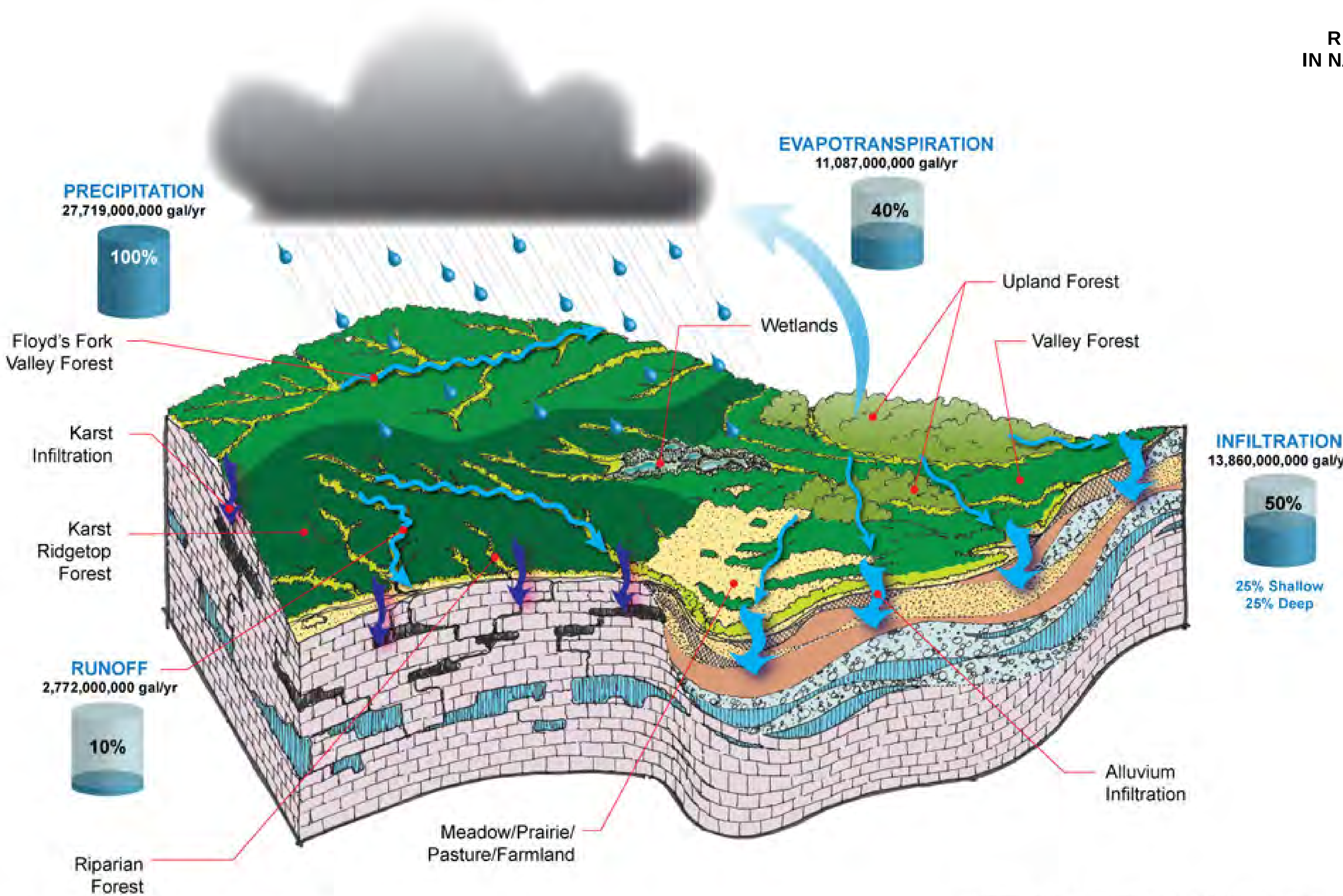
LOJIC MSD PROJECT WIN

Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_Impervious_CSO_323.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

FIGURE 3.2.4
HISTORIC CIVIL WAR MAP

FIGURE 3.2.5
RUNOFF SCENARIO
IN NATURAL CONDITIONS



NOTE: Water quantities are for CSO areas only.

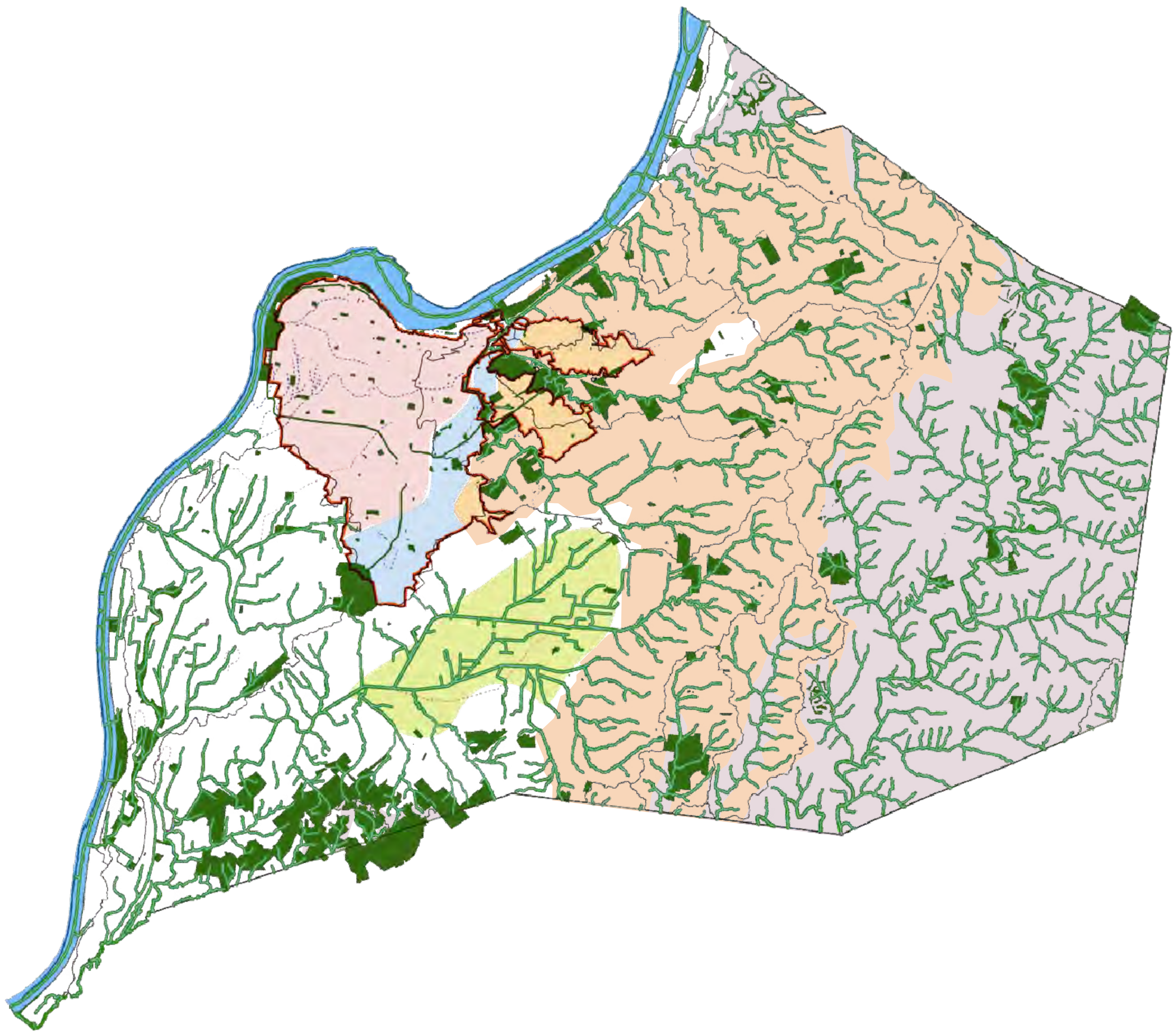
FIGURE 3.2.6
TREE CANOPY
EVALUATION RESULTS

	American Forests, Inc.	Land Development Code	Considerations
Suburban	60%	20%	↑
Commercial	25%	20%	↑
Urban Residential	15%	20%	✓

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.7
CSS SYSTEM AND THE LOCAL STREAM NETWORKS



LEGEND

- Streams with LDC-Recommended Buffers
- Historic Streams
- Loess Terrace Geology with Moderate Infiltration Potential
- Karst Geology with Strategic Infiltration Potential
- Alluvial Geology with High Infiltration Potential
- Karst (Major)
- Karst (Moderate)
- Low Land
- Watershed
- Metro Parks & Open Space

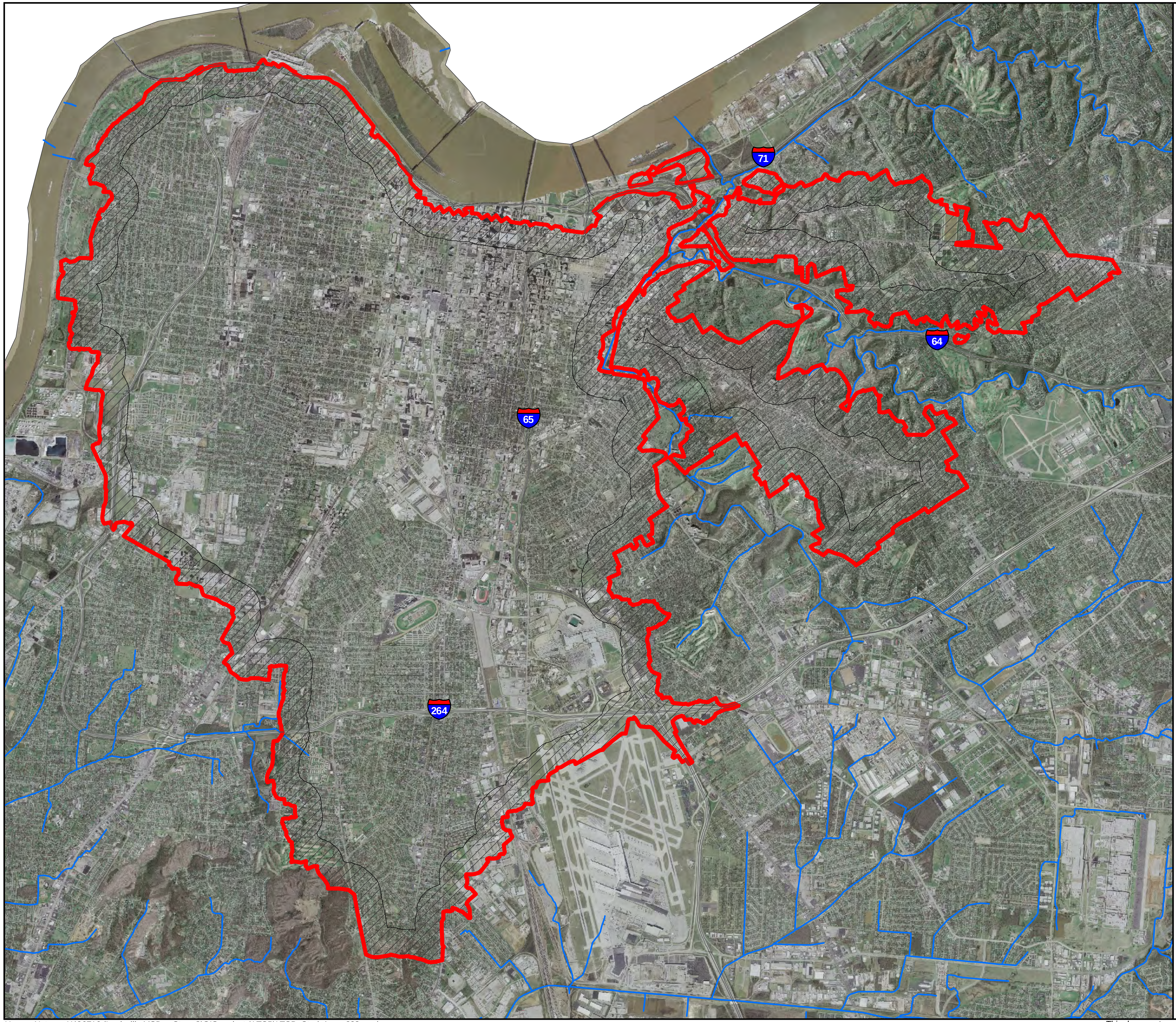
This document was developed in color. Reproduction in black and white may not represent the data as intended.

Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_StreamNet_327.ai

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.8
STUDY AREA PARALLEL TO THE CSS 1/4 MILE INSIDE EXISTING BOUNDARY FOR STORMWATER REDIRECTION



LEGEND

- Major Roads
- Streams
- CSO Boundary
- 1/4Mile CSO Buffer (8,000 Acres)

LOJIC

MSD

PROJECT WIN

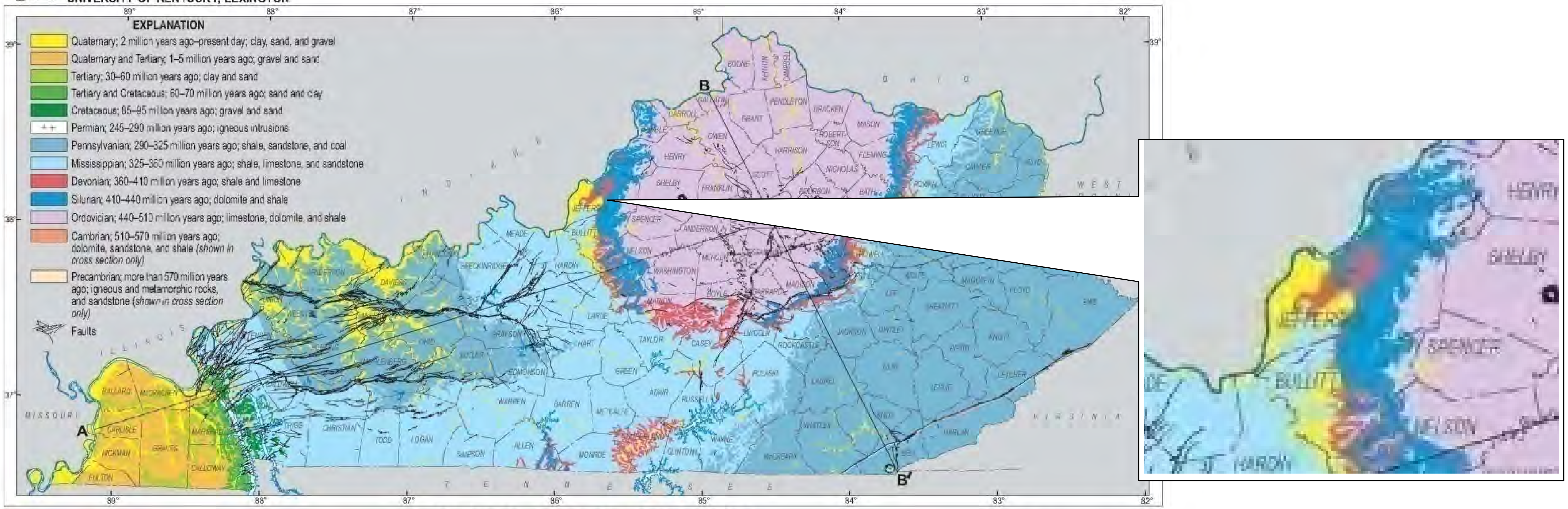
Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_StudyArea_328.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

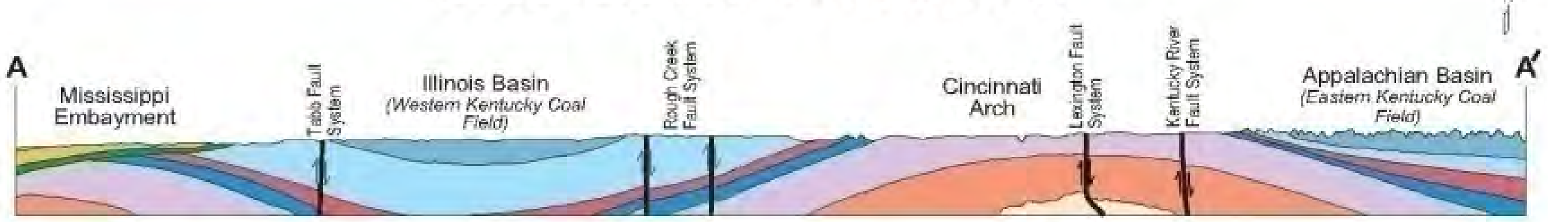
FIGURE 3.2.9
KENTUCKY GEOLOGIC MAP

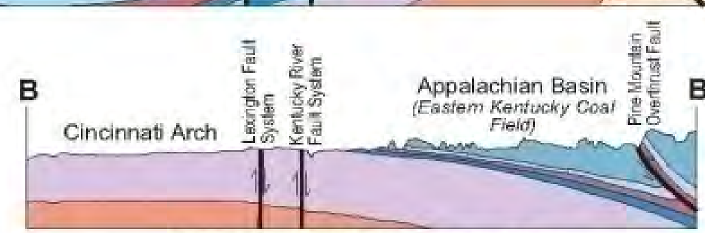
KGS KENTUCKY GEOLOGICAL SURVEY
James C. Cobb, State Geologist and Director
UNIVERSITY OF KENTUCKY, LEXINGTON

MAP AND CHART 23
Series XII, 2001



GEOLOGIC MAP OF KENTUCKY





Generalized geologic cross sections

Cross sections are diagrammatic; not to scale

Compiled from Noger, M.C., 1988, Geologic map of Kentucky: U.S. Geological Survey, scale 1:500,000.
Cartography by Terry Hounshell

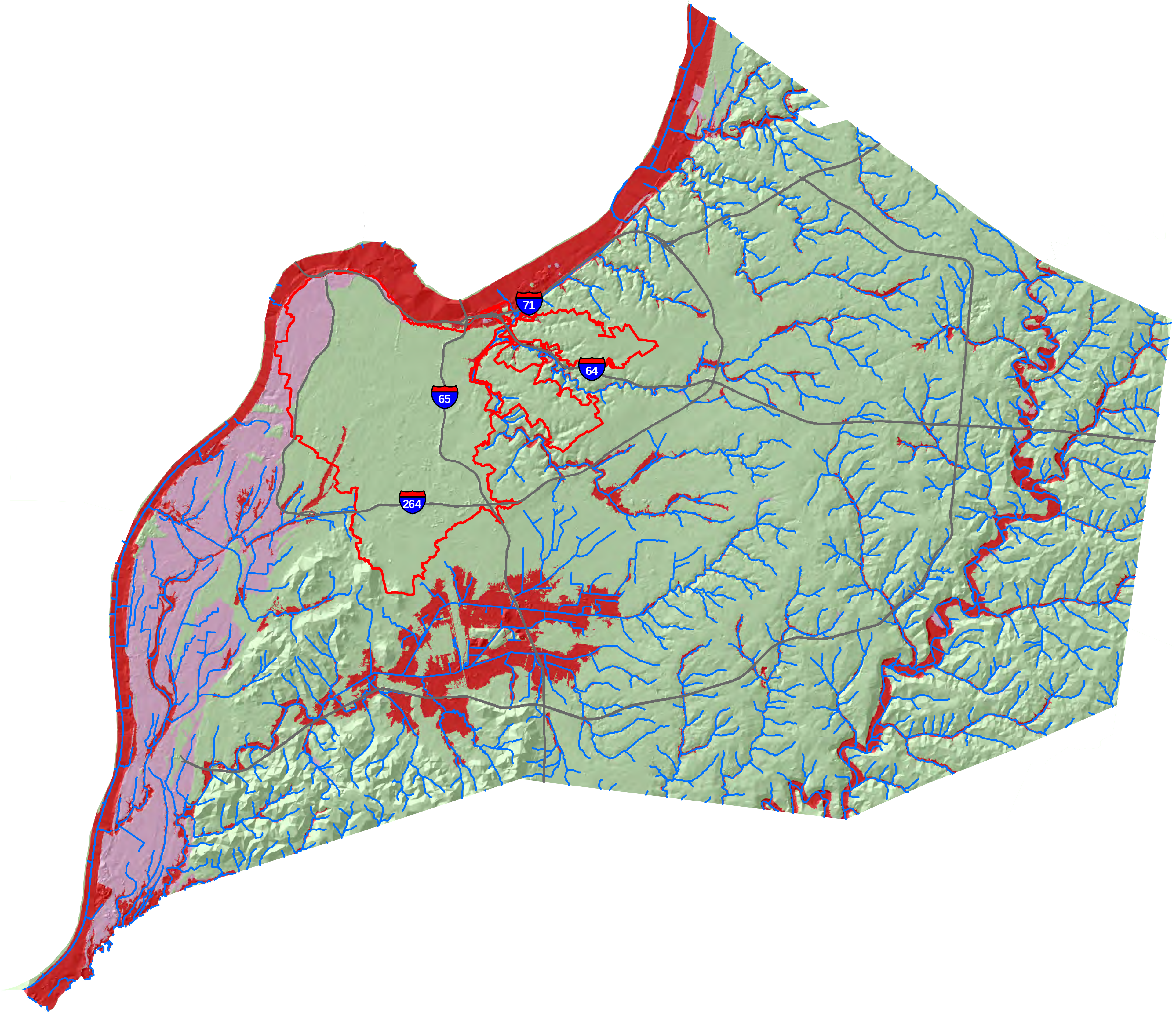
View the KGS World Wide Web site at
www.uky.edu/kgs

For information on obtaining copies of this map and other Kentucky Geological Survey maps and publications call:
Publication Sales
(859) 257-3896

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.10
Flood Zones



LEGEND

Major Roads
Streams
CSO Boundary

Flood Zones

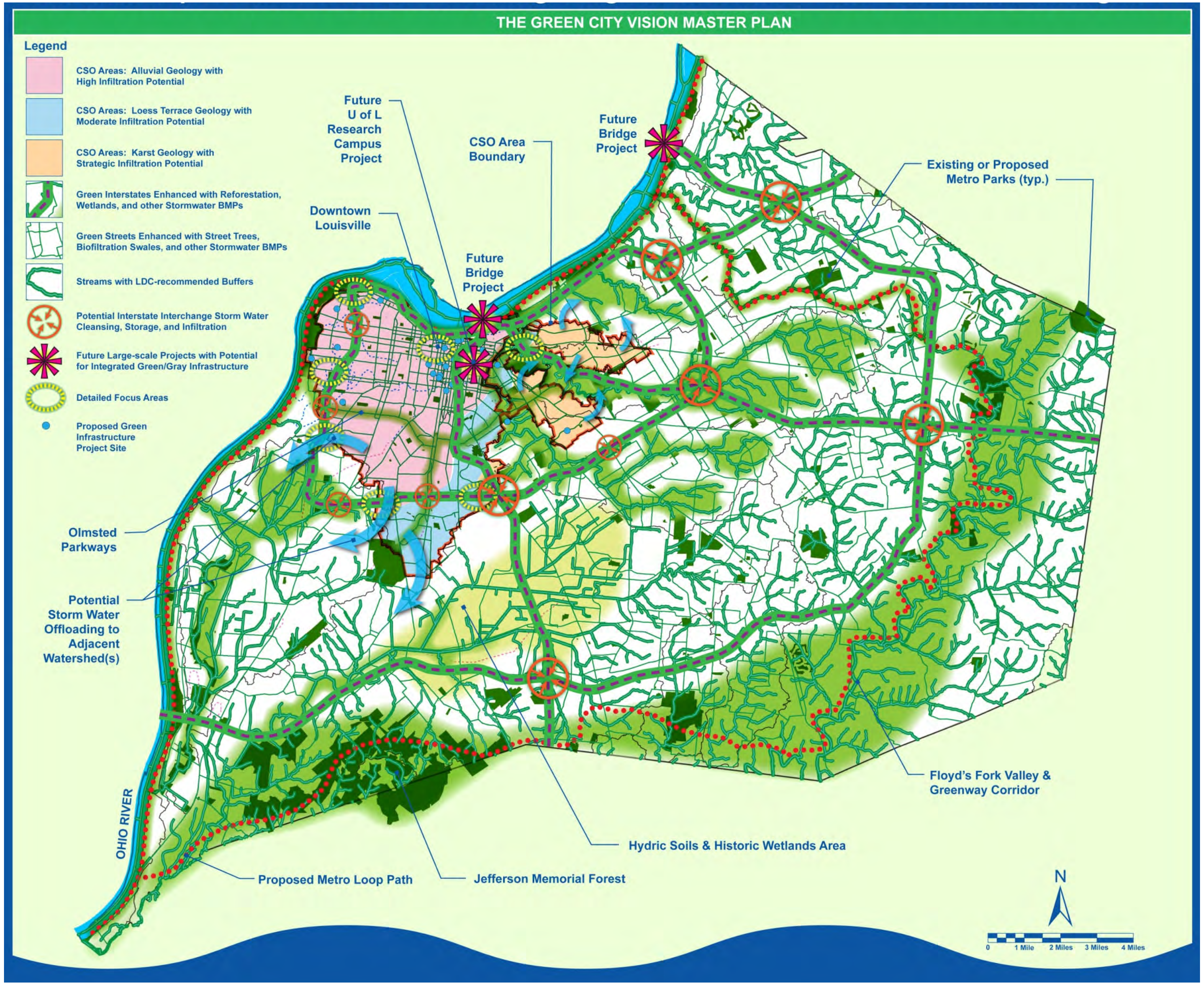
Outside Floodplain
100 Yr Floodplain
500 Yr Floodplain

LOJIC
MSD
PROJECT WIN

Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_Flood_3210.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

FIGURE 3.2.11
GRAPHICAL DEPICTION
OF REGIONAL EVALUATION



This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.12
NORTHWEST GREEN FOCUS AREA

LEGEND

- Flow Direction
- Proposed Pipe Solution
- CSO Boundary
- Drainage Area
- Potential Infiltration Area
- Impervious Area
- Right of Way
- Ohio River
- Alluvium
- Glacial outwash (Wisconsinan)
- Artificial fill

Soils
Outwash; Silts and clays in upper 15 to 20 feet, sands below, grading into gravel. Limestone 70 to 100 feet deep

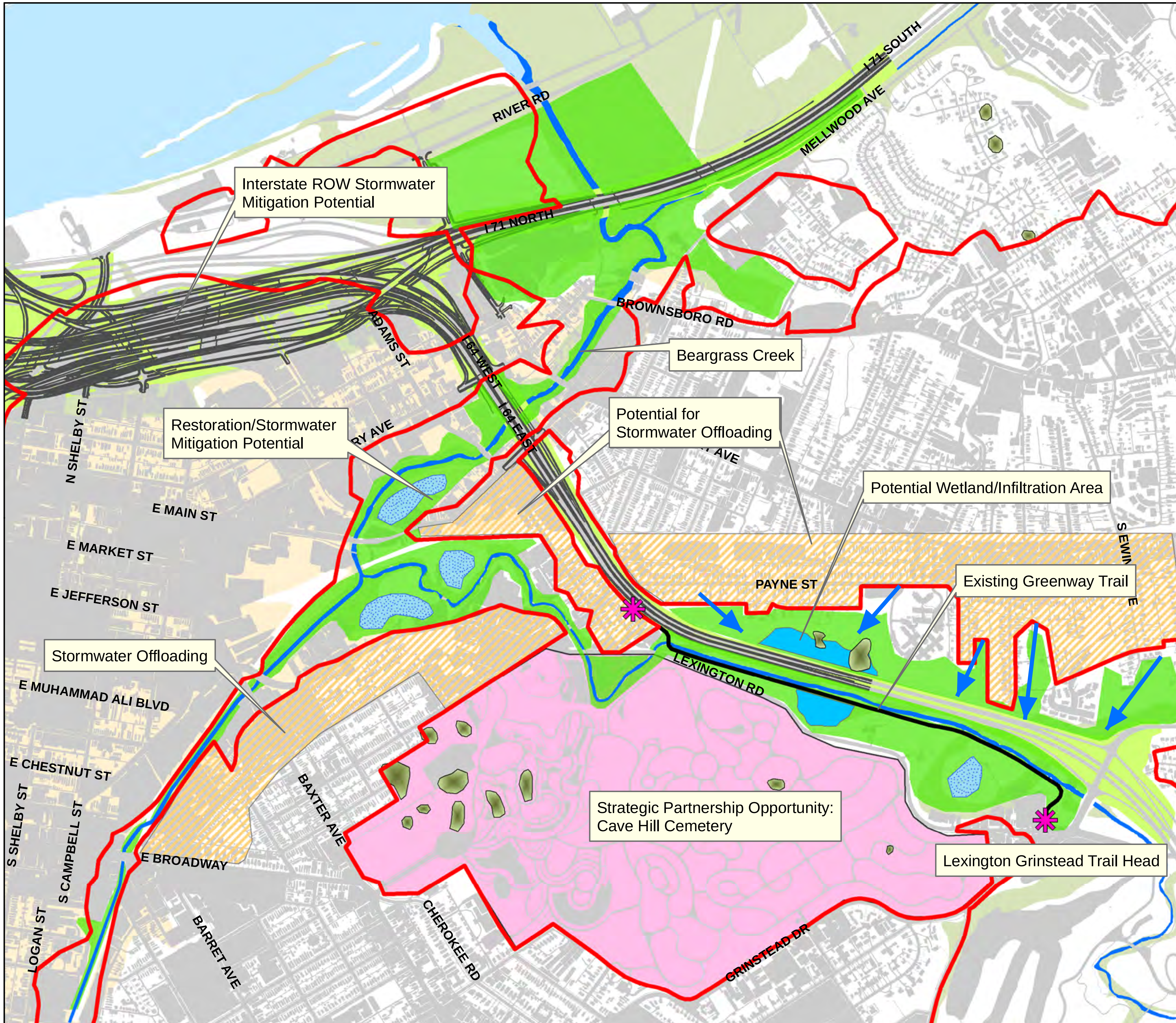
Features	Area (Acres)
Drainage Basin NW	272
Interstate	
Road Right of Way	50
Impervious	17
Metro	
Road Right of Way	22
Impervious	15
Other	
Impervious	72

LOJIC MSD PROJECT WIN

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.13
NORTHEAST GREEN FOCUS AREA



LEGEND

- Trailhead
- Kennedy Interchange
- Trail
- CSO Boundary
- Stormwater Mitigation Sites
- Sinkholes
- Potential Infiltration Area
- Stream Restoration
- Stormwater Offloading
- Ohio River
- Impervious Surfaces
- Right of Way
- Stream
- Strategic Partnership Opportunity
- Glacial outwash (Wisconsinan)
- Alluvium

Features	Area (Acres)
Stream Restoration	289
Stormwater Offloading Area	216
Strategic Partner Opportunity	324
Potential Wetland/Infiltration Area	9
Stormwater Mitigation Sites	12
Interstate ROW Mitigation Potential	167

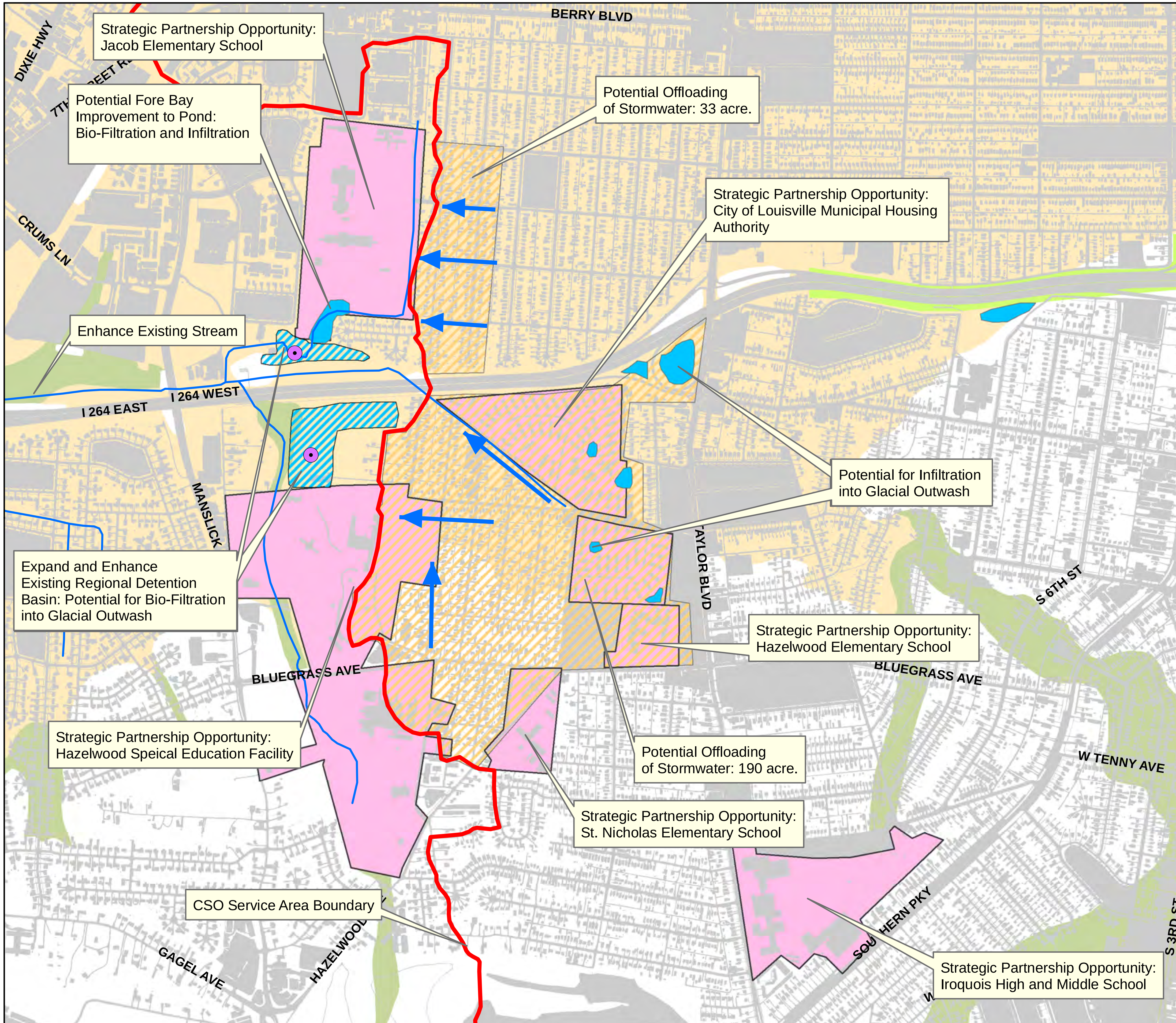
Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_FocusArea_NE_3213.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.14
SOUTH CENTRAL WEST GREEN FOCUS AREA



LEGEND

- MSD Detention Basins
- Streams
- CSO Boundary
- Existing Detention Basins
- Potential Infiltration Area
- Stormwater Offloading
- Strategic Partnership Opportunity
- Impervious Surfaces
- Glacial outwash (Wisconsinan)
- Alluvium

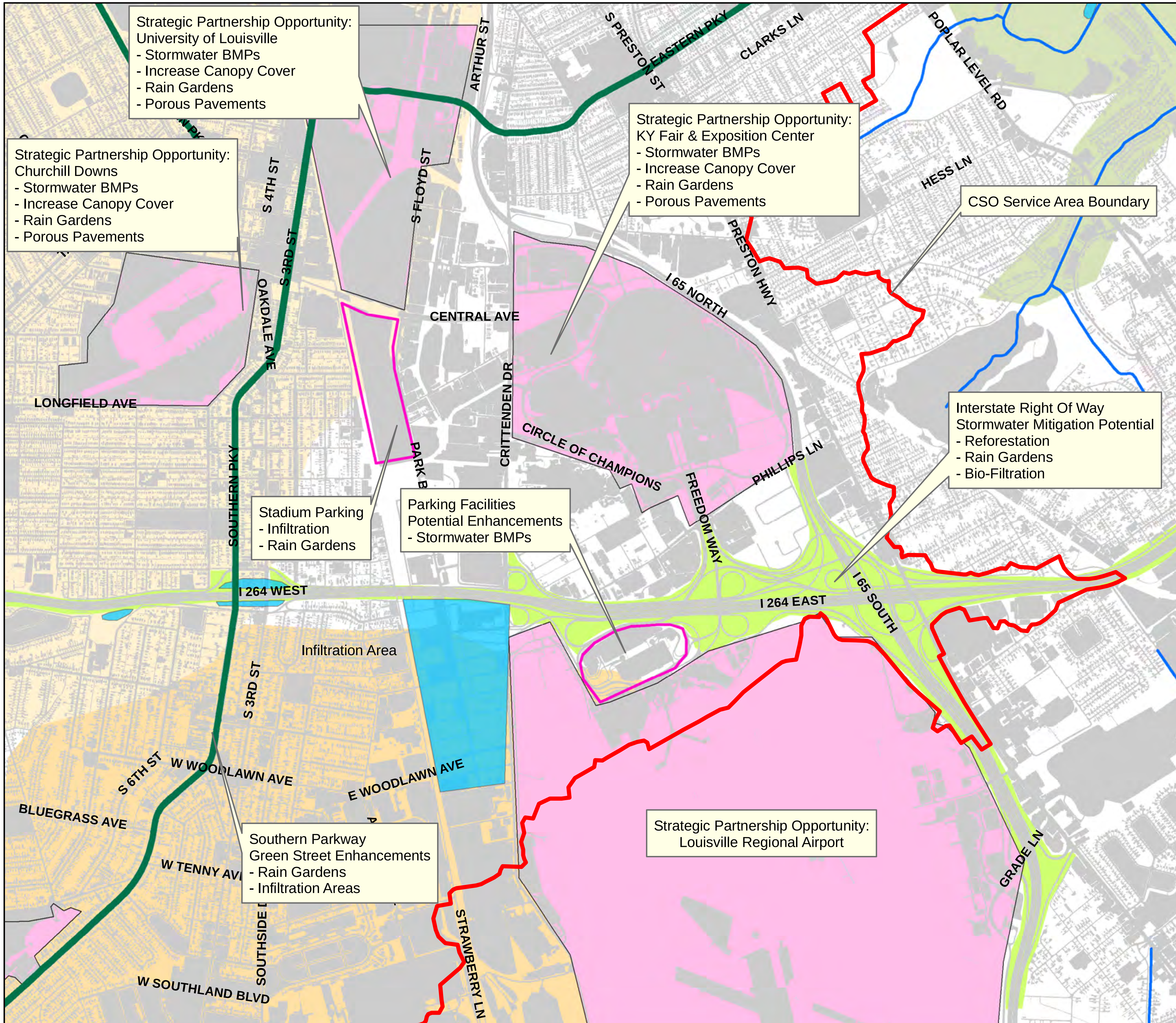
Features	Area (Acres)
Stormwater Offloading Area	223
Strategic Partner Opportunity	254
Potential Infiltration Area	6
Existing Detention Basins	15

LOJIC MSD Metropolitan Sewer District PROJECT WIN

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.15
SOUTH CENTRAL EAST GREEN FOCUS AREA



LEGEND

- Streams
- CSO Boundary
- Parking Enhancement Opportunity
- Olmsted Parkway System
- Potential Infiltration Area
- Strategic Partnership Opportunity
- Impervious Surfaces
- Right of Way
- Alluvium
- Outwash
- Terrace

Features	Area (Acres)
Strategic Partner Opportunity	2540
Potential Wetland/Infiltration Area	113
Parking Enhancement Potential	75
Interstate ROW Mitigation Potential	172

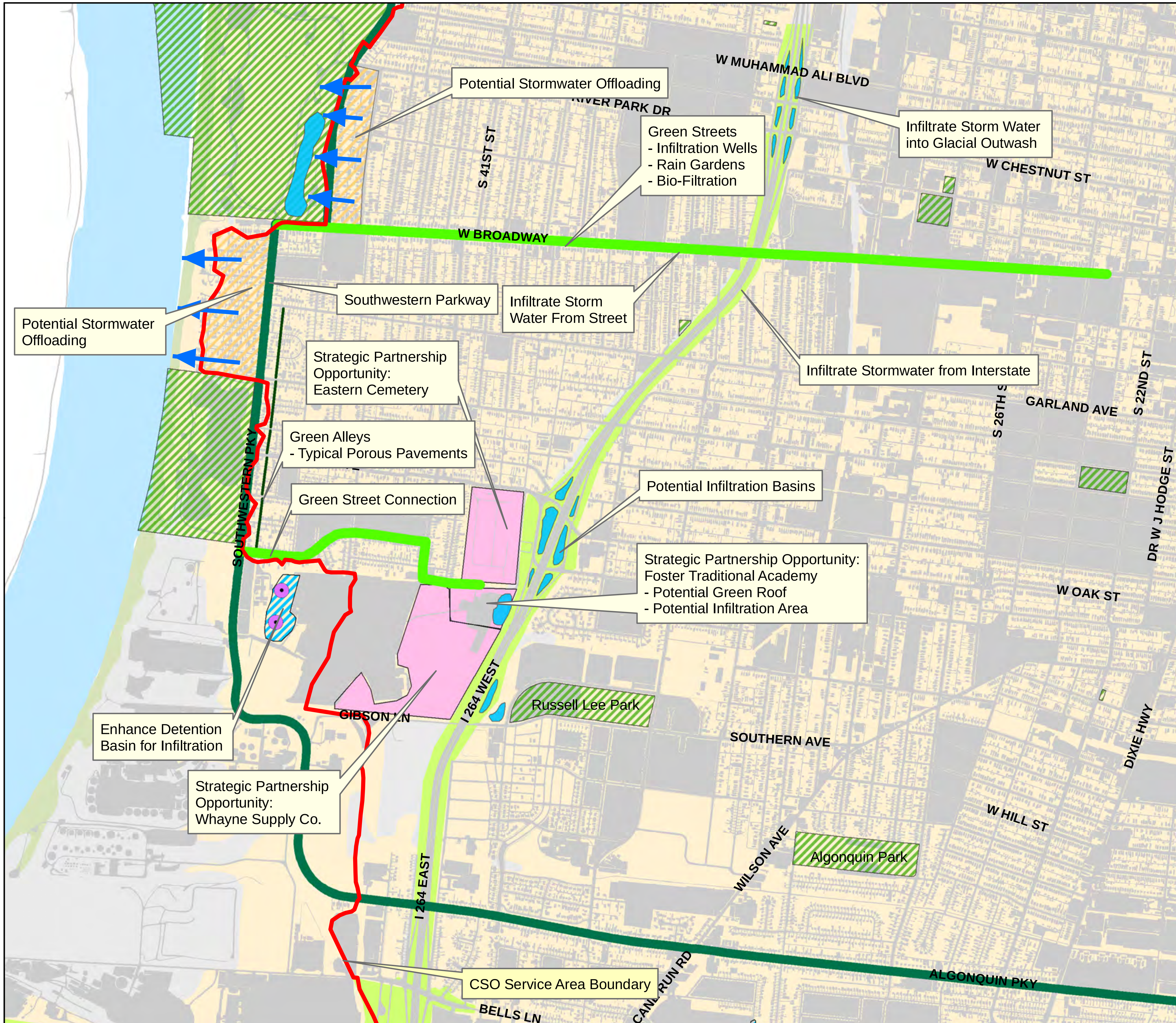
Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_FocusArea_SCE_3215.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.16
SOUTHWESTERN PARKWAY
GREEN FOCUS AREA



LEGEND

- MSD Detention Basins
- Streams
- Green Alley
- Green Street
- CSO Boundary
- Olmsted Parkway System
- Stormwater Offloading
- Potential Infiltration Area
- Existing Detention Basins
- Metro Parks & Open Space
- Ohio River
- Impervious Surfaces
- Strategic Partnership Opportunity
- Right of Way
- Alluvium
- Glacial outwash (Wisconsinan)
- Artificial fill

Features	Area (Acres)
Strategic Partnership Opportunity	68
Potential Infiltration Area	13
Green Streets Right of Way	45
Storm Water Off Loading	56
Existing Detention Basins	6
Interstate Right of Way *	121

* Including Insterstate ROW in both Southwestern Area and Southwest Greenway & Parkway Area

Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_FocusArea_SWPKY_3216.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.17
SOUTHWEST GREENWAY
AND PARKWAY GREEN FOCUS AREA

LEGEND

- MSD Detention Basins
- Streams
- Bike Route
- Olmsted Parkway System
- Potential Infiltration Area
- Existing Detention Basins
- Metro Parks & Open Space
- Ohio River
- Strategic Partnership Opportunity
- Impervious Surfaces
- Right of Way
- Greenway Connection
- Alluvium
- Glacial outwash (Wisconsinan)
- Artificial fill

Features	Area (Acres)
Potential Infiltration Area	13
Greenway Connection	331
Existing Detention Basins	1.5

Human Nature: X:\20710 (Louisville MSD w Strand)\GIS projects\LTCP\LTCP_FocusArea_SW_3217.mxd

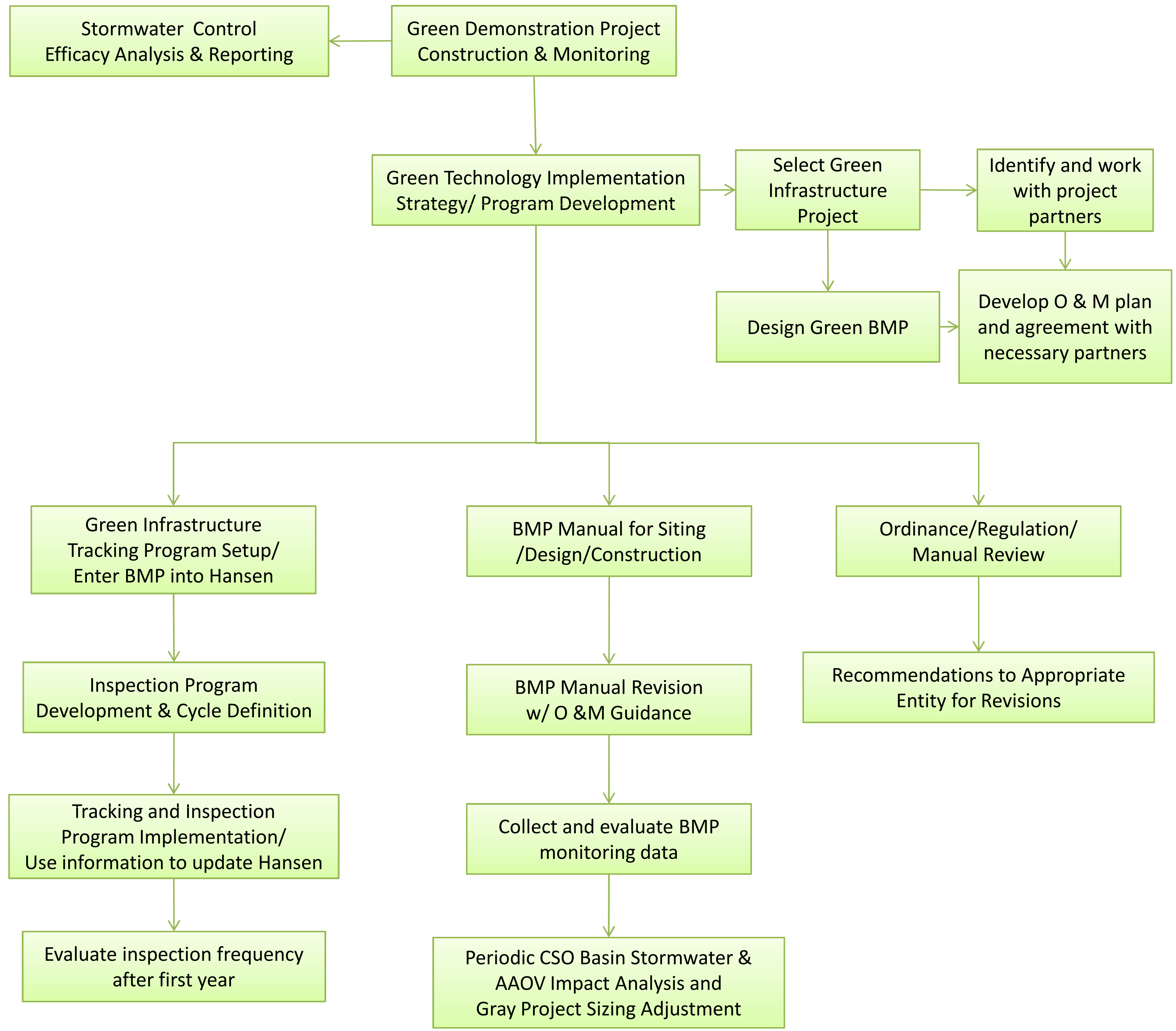
This document was developed in color. Reproduction in black and white may not represent the data as intended.

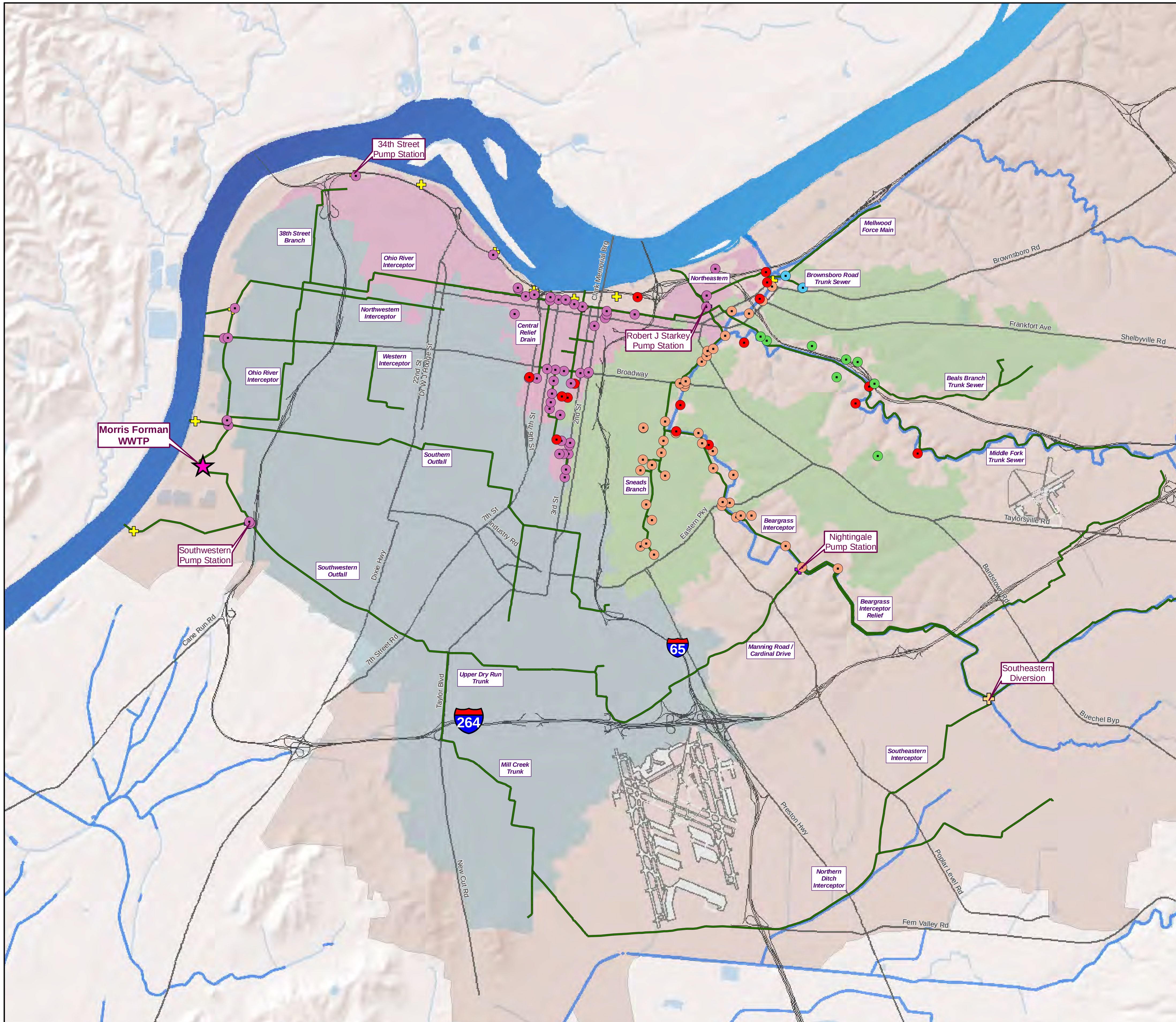
FIGURE 3.2.18
CENTRAL BUSINESS DISTRICT
GREEN FOCUS AREA
GREEN STREET CONCEPT PLAN

Integrated Overflow Abatement Plan

Vol. 2 – Final CSO Long-Term Control Plan

FIGURE 3.2.19
Green Infrastructure Program Implementation Preliminary Flow Diagram





Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.2.20
CSO DISTRIBUTION BY REGION

LEGEND

CSO by Region
- Ohio River
- Middle Fork Beargrass Creek
- Muddy Fork Beargrass Creek
- South Fork Beargrass Creek
- Eliminated CSO
- Flood Pump Station
- Sanitary Pump Station
- Southeastern Diversion
- Wastewater Treatment Plant
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries
- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD Metropolitan Sewer District PROJECT WIN

Figure 3.2.21
Off-Line Storage
Pumped Effluent
Flow Diagram

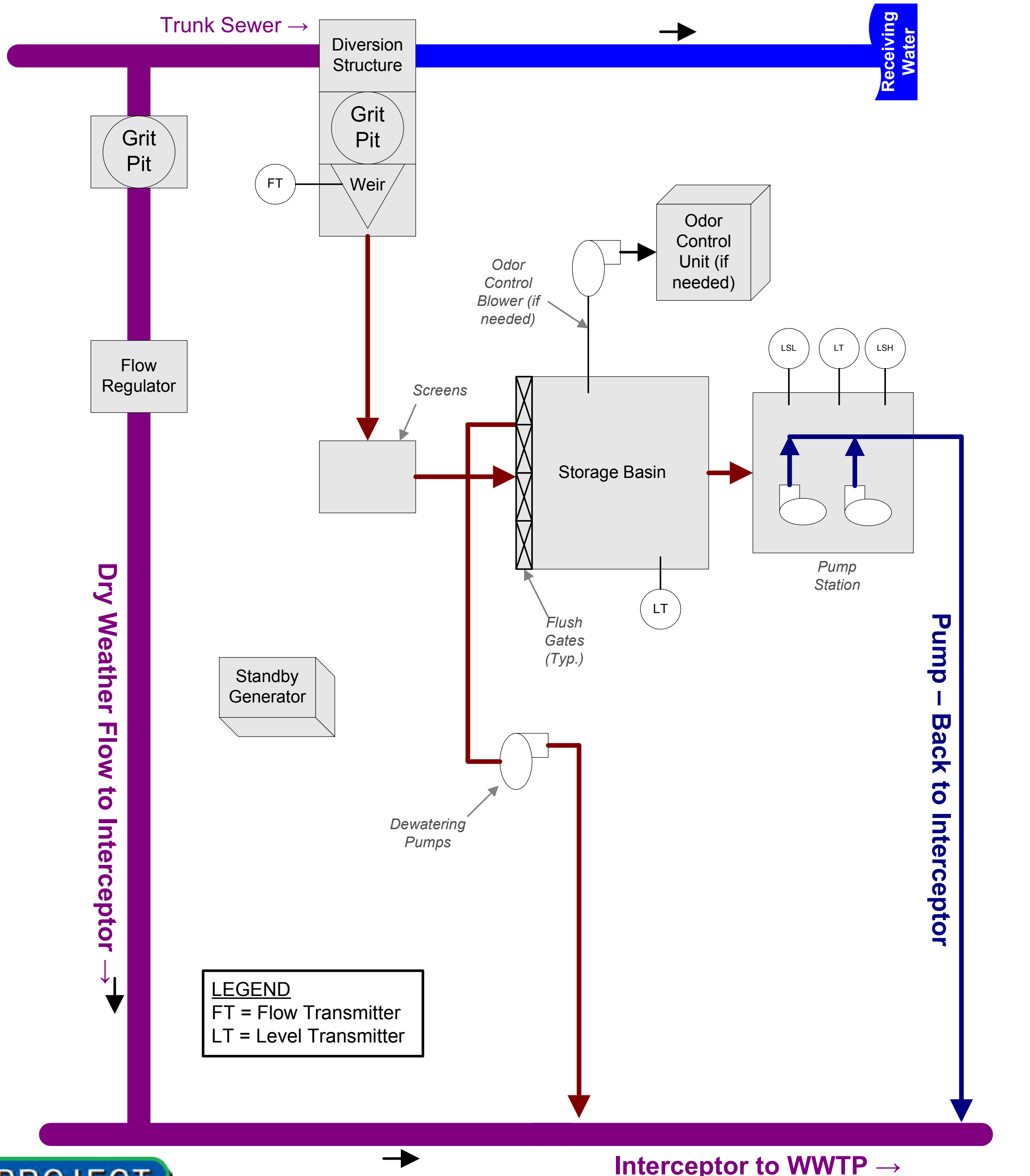


Figure 3.2.22
Off-Line Storage
Gravity Effluent
Flow Diagram

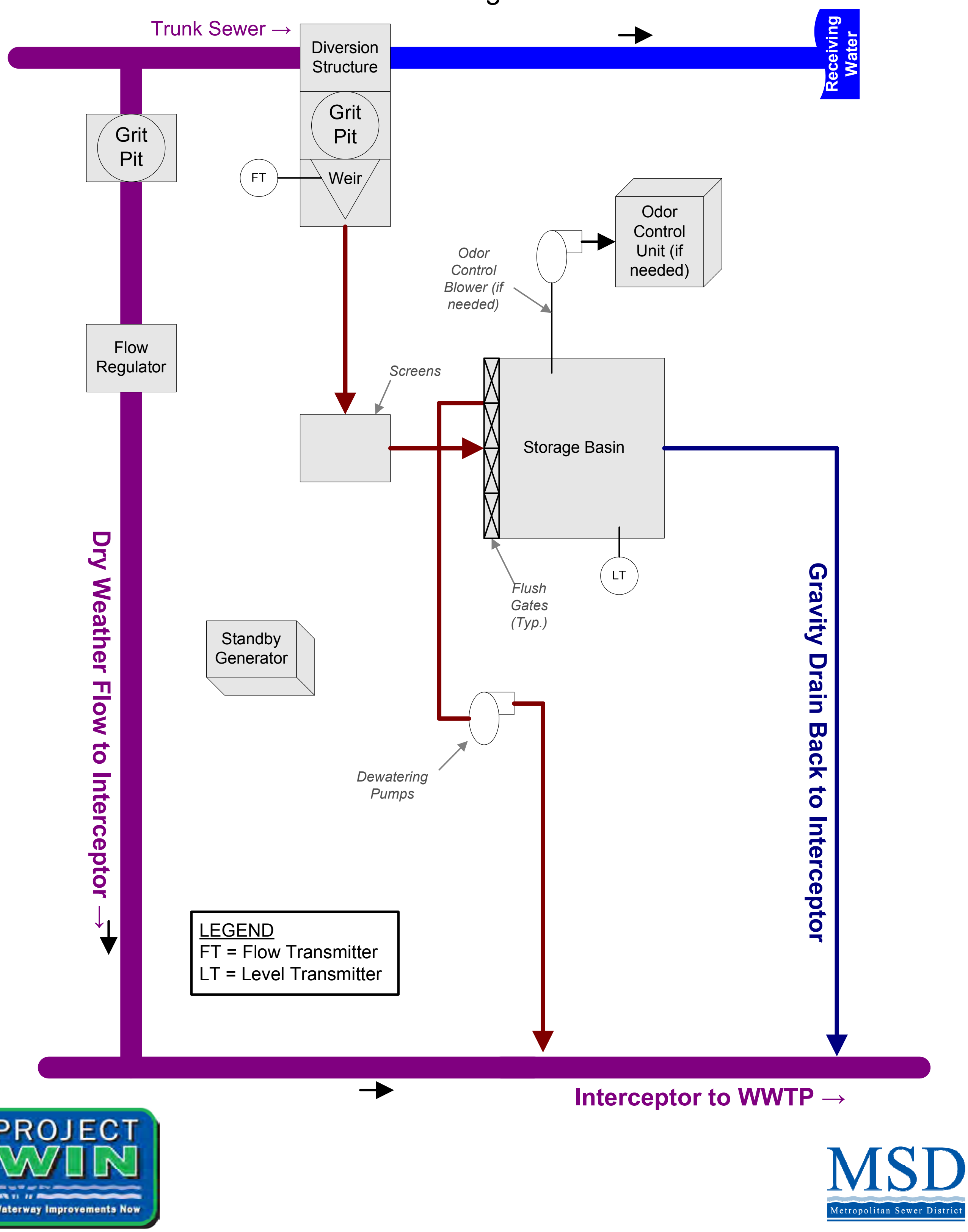
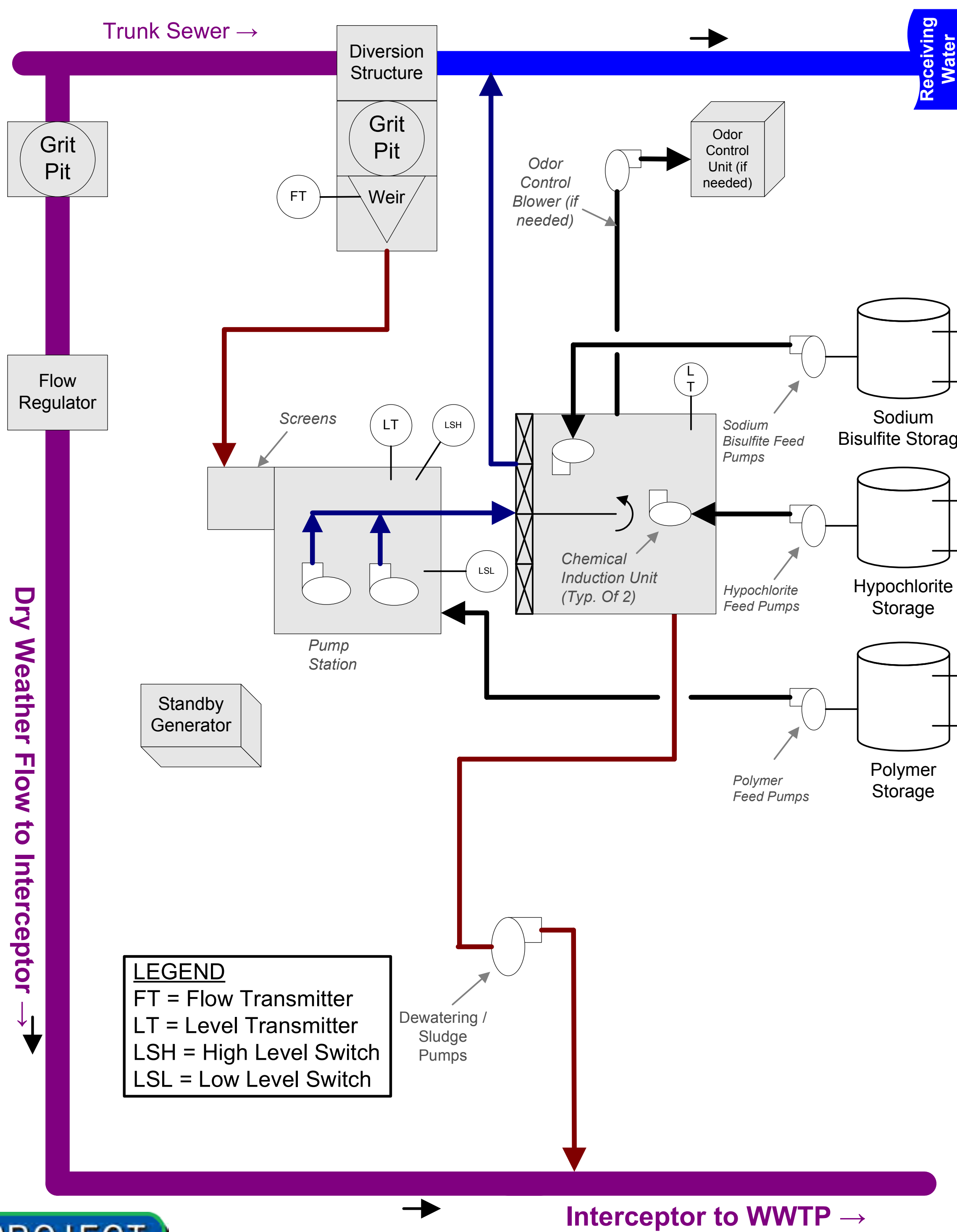


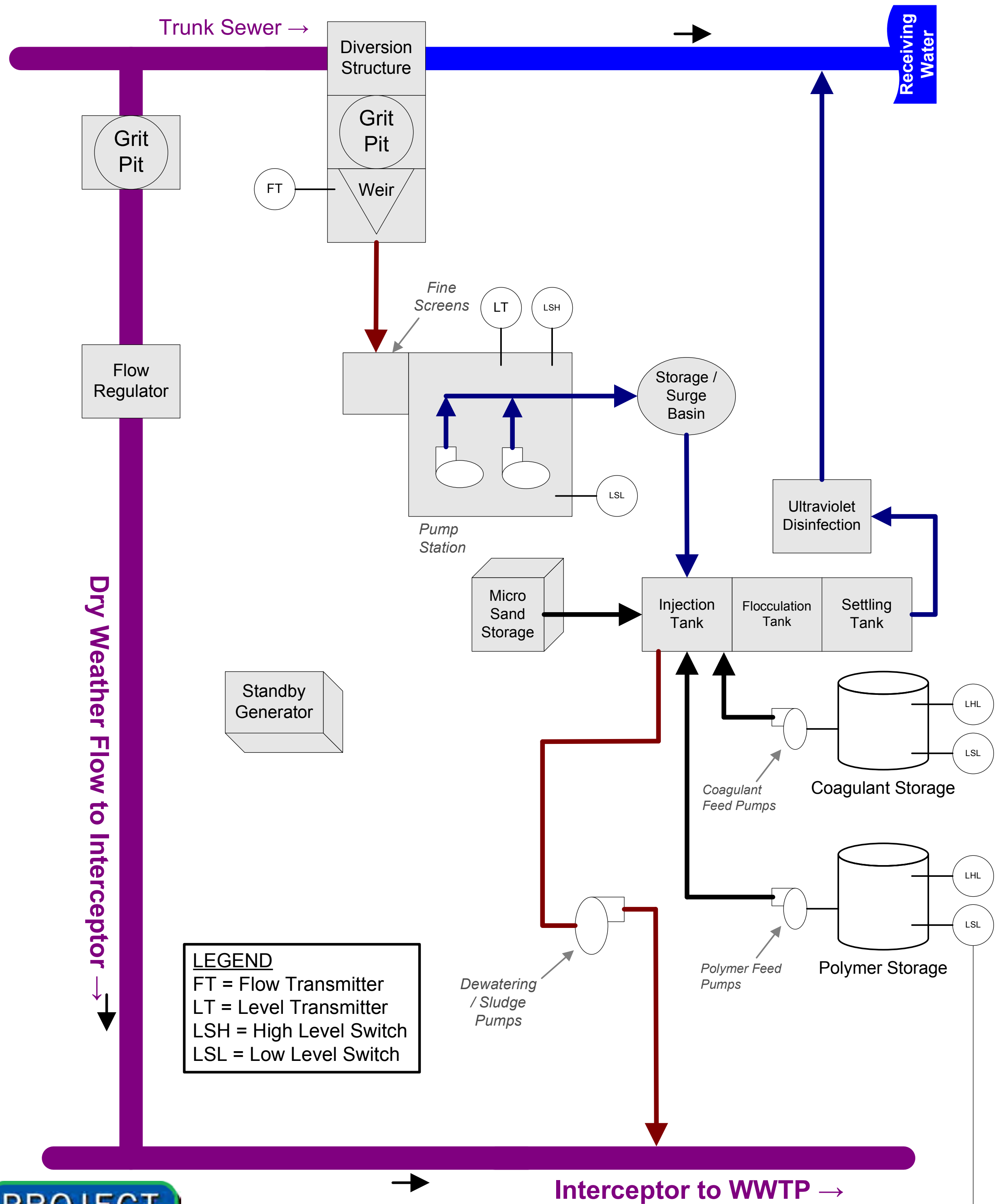
Figure 3.2.23
Retention Treatment Basin
Process Flow Diagram



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

Figure 3.2.24
Ballasted Flocculation
Process Flow Diagram



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

Figure 3.2.25
Hybrid Technology:
Off-Line Storage with Real Time Control
Pumped Effluent
Flow Diagram

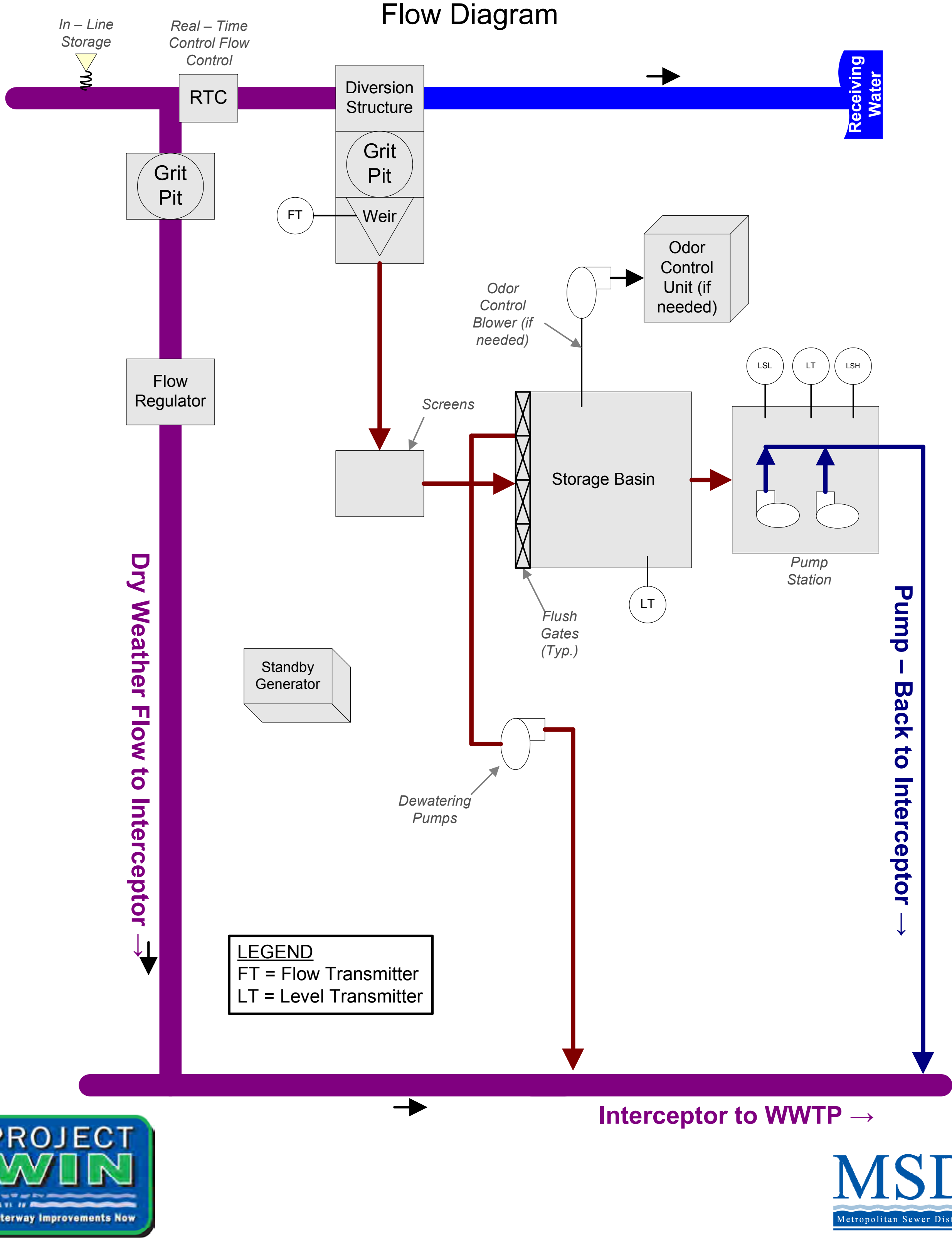
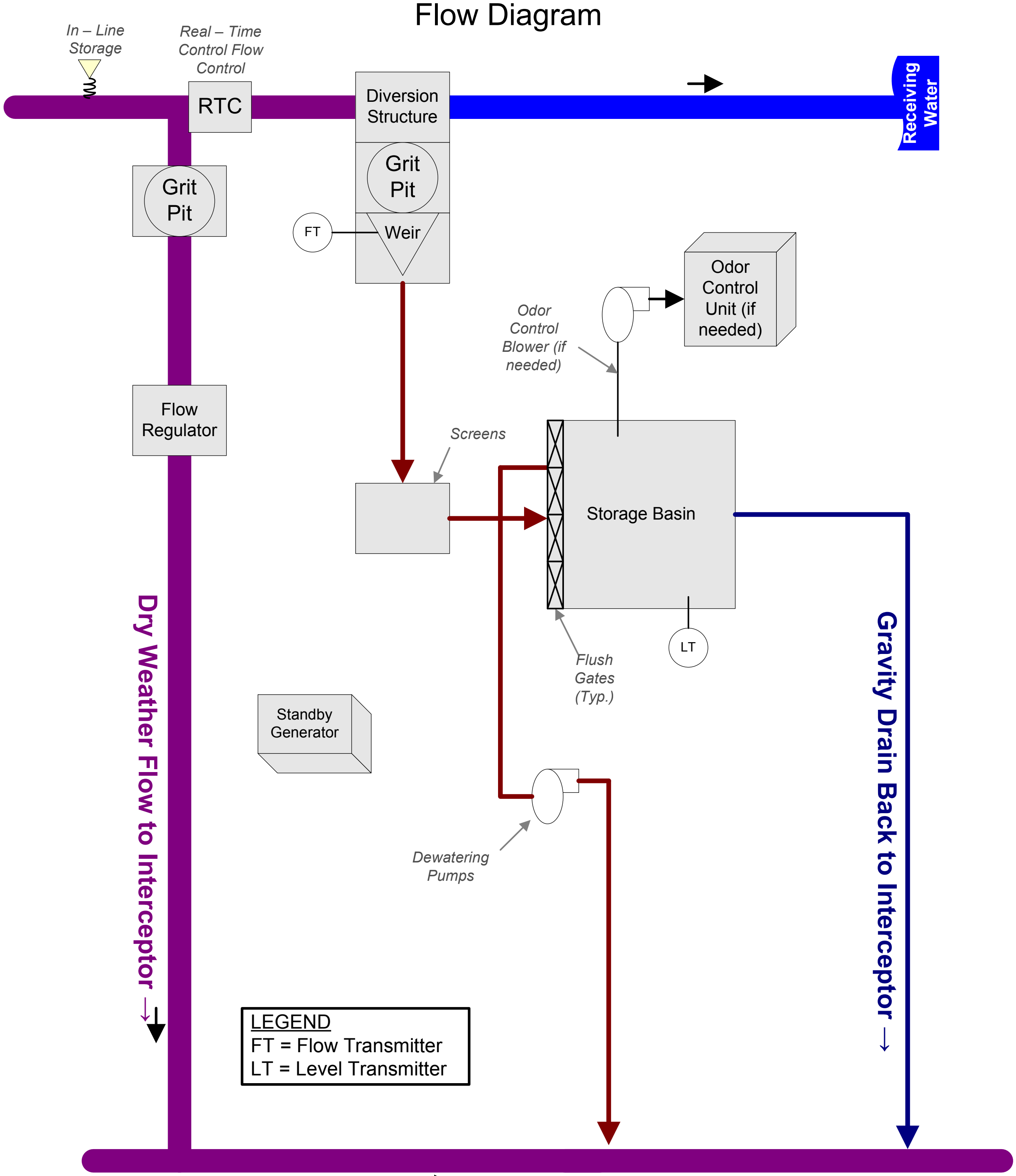


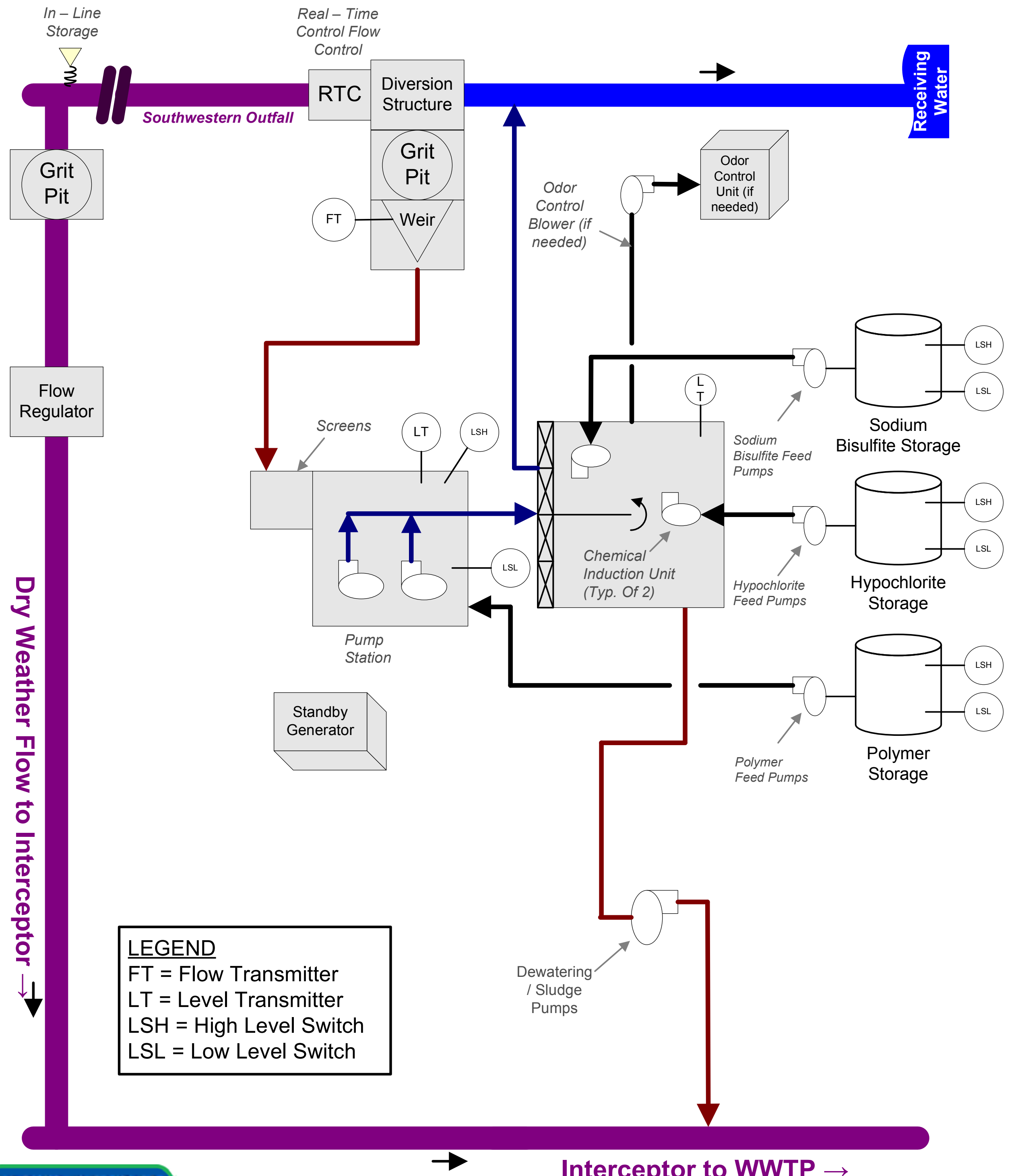
Figure 3.2.26
Hybrid Technology:
Off-Line Storage with Real Time Control
Gravity Effluent
Flow Diagram



PROJECT WIN Waterway Improvements Now

MSD Metropolitan Sewer District

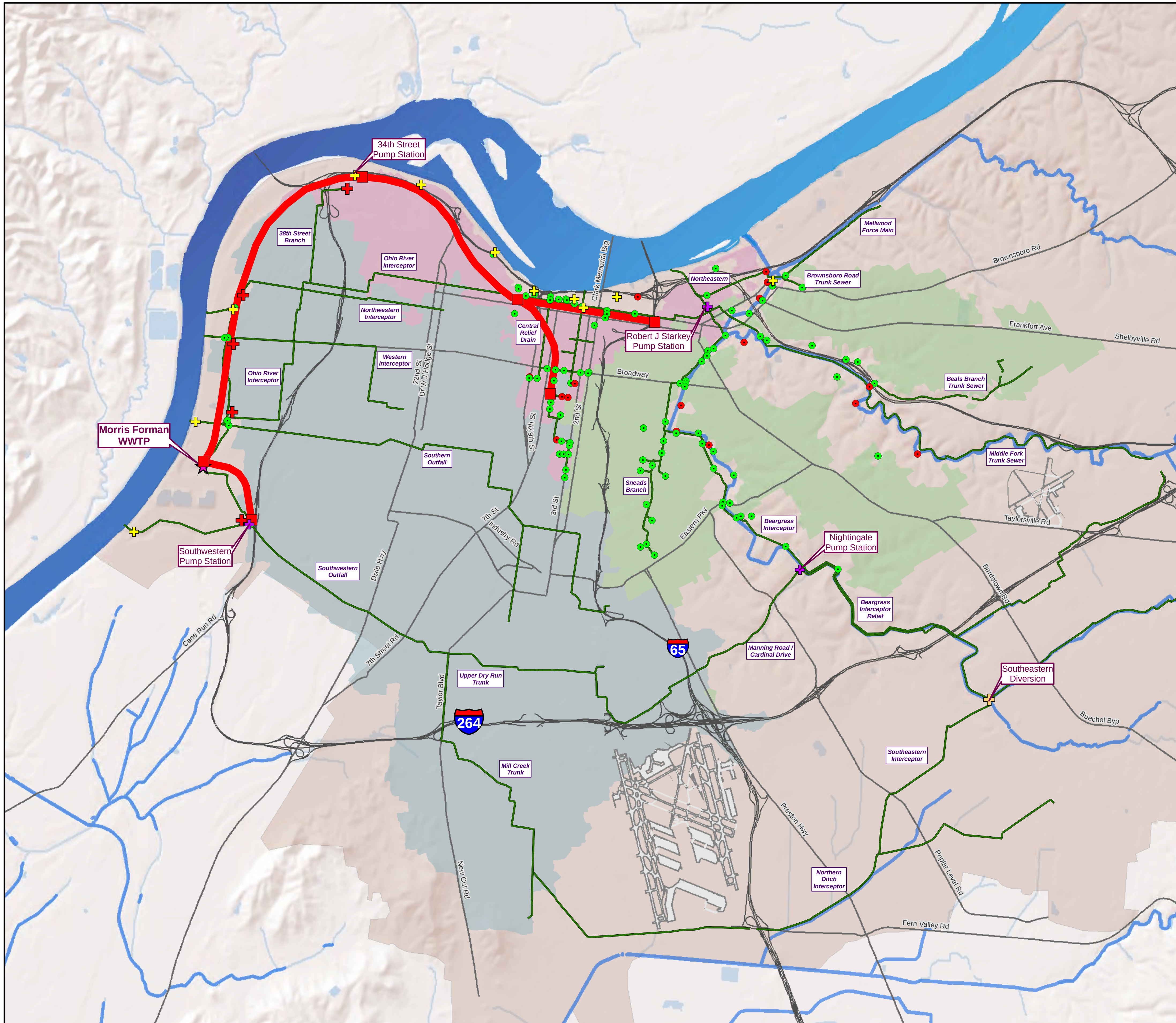
Figure 3.2.27
Hybrid Technology:
Retention Treatment Basin with Real-Time Control
Process Flow Diagram



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.3.2
REGIONAL CONSOLIDATION ALTERNATIVE 1



LEGEND

- Construction Access Shaft
- Drop Shaft >= 12 MGD
- Active CSO Location
- Eliminated CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Regional Consolidation Alternative
- Major Sewer Line
- Interstate
- Major Road

Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD PROJECT WIN

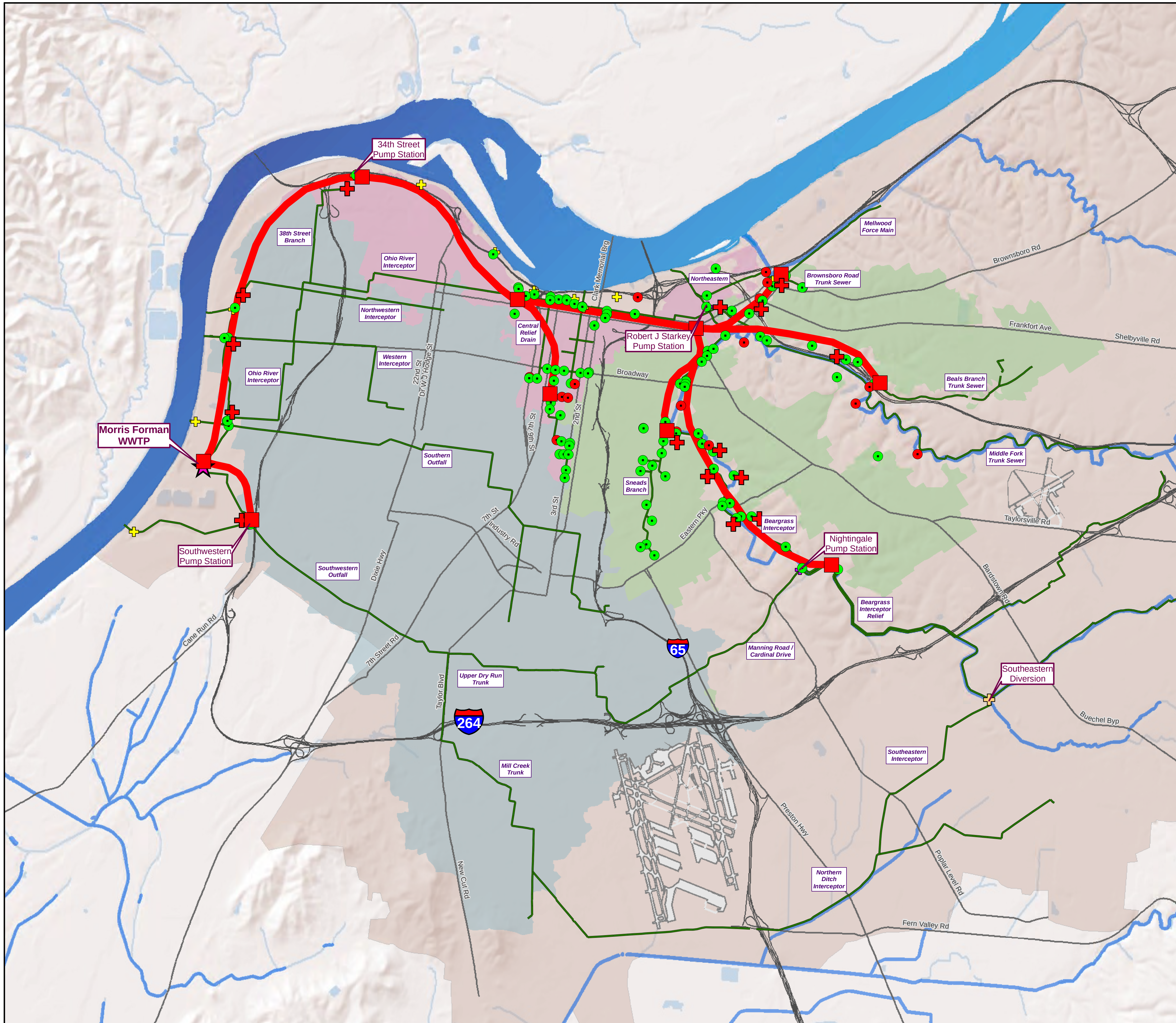
O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\3.3.2 Regional Consolidation - Alternative 1.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 3.3.3
REGIONAL CONSOLIDATION ALTERNATIVE 2



LEGEND

- Construction Access Shaft
- Drop Shaft >= 12 MGD
- Active CSO Location
- Eliminated CSO Location
- Flood Pump Station
- Sanitary Pump Station
- Wastewater Treatment Plant
- Regional Consolidation Alternative
- Major Sewer Line
- Interstate
- Major Road

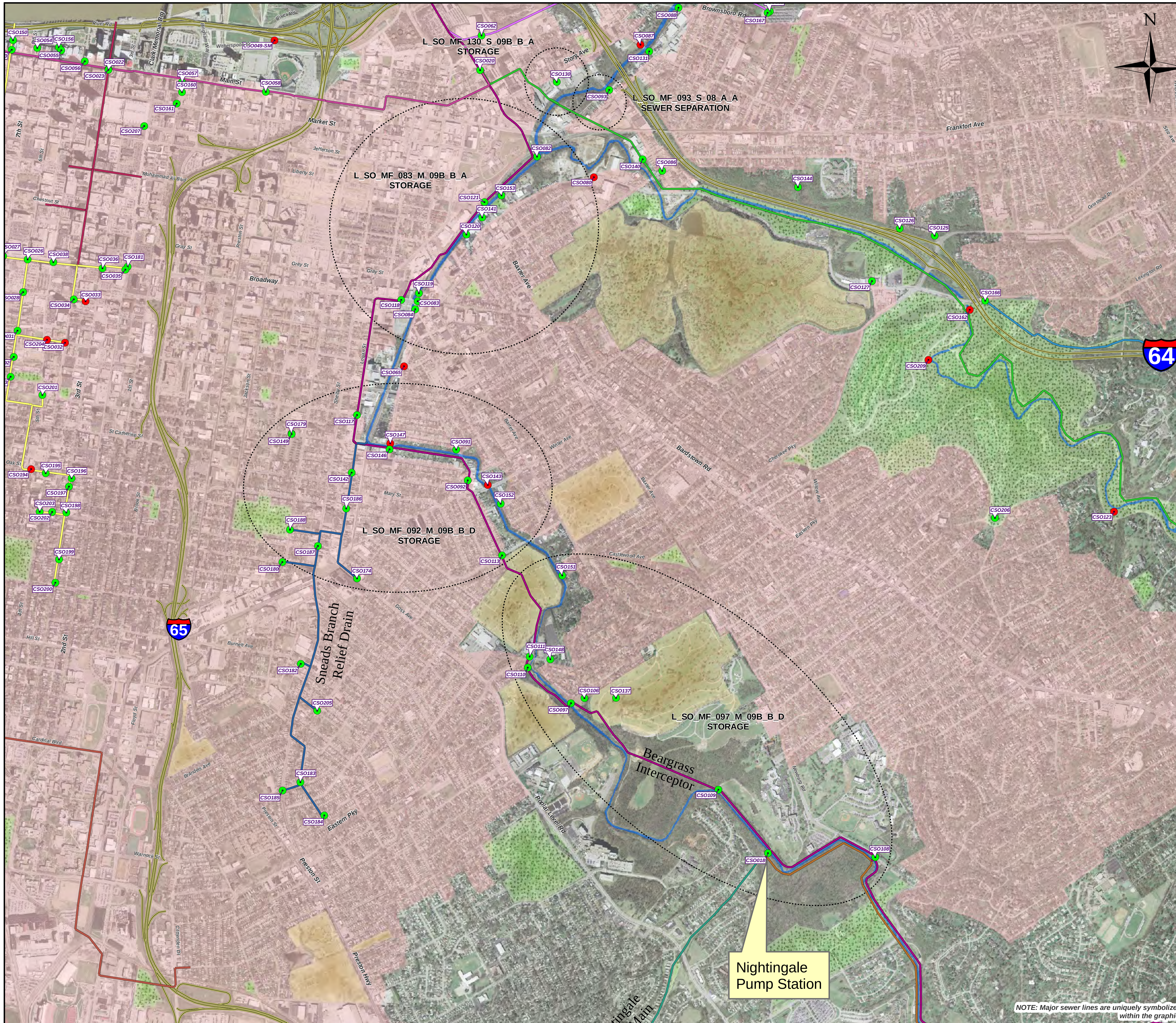
Regional Boundaries

- Beargrass Creek
- Ohio River North
- Ohio River West
- Morris Forman Service Area
- Water Feature

LOJIC MSD PROJECT WIN

O'Brien & Gere: I:\Lville-Jeff-Msd.10777\40109.Cso-Ltcp-Develo\LTCP PROJECT\GIS\MXDs\for LTCP Document\3.3.3 Regional Consolidation - Alternative 2.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

FIGURE 3.3.4
BEARGRASS CREEK SOUTH FORK INITIAL SOLUTIONS

(Refer to Table 3.3.2 Beargrass Creek South Fork Matrix)

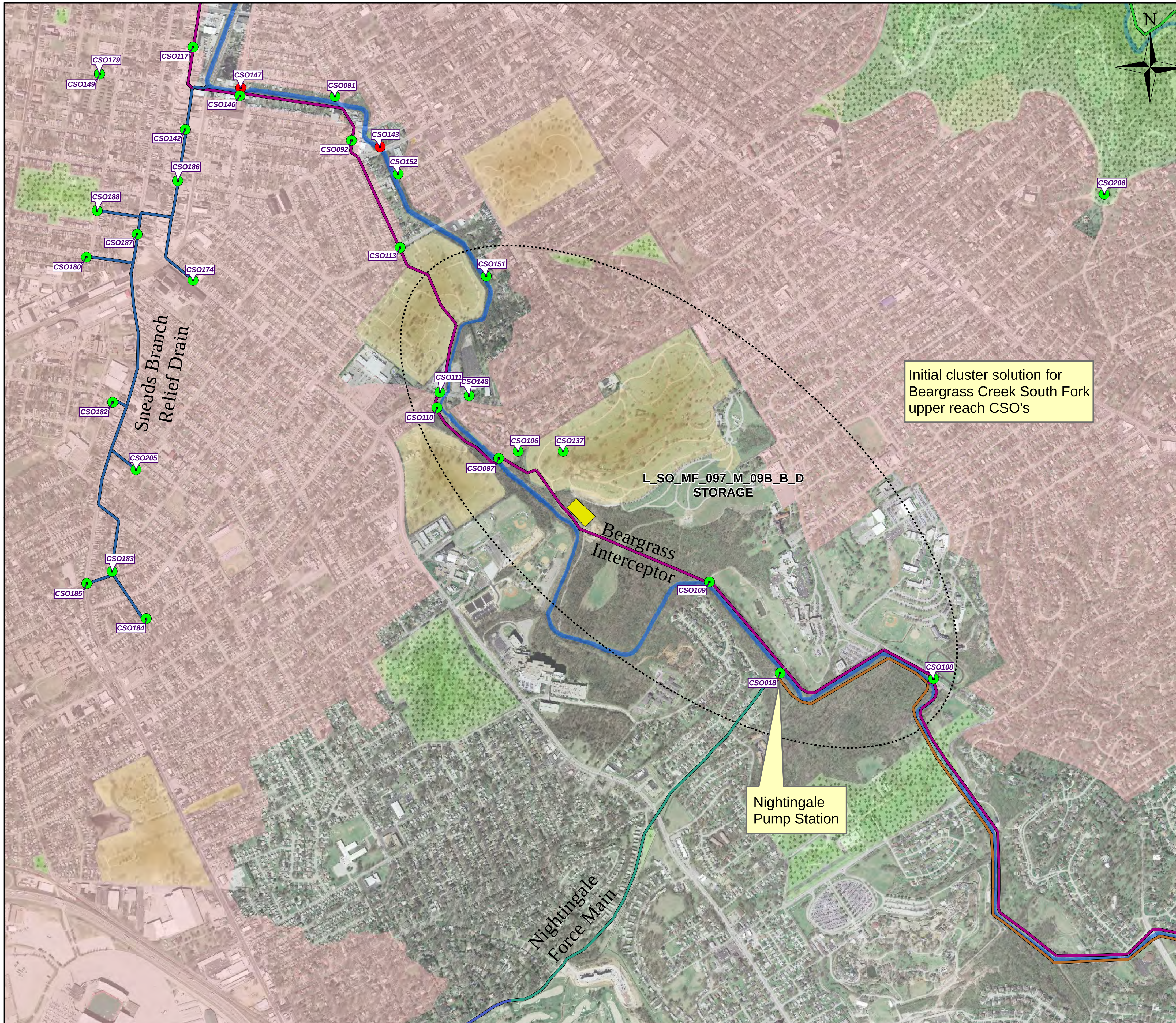
LEGEND

- Active CSO Location
- Eliminated CSO Location
- SFBCG Initial Cluster
- Cemetery
- Metro Park
- Major Stream
- CSO General Boundary

1 inch = 2,000 feet

O'Brien and Gere: PATH: I:\Lville-Jeff-Msd.10777\STDS\GIS\CSO-LTCP-Phase-II\MXD\SFBGC Initial Project Clusters.mxd (O'Brien and Gere)

This document was developed in color. Reproduction in black and white may not represent the data as intended.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

FIGURE 3.3.5
BEARGRASS CREEK SOUTH FORK UPPER REACH SOLUTION

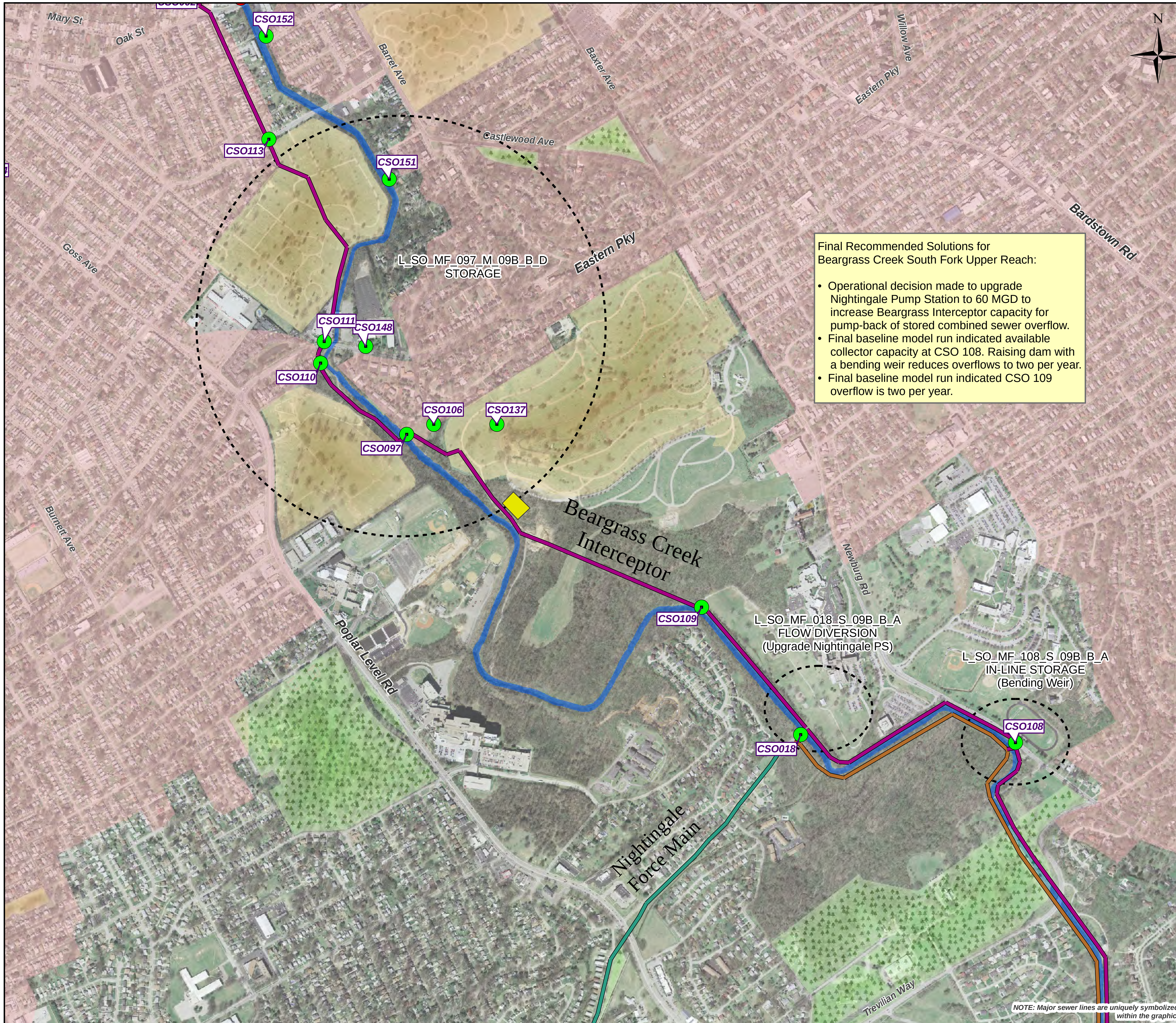
(Refer to Table 3.3.2 Beargrass Creek South Fork Matrix)

LEGEND

- Active CSO Location
- Eliminated CSO Location
- Offline Storage Basin
- SFBCG Initial Cluster
- Cemetery
- Metro Park
- Major Stream
- CSO General Boundary

1 inch = 1,400 feet

LOJIC MSD PROJECT WIN



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

FIGURE 3.3.6
BEARGRASS CREEK SOUTH FORK
UPPER REACH FINAL SOLUTIONS

(Refer to Final Recommended Project List Table 4.1.5)

LEGEND

- Active CSO Location
- Eliminated CSO Location
- Offline Storage Basin
- SFBCG Final Cluster
- Major Stream
- Metro Park
- Cemetery
- CSO General Boundary

1 inch = 1,000 feet

Chapter 4

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CHAPTER 4: SELECTION OF A FINAL CSO LONG-TERM CONTROL PLAN

Special Note: This chapter was developed in 2008. The statistical data for the CSO's reported, specifically related to individual CSO overflow volumes and frequency in a typical rainfall year, were derived from the CSS model calibrated in 2007. Since then, a more detailed calibration and validation effort has adjusted the average annual overflow volumes and frequencies in the typical year. This information is provided in Chapter 5. The vast majority of the physical system characterization in this chapter is still accurate.

TABLE OF CONTENTS

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

SUPPORTING INFORMATION

Appendix 4.1.1 Re-evaluation of LTCP Projects Technical Memorandum
Appendix 4.1.2 Recommended Project Cost Estimates
Appendix 4.1.3 Recommended Project Benefits
Appendix 4.1.4 Recommended Project Ground Truthing Documents

Appendix 4.2.1 IOAP Public Notice

CHAPTER 4: SELECTION OF A FINAL CSO LONG-TERM CONTROL PLAN

The development of the Final Combined Sewer Overflow (CSO) Long-Term Control Plan (Final CSO LTCP), as presented in the Volume 2 chapters, is the result of applying a well-documented and highly structured decision analysis process. This process considers a wide range of factors, resulting in a comprehensive program that significantly reduces Louisville and Jefferson County Metropolitan Sewer District (MSD) CSOs. The evolution of the Final CSO LTCP program includes an integration of both green infrastructure and conventional gray infrastructure solutions. In total, the recommended suite of projects in conjunction with the application of the programmatic elements captures and treats 96 percent of the volume of combined sewage collected in the combined sewer system (CSS).

Chapter 4 presents the final list of elements that comprise the Final CSO LTCP. The process to develop final gray infrastructure projects, followed by summaries of the final recommended green, gray, and flood pump station programs and projects is presented. Chapter 4 concludes with a discussion of the benefits and successes resulting from implementation of the Final CSO LTCP.

4.1 FINAL SELECTION OF RECOMMENDED PLAN

MSD developed a Final CSO LTCP to address CSOs discharging to four receiving streams:

- Ohio River
- Beargrass Creek Muddy Fork
- Beargrass Creek Middle Fork
- Beargrass Creek South Fork

As presented in Chapter 3 and in Figure 3.3.1, the process for final selection of CSO control solutions followed these sequential steps:

- Develop Initial Solutions List
- Apply Initial Solutions Screening Criteria
- Prepare Conceptual Design
- Prepare Planning-level Cost Estimates
- Determine Risk Reduction/Benefit Increment
- Calculate Benefit - Cost Ratio

- Develop Recommended Solutions List
- Perform Recommended Solutions Performance Optimization
- Select CSO Control Solutions

The selection and sizing of the CSO controls was based on CSS model results using Jefferson County, 2001 rainfall data and the InfoWorks Collection System (InfoWorks CS) software. To fully incorporate a Green Infrastructure Program into the Final CSO LTCP, programmatic decisions were made by MSD and a technical team, the Wet Weather Team (WWT), and the Stakeholder Group. The proposed Green Infrastructure Program will reduce stormwater runoff into the CSS, and implementation of future Real Time Control (RTC) projects will maximize storage within the existing collection system along with actively managing flow diversions. These programmatic elements downsize the gray infrastructure solutions, satisfying the WWT Stakeholder Group and community requests to merge environmental and aesthetic values of green infrastructure solutions with traditionally constructed facilities (gray infrastructure). The final design process for gray infrastructure projects in the Final CSO LTCP will include an adaptive management approach that will allow for cost effective expansion or retrofitting should the anticipated water quality improvements in Beargrass Creek and the Ohio River not be realized.

The objective of applying CSO control solutions to a CSS is to reduce combined sewage discharge to receiving streams as required by the 1972 Clean Water Act (CWA) and the 1994 CSO Control Policy (59 Code of Federal Regulations {CFR} 18688). One element of the Consent Decree is the reduction of CSO discharges to levels prescribed in the CSO Control Policy by December 31, 2020. The proposed programmatic elements mentioned above and the selected control solutions reduce the MSD CSS CSO discharge from a 2008 modeled baseline of 2,833 million gallons (MG) average annual overflow volume (AAOV) to a predicted 2020 performance level of 425 MG AAOV. This represents an 85 percent reduction in CSO volume when compared to the 2008 modeled baseline, and a 96 percent capture and treatment of the 11,000 MG of modeled wet weather flow entering the CSS exceeding, the requirements of the CSO Control Policy.

4.1.1 Process of Gray Solutions Analysis

The MSD CSS has 106 CSO discharge points, spatially distributed across 37 square miles of Louisville Metro. A total of 198 gray infrastructure CSO control alternatives were originally proposed by the technical team and MSD staff. An initial screening by the technical team pared this list to 136 viable alternatives that consisted of different types of control technologies, widespread geographic siting, and numerous consolidations of CSO control structures such as outfall, localized, or regionalized solutions. These projects, in turn were subjected to the benefit-cost evaluation process at a level of control of four overflows per year that resulted in a suite of 19 preferred gray infrastructure projects. To determine whether the technology comparison performed at four overflows per year was valid, three of the preferred projects were re-assessed at a level of control of two overflows per year to determine if the same technology would be selected. The outcome of this exercise produced identical results. The details and summary of this information is included in Appendix 4.1.1, Re-evaluation of LTCP Projects Technical Memorandum.

The 19 preferred gray infrastructure projects were further subjected to an optimization exercise at performance level of control of zero, two, and eight overflow events per year. The 19 alternatives were re-sized (based on volume of overflow with the associated level of control), new conceptual designs prepared, new costs estimated, and associated benefit-cost ratios calculated. Next, a matrix of CSO control alternative versus benefit-cost ratio at zero, two, four, and eight overflow events per year was created. Under this level of control evaluation process, the best present worth benefit-cost ratio, highlighted in Table 4.1.1, was selected as the CSO control alternatives to be the final recommended projects in this Final CSO LTCP.

TABLE 4.1.1
PREFERRED LTCP PROJECT LEVEL OF CONTROL ANALYSIS

Project Name	Receiving Stream	CSO Controlled	Technology	0 Overflows/YR		2 Overflows/YR		4 Overflows/YR		8 Overflows/YR	
				Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost
Paddy's Run Wet Weather Treatment Facility	Ohio River	CSO015,CSO191	Treatment with RTC	900 mgd	2.23	450 mgd	2.83	175 mgd	5.54	50 mgd	9.3
Adams Street Storage Basin	Ohio River	CSO172	Off-Line Storage	0.12	80.63	0.11	51.34	0.08	52.69	0.06	56.18
CSO160 Sewer Separation	Ohio River	CSO160	Sewer Separation	N/A	-310.87	N/A	N/A	N/A	N/A	N/A	N/A
Nightingale Pump Station Replacement	South Fork	N/A	Pump Station Expansion	60 mgd	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Logan Street and Breckinridge Street Storage Basin	South Fork	CSO113, CSO152, CSO091, CSO092, CSO146, CSO179, CSO149, CSO117, & CSO011 Sneads Branch Relief CSOs	Off-Line Storage	24.31	38.05	18.74	47.44	16.47	44.87	11.83	48.1
Story Avenue and Spring Street Storage Basin	South Fork	CSO130	Off-Line Storage	0.17	48.1	0.13	35.53	0.09	43.14	0.01	65.94

TABLE 4.1.1
PREFERRED LTCP PROJECT LEVEL OF CONTROL ANALYSIS

Project Name	Receiving Stream	CSO Controlled	Technology	0 Overflows/YR		2 Overflows/YR		4 Overflows/YR		8 Overflows/YR	
				Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost
13th Street and Rowan Street Storage Basin	Ohio River	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150,CSO15, CSO156, CSO208, & Central Relief Drain	Off-Line Storage	30.8	31.08	20.52	26.46	14.44	34.56	10.06	31.82
Lexington Road and Payne Street Storage Basin	South Fork	CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153 & CSO082	Off-Line Storage	13.74	45.76	11.22	42.66	9.42	49.72	7.31	50.71
CSO058 Sewer Separation	Ohio River	CSO058	Sewer Separation	N/A	87.24	N/A	N/A	N/A	N/A	N/A	N/A
CSO140 Sewer Separation	Middle Fork	CSO140	Sewer Separation	N/A	30.95	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 4.1.1
PREFERRED LTCP PROJECT LEVEL OF CONTROL ANALYSIS

Project Name	Receiving Stream	CSO Controlled	Technology	0 Overflows/YR		2 Overflows/YR		4 Overflows/YR		8 Overflows/YR	
				Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost
Calvary - Creekside Storage Basin	South Fork	CSO097, CSO106, CSO110, CSO111, CSO137, CSO148, & CSO151	Off-Line Storage	7.53	68.39	5.52	72.86	4.69	87.45	3.46	90.95
I-64 and Grinstead Drive Storage Basin	Middle Fork	CSO125, CSO126, CSO127, CSO166	Off-Line Storage	5.7	35.20	4.96	31.99	4.08	37.13	2.74	38.75
Clifton Heights Storage Basin	Muddy Fork	CSO132, CSO154 & CSO167	Off-Line Storage	12.7	26.66	9.14	29.12	7.95	30.39	6.55	31.93
18th and Northwestern Pky Storage Basin	Ohio River	CSO190	Off-Line Storage	2.12	36.98	2.06	34.17	1.78	31.48	1.31	41.49
Portland Wharf Storage Basin	Ohio River	CSO019	Off-Line Storage with RTC	19.1	8.48	15.64	8.85	11.07	10.44	6.37	10.50
Southwestern Parkway Storage Basin	Ohio River	CSO104, CSO105, & CSO189	Off-Line Storage with RTC	5.08	30.62	3.46	28.41	3.33	28.85	2.52	22.72
Story Avenue and Main Street Storage Basin	Ohio River	CSO020	Off-Line Storage	1.18	35	0.89	31.39	0.57	29.6	0.13	70.83
CSO093 Sewer Separation	South Fork	CSO093	Sewer Separation	N/A	70.49	N/A	N/A	N/A	N/A	N/A	N/A
Algonquin Parkway Storage Basin	Ohio River	CSO016, CSO210, & CSO211	Off-Line Storage with RTC	24.77	28.98	18.74	28.39	12.69	28.57	4.84	37.24

4.1.2 Presentation of Recommended Plan

MSD is one of the first CSO communities in the U.S. to fully integrate a comprehensive Green Infrastructure Program into the Final CSO LTCP planning process. Several Green Infrastructure Program components are being implemented at the outset of the IOAP and will complement the Gray Infrastructure Program. All elements of the Final CSO LTCP, the Green Infrastructure Program, the Gray Infrastructure Program, and Flood Pump Station Modification Projects are explained in the following sections.

4.1.2.1 Green Infrastructure Program

MSD's Green Infrastructure Program will utilize both specific green demonstration projects and program elements. Integrated with traditional gray solutions, various green techniques will continue to be used to capture, treat, and/or infiltrate stormwater runoff from existing impervious areas.

After an extensive evaluation of impervious surface types and local physical conditions such as soils and geology, MSD has proposed a Green Infrastructure Program that includes the following diverse elements:

- Vegetated roofs
- Downspout disconnection
- Rain barrels
- Green streets
- Urban reforestation
- Green alleys
- Biofiltration
- Rain gardens

A rain garden is a great way to capture runoff before it reaches storm drains. The one above is located at the Americana Community Center.

Demonstration Projects

In 2009, MSD identified 19 locations for green infrastructure demonstration projects. These projects were completed in 2010 and 2011, in accordance with the previously approved IOAP schedules, or as modified in subsequent quarterly or annual reports.

The proposed demonstration projects include a variety of green initiatives as follows:

<u>Green Alleys</u> (three projects)

- Gaulbert and W Hill Permeable Alley
- 2300 Congress Permeable Alley
- Billy Goat Strut Permeable Alley

Throughout the course of 2011, MSD engaged EPA Underground Injection Control (UIC) in discussions on the level of permitting required for this technology type. Due to the need to develop pilot project areas to examine the short and long-term effects of storm water injection into the aquifer under the CSS, an extensive amount of study will need to be performed prior to the issuance of permits or a streamlined permitting process. This dry well pilot area data collection process made the construction of the five demonstration dry well projects impossible to accomplish prior to December 31, 2011.

The following Table 4.1.2 shows demonstration project alternatives were constructed to replace the five dry well demonstration projects:

TABLE 4.1.2
CERTIFICATION DATES FOR IOAP PROJECTS
(SORTED BY ACD CERTIFICATION DATE)

Budget ID	ACD Project Number	IOAP (September 30, 2009) Project Name	Proposed Green Demonstration Project Location (September 30, 2011)	ACD Date
H09444	L_OR_MF_191_S_12_A_A	I-264 AND GIBSON DRY WELL	University of Louisville - Grawemayer Hall Green Parking Lot	31-Dec-11
H09442	L_OR_MF_189_S_12_A	I-264 OFF-RAMP DRY WELL	Speed Art Museum - Infiltration Trench	31-Dec-11
H09443	L_OR_MF_019_S_12_A	I-264 ON-RAMP DRY WELL	CSO 130 - Green Street	31-Dec-11
H09446	L_OR_MF_191_S_12_A_B	JFK MONTESSORI AREA DRY WELL	3rd Street Ventures	31-Dec-11
H09445	L_OR_MF_191_S_12_A_C	RUSSELL LEE DRIVE DRY WELL	Wilson Crossings - Green Parking Lot	31-Dec-11
TBD	ADD. RAIN GARDEN PROJECT	TBD	German/Paristown - Green Street/Rain Garden	31-Dec-11
H11044	Bardstown Rd Presbyterian Church Green Parking Lot	TBD	Brown-Forman Green Roof	31-Dec-11

Biofiltration Projects (Green Roofs, Parking Lots, Rain Gardens, Infiltration Trenches) (fourteen projects)

- MSD Main Office Parking Lot Biofiltration Swale
- Seventh and Cedar Green Parking Lot
- Downtown Scholar House Green Parking Lot
- Third and West Ormsby Biofiltration Swales
- Sixth Street and MLK Green Parking Lot
- Louisville Metro Housing Authority Green Roof
- Swift Parking Lot Bioswale
- Clifton Triangle Rain Garden
- Brandeis Apartments Rain Garden
- University of Louisville Grawemayer Hall Green Parking Lot
- Speed Art Museum Infiltration Trench
- 3rd Street Ventures Green Parking Lot/Green Roof
- Wilson Crossings Green Parking Lot
- Brown Forman Green Roof

Green Streets (two projects)

- CSO 130 Green Street (Adams and Washington Streets)
- German/Paristown Green Street

Combined, these 19 demonstration projects represent an estimated $1.5 million in construction costs to remove approximately 12 MG of stormwater from the CSS resulting in an average cost to MSD of $0.06 per gallon removed. It should be noted that the water quality benefits of MSD's Green Infrastructure Program have not been directly simulated in the receiving water quality models. The benefits of green infrastructure, particularly in Beargrass Creek, could include delayed runoff flow to the stream, reduced peak flow rates, elimination of runoff flow from smaller storms and additional pollutant removal.

MSD's proposed approach provides a relatively aggressive schedule at the beginning of program implementation to demonstrate performance, refine design standards, and develop operations and maintenance (O&M) information in an effort to inform the long-term level of commitment to specific green practices. In addition, MSD plans to coordinate the proposed locations for the demonstration projects with the schedule for the implementation of gray projects in an effort to maximize opportunities to reduce the need for gray controls. Table 4.1.3 summarizes MSD's proposed Green Infrastructure Demonstration Projects List.

Table 4.1.4 summarizes MSD's proposed regional Green Infrastructure Program and presents estimated stormwater reductions over a 15-year planning horizon. The budget of the Green Infrastructure Program was developed for the 15-year period. However, MSD is specifically committed to implementing green programs at this level for the first six years. As discussed earlier in Chapter 3 MSD plans on assessing the performance of green infrastructure demonstration projects, projects with EPA ORD monitoring components, and program performance during the first six years of implementation with the goal of evaluating and adjusting financial allocations for particular green elements based on a cost-benefit analysis. Therefore, while green infrastructure is envisioned to be an important component to the Final CSO LTCP, MSD's long-range commitment to this program will be based on how green performs in comparison to more traditional gray solutions.

Utilizing the Green Infrastructure Program Cost Tool as the baseline for green implementation, MSD plans to commit approximately $6 million per year for the first six years, followed by an allocation of $1 million per year for nine additional years. These committed funds, plus the $1.5 million committed for the green demonstration projects, result in a comprehensive Green Infrastructure Program budget of $47 million. Removal of stormwater runoff from the combined system is accomplished for an average cost to MSD of $0.06 per gallon. By working through partners, and offering incentives and partial subsidies to encourage green infrastructure investments, MSD expects to leverage its spending to more than double the green infrastructure investments community-wide. Additionally, MSD will continue to implement a post-construction monitoring program to evaluate the performance of various green infrastructure elements. Based on the results of the monitoring effort, MSD will make appropriate adjustments to the mix of projects and total investment level in the green infrastructure initiative to achieve maximum community benefit for the dollars invested.

TABLE 4.1.3
FINAL RECOMMENDED GREEN DEMONSTRATION PROJECT LIST

Project Name	Location	CSO Controlled	Technology	Gallons Removed Annually (MG)	Capital Cost	Cost per Gallon Removed	Completion Date
MSD Main Office Parking Lot Bioswale	Ohio River	CSO053	Biofiltration Technique	0.235 MG	$80,000	$0.09	12/31/2010
Seventh and Cedar Green Parking Lot	Ohio River	CSO022	Biofiltration Technique	1.4 MG	$500,000	$0.09	12/31/2010
Scholar House Green Parking Lot	South Fork	CSO084	Biofiltration Technique	.9 MG	$60,000	$0.09	12/31/2010
Third and Ormsby Biofiltration Swales	Ohio River	CSO198	Biofiltration Technique	0..3 MG	$ 30,000	$0.09	12/31/2010
Sixth and MLK (Federal Building) Parking Lot	Ohio River	CSO022	Biofiltration Technique	1.1 MG	$96,000	$0.09	12/31/2010
Housing Authority Green Roof at 801 Vine Street	Ohio River	CSO084	Green Roof	.9 MG	$60,000	$0.09	12/31/2010
W. Gaulbert and W Hill Permeable Alley	Ohio River	CSO015	Permeable Alley	1.74 MG	$278,000	$0.16	12/31/2010
2300 Congress Permeable Alley	Ohio River	CSO053	Permeable Alley	0.97 MG	$155,000	$0.16	12/31/2010
Billy Goat Strut Permeable Alley	South Fork	CSO121	Permeable Alley	0.41 MG	$65,000	$0.16	12/31/2010
Swift Parking Lot Bioswale	Ohio River	CSO130	Biofiltration Technique	0.53 MG	$48,000	$0.09	12/31/2010
Speed Art Museum Infiltration Trench	Middle Fork	CSO189	Biofiltration Technique	0.15 MG	$30,000	$0.20	12/31/2011
CSO 130 Green Street	Middle Fork	CSO130	Green Street	0.15 MG	$30,000	$0.20	12/31/2011
University of Louisville – Grawemayer Hall Green Parking Lot	Ohio River	CSO191	Biofiltration Technique	0.6 MG	$120,000	$0.20	12/31/2011
Wilson Crossings- Green Parking Lot	Ohio River	CSO191	Biofiltration Technique	0.15 MG	$30,000	$0.20	12/31/2011
3rd Street Ventures	Ohio River	CSO191	Dry Well	0.3 MG	$60,000	$0.20	12/31/2011
Clifton Triangle Rain Garden	Muddy Fork		Rain Garden	0.53 MG	$48,000	$0.09	12/31/2010
German/Paristown Green Street/Rain Garden	South Fork	TBD	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2011
Brown Forman Green Roof	Ohio River	TBD	Green Roof	0.53 MG	$42,000	$0.09	12/31/2011
TOTAL				**12 MG**	**$1,500,000**	**$0.13**	

TABLE 4.1.4
GREEN INFRASTRUCTURE PROGRAM INITIATIVE (FIRST 6 YEARS)

Impervious Surface and Best Management Practice (BMP) Type[1]	Implementation Level over a 15-year Planning Horizon[2]	Estimated Annual Stormwater Reduction over a 15-year Planning Horizon[3]	Annual Cost[4]	Program Cost Per Gallon[5]
Public Roofs				
Extensive Vegetated Roofs	7%	21,327,000	$427,000	$0.30
Tray System Vegetated Roofs	3%	5,625,000	$112,000	$0.30
Commercial Roofs				
Extensive Vegetated Roofs	1%	4,376,000	$88,000	$0.30
Tray System Vegetated Roofs	1%	2,693,000	$54,000	$0.30
Industrial Roof				
Extensive Vegetated Roofs	1%	6,532,000	$131,000	$0.30
Tray System Vegetated Roofs	1%	4,020,000	$80,000	$0.30
Single Family Residential Roofs				
Downspout Disconnection	10%	123,792,000	$386,000	$0.05
Rain Barrel Program	N/A	0	$165,000	$0.00
Local Roads				
Green Street	1%	245,901,000	$3,070,000	$0.19
Urban Reforestation	14,000 trees	11,200,000	$224,000	$0.30
Highways				
Biofiltration	0.5%	10,691,000	$7,000	$0.01
Alleys				
Type A Alley (porous strip)	5%	11,885,000	$238,000	$0.30
Type B Alley (porous entire width)	5%	11,885,000	$238,000	$0.30
Public Parking/Driveways				
Biofiltration	5%	305,541,000	$191,000	$0.01
Commercial Parking/Driveways				
Biofiltration	1%	84,098,000	$52,000	$0.01
Industrial Parking/Driveway				
Biofiltration	0.5%	44,716,000	$28,000	$0.01
Single Family Residential Property				
Biofiltration	0.5%	52,035,000	$32,000	$0.01
Subtotal		**946,317,000 gallons**	**$5,523,000**	**N/A**
Technical Support			**$276,000**	**N/A**
TOTAL			**$5,799,000**	**N/A**
Green Infrastructure Program Cost to MSD per Gallon Removed			**$0.09**	

[1] Estimated stormwater reductions and Green Infrastructure Program costs were derived from the green infrastructure cost tool developed by Strand Associates, Inc.

[2] Implementation level defines the proposed percentage of that impervious surface type to be retrofitted with a green control as part of the Green Infrastructure Program.

[3] Represents the potential reduction in annual stormwater reduction if the listed implementation rates are successfully carried out over 15 years as part of the Green Infrastructure Program.

[4] Anticipated Annual Costs will vary based on opportunities and partnership agreements. Total six-year costs will not be less than $36,000,000.

[5] MSD's cost share for green infrastructure controls is based on the marginal cost of gray storage at $0.30 per gallon. Therefore, the maximum amount MSD will pay for a green control is $0.30 per gallon of stormwater removed.

4.1.2.2 Gray Infrastructure Program

The 19 optimized gray infrastructure project technologies, plus four additional gray project technologies identified during the optimization process, are listed in Table 4.1.4.

TABLE 4.1.4
OPTIMIZED CSO CONTROL GRAY INFRASTRUCTURE PROJECT TECHNOLOGIES

Project Type	Number of Projects	Receiving Stream(s)
Pump Station Expansion	1	Beargrass Creek South Fork
Sewer Separation	6	Beargrass Creek Middle Fork Beargrass Creek South Fork Ohio River
Off-line Storage	10	Beargrass Creek Middle Fork Beargrass Creek Muddy Fork Beargrass Creek South Fork Ohio River
Hybrid Technology: Off-line Storage w/In-line Storage (RTC)	3	Ohio River
Hybrid Technology: Treatment w/In-line Storage (RTC)	1	Ohio River
In-Line Storage	1	Beargrass Creek South Fork
Miscellaneous Technology: Beargrass Creek Parallel Interceptors – Upper and Lower Reaches	1	NA
TOTAL	**23**	

Please note the four additional projects are described in detail at the end of this Section. The following sub-sections are descriptions of the project technologies.

Pump Station Expansion

This project is associated with CSO018. The project scope is to replace the aging 37-mgd Nightingale Pump Station flow diversion facility on Beargrass Creek South Fork. Currently, partial flow is diverted from this sewershed into the Ohio River sewershed. This Final CSO LTCP proposes construction of a new 60-mgd pump station that will achieve improvement in the following CSS operating conditions:

- Diversion of flow (including wet weather flow under model design rainfall) at this point to the Ohio River sewershed, which provides increased downstream capacity in the Beargrass Interceptor. The increased capacity in the Beargrass Interceptor results in reduction of the sizing of four CSO off-line storage facilities further downstream in the Beargrass Creek South Fork sewershed.

- Diversion of an increased volume of combined sewage at this location also off-loads the Ohio River Interceptor, and ultimately the receiving treatment facility, Morris Forman Water Quality Treatment Center (WQTC), a critical element in CSS operation once the new off-line storage facilities are constructed and placed in service.
- Ultimately, flow diverted at this point will be transported through the Upper Dry Run Trunk to the Southwestern Outfall with the overflow from the Southwestern Outfall diverted to a new proposed treatment facility, where equivalent primary treatment will be processed and discharged to the Ohio River.

Sewer Separation

A total of six sewer separation projects are recommended at CSO058, CSO093, CSO123, CSO140, CSO160 and CSO206. All projects except CSO123 and CSO206 are designed to provide new stormwater collection piping; transferring existing catch basins and/or constructing new catch basins; and disconnect downspouts where feasible. The existing combined pipes will be converted to carry only sanitary flow. The separation projects at CSO123 and CSO206 are a continuation of sewer separation projects partially complete.

Off-Line Storage

A total of ten off-line storage projects, ranging from 0.01 MG to 14.5 MG, are recommended. The control types for these storage projects include outfall specific controls at CSO020, CSO130, CSO154, CSO172 and CSO190; localized consolidation of CSOs at CSO083, CSO092, CSO097, CSO127 and CSO155. In total, 83 CSOs are being managed with these projects.

These ten off-line storage projects, all below-grade, covered concrete tanks, store a total of 50 MG of combined sewage and are, distributed across the associated receiving streams:

- Ohio River 16 MG
- Beargrass Creek Muddy Fork 6.5 MG
- Beargrass Creek Middle Fork 2.8 MG
- Beargrass Creek South Fork 24.7 MG

System pump-back operation into the Morris Forman WQTC tributary CSS was conceptually designed for 24-hour pump out of the tanks; however, final design can configure pumping units for a variety of return scenarios. It is envisioned that an integrated control system will manage the storage basin pump-back operations, coordinating interceptor capacities and capacity at

Morris Forman WQTC. If necessary, odor control facilities can be incorporated into final design should septic odor generation be a concern of facility operation.

Hybrid Technology: Off-Line Storage with In-line Storage (RTC)

Three hybrid technologies are recommended at CSO019, CSO105 and CSO211 that discharge into the Ohio River. These three off-line storage facilities, two below-grade covered concrete tanks, and one at-grade concrete tank, plus their respective in-line storage control gates and dams can store up to 43 MG of combined sewage, allocated as follows:

- Off-line Storage 16.3 MG
- In-line Storage (RTC) 26.7 MG

Hybrid Technology: Treatment with In-Line Storage (RTC)

The hybrid technology treatment with In-line storage (RTC) is recommended at CSO015 and CSO191, on the common outfall that discharges into the Ohio River. The proposed treatment process is equivalent primary treatment utilizing a retention treatment basin. Effluent water quality produced by this technology is discussed in Chapter 3 Section 3.3. Operation of the treatment plant is specific to wet weather events only (that is, only for an established volume of CSO into the Southwestern Outfall to warrant plant startup). The facility will be located adjacent to the Southwestern Outfall near the Paddy's Run Flood Pump Station. Siting at this location allows storage to be maximized in the 18'-4" x 27'-6" pipe, utilizing RTC. Hydraulic calculations show unused storage potential to be 9.6 MG. The minimum treatment rate is 0.5 mgd. Model results predict, on average, there will be 11 storm events annually that require treatment of CSO.

Operation of this facility envisions plant start-up at the beginning of the defined wet weather event. Through variable speed pumping, the plant is filled and placed into operation as the precipitation occurs. From hydrographs, it is determined that at the design treatment rate of 50 MGD, 9.6 MG will be stored (shaving the peak rate), with the stored volume treated as the storm recedes. Since the RTC flow control elements can cause CSO volume from smaller storms to be captured in the Southwestern Outfall, a smaller 0.5 MG pump station is also included for pump-back to the CSS as capacity becomes available. Other pump-back to the CSS includes solids accumulated in the retention treatment basin sedimentation tank.

As noted in Section 4.1, integration of these recommended CSO controls reduces CSO discharge from a 2008 modeled baseline of 2,833 MG AAOV to a predicted 2020 performance level of 425 MG AAOV. The reductions of CSO discharge is presented in more detail in Section 4.4.1.

In-Line Storage

During the optimization process of the CSS it was determined that by making modifications to a control dam at CSO108, that associated overflow frequency would be reduced to less than four events per year. Thus a new project was created, anticipating installation of a bending weir at this location to raise the elevation by one foot. The CSS at this location has sufficient unused capacity to store the necessary volume within the collection system.

Conveyance Technology: Beargrass Creek Parallel Interceptor

Also during the optimization process of the CSS, it was determined that additional interceptor capacity would be needed for pump-back of combined sewage stored in basins recommended to be constructed along Beargrass Creek South Fork. A new gravity interceptor parallel to the existing Beargrass Interceptor is recommended in the lower reach, constructed from the proposed Logan and Breckenridge Streets Storage Basin to Starkey Pumping Plant to allow pump-back within 48 hours to minimize odor potential in this densely urban corridor. Eventually, this combined sewage is conveyed to Morris Forman WQTC for treatment prior to discharge to the Ohio River.

In addition, a new force main parallel to the existing Beargrass Interceptor is recommended in the upper reach. The force main will be constructed from the Calvary-Creekside Storage Basin to the upgraded Nightingale Pump Station to divert a portion of the pumped-back CSO from the Beargrass Creek watershed to the Ohio River watershed to further offload the Interceptor and accelerate the ability to return of stored CSO to the CSS.

Table 4.1.5 summarizes the 23 final recommended gray infrastructure projects.

TABLE 4.1.5
FINAL RECOMMENDED GRAY INFRASTRUCTURE PROJECT LIST

Project Name and Project ID	Watershed	CSOs Controlled	Technology	Storage Volume or Treatment/Pumping Rate	Capital Cost (2008 Dollars)	Completion Date
CSO108 Dam Modification L_SO_MF_108_S_09A	South Fork	CSO108	In-Line Storage	NA	$150,000	12/31/2010
CSO123 Downspout Disconnection L_MI_MF_123_S_08	Middle Fork	CSO123	Sewer Separation	NA	$315,000	12/31/2012
Adams Street Storage Basin L_OR_MF_172_S_09B	Ohio River	CSO172	Off-Line Storage	0.12 MG	$983,000	12/31/2012
Story Avenue and Main Street Storage Basin L_OR_MF_020_S_09B	Ohio River	CSO020	Off-Line Storage	0.13 MG	$1,580,000	12/31/2013
CSO206 Sewer Separation L_MI_MF_206_S_08	Middle Fork	CSO206	Sewer Separation	NA	$3,842,000	12/31/2013
Paddy's Run Wet Weather Treatment Facility L_OR_MF_015_M_13	Ohio River	CSO015, CSO191	Treatment with RTC	50 mgd	$24,940,000	12/31/2014
I-64 and Grinstead Drive Storage Basin L_MI_MF_127_M 09B	Middle Fork	CSO127, CSO125, CSO126, CSO166	Off-Line Storage	2.74 MG	$12,950,000	12/31/2014
CSO058 Sewer Separation L_OR_MF_058_S_08	Ohio River	CSO058	Sewer Separation	N/A	$1,361,000	12/31/2014
CSO140 Sewer Separation L_MI_MF_140_S_08	Middle Fork	CSO140	Sewer Separation	N/A	$3,150,000	12/31/2015
CSO093 Sewer Separation L_SO_MF_093_S_08	South Fork	CSO093	Sewer Separation	N/A	$952,000	12/31/2015
CSO160 Sewer Separation L_OR_MF_160_S_08	Ohio River	CSO160	Sewer Separation	N/A	$237,000	12/31/2015
Nightingale Pump Station Replacement L_SO_MF_018_S_03	South Fork	CSO018	Pump Station Expansion	60 mg	$15,710,000	12/31/2016

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

CSO Data Outdated

Refer to Chapter 5

TABLE 4.1.5
FINAL RECOMMENDED GRAY INFRASTRUCTURE PROJECT LIST

Project Name and Project ID	Watershed	CSOs Controlled	Technology	Storage Volume or Treatment/Pumping Rate	Capital Cost (2008 Dollars)	Completion Date
Story Avenue and Spring Street Storage Basin L_SO_MF_130_S_09B	South Fork	CSO130	Off-Line Storage	0.01 MG	$1,077,000	12/31/2016
Logan Street and Breckinridge Street Storage Basin L_SO_MF_092_M_09B	South Fork	CSO 113, CSO152, CSO091, CSO146, , CSO149, CSO117, and 11 Sneads Branch Relief Sewer CSOs	Off-Line Storage	11.83 MG	$30,320,000	12/31/2017
Calvary - Creekside Storage Basin L_SO_MF_097_M_09B	South Fork	CSO097, CSO106, CSO110, CSO137, CSO148, and CSO151	Off-Line Storage	3.46 MG	$13,720,000	12/31/2017
18th and Northwestern Pky. Storage Basin L_OR_MF_190_S_09B	Ohio River	CSO190	Off-Line Storage	1.31 MG	$4,514,000	12/31/2017
Beargrass Creek Parallel Interceptor – Lower and Upper Reaches L_SO_MF_097_M_13	South Fork	Lower Reach: Logan Street and Breckenridge Street Storage Basin to Starkey Pumping Plant Upper Reach: Calvary-Creekside Storage Basin to Nightingale Pump Station	Conveyance	NA	$12,994,000	12/31/2017
Clifton Heights Storage Basin L_MU_MF_154_M_09B	Muddy Fork	CSO154, CSO132 and CSO167	Off-Line Storage	6.55 MG	$13,870,000	12/31/2018
Algonquin Parkway Storage Basin L_OR_MF_211_M_13	Ohio River	CSO211, CSO016, and CSO210	Off-Line Storage with RTC	4.84 MG	$17,300,000	12/31/2018
Southwestern Parkway Storage Basin L_OR_MF_105_M_13	Ohio River	CSO105, CSO104, and CSO189	Off-Line Storage with RTC	5.08 MG	$17,620,000	12/31/2018

CSO Data Outdated

Refer to Chapter 5

TABLE 4.1.5
FINAL RECOMMENDED GRAY INFRASTRUCTURE PROJECT LIST

Project Name and Project ID	Watershed	CSOs Controlled	Technology	Storage Volume or Treatment/Pumping Rate	Capital Cost (2008 Dollars)	Completion Date
Portland Wharf Storage Basin L_OR_MF_019_S_13	Ohio River	CSO019	Off-Line Storage with RTC	6.37 MG	$20,000,000	12/31/2019
13th Street and Rowan Street Storage Basin L_OR_MF_155_M_09B	Ohio River	CSO155, CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO156, CSO208, and Central Relief Drain (CRD)	Off-Line Storage	14.44 MG	$49,680,000	12/31/2020
Lexington Road and Payne Street Storage Basin L_SO_MF_083_M_09B	South Fork	CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153 & CSO082	Off-Line Storage	7.31 MG	$25,200,000	12/31/2020

4.1.2.3 Flood Pump Station Modifications Projects

Table 4.1.6 summarizes the five flood pump station physical modification projects. These projects were developed in response to the provision under the Consent Decree; MSD is required to provide for the following outcomes:

- Paragraph 25b. (2) A. (i) - "The final Long-Term Control Plan shall meet the following goals: Ensure that if CSOs occur, they are only as a result of wet weather (this goal shall include addressing those discharges resulting from MSD's compliance with the requirements of the USACE' Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988);"
- Paragraph 25b, (2) B. (i) - "The final Long-Term Control Plan shall include, at a minimum, the following elements: The results of characterization, monitoring, modeling activities and design parameters as the basis for selection and design of effective CSO controls (including controls to address those discharges resulting from MSD's compliance with the requirements of the USACE's Ohio River Flood Protection System Pumping Operations Manual, dated 1954 and revised 1988);"

Pursuant to this requirement of the Consent Decree, the flood pump station projects identified in Table 4.1.6 are a component of the selected plan and were not subject to the cost benefit analysis.

Flood pump station projects have been identified for the following facilities:

- 27th Street Flood Pump Station
- 34th Street Flood Pump Station
- Shawnee Flood Pump Station
- 4th Street Flood Pump Station
- 17th Street Flood Pump Station

To implement these projects the following actions will need to occur:

- Develop plans and specifications for each of the identified projects.
- Prepare revisions to the USACE Manual that reflects the operational and physical modifications proposed in the USACE Flood Pump Station Operation Modification Technical Memorandum (See Appendix 2.3.1).

- Secure review and approval by the USACE. Coordination with, and approval by the USACE will be required prior to any modifications being made to the congressionally authorized flood protection works for Louisville, Kentucky. The implementation schedule includes two nine-month review periods per project for USACE review of the conceptual plans and proposed Manual revisions and the final plans and specifications. Delays in USACE approval and responses beyond this time estimate could impact scheduled completion dates, as detailed in Table 4.1.6.

TABLE 4.1.6
FINAL RECOMMENDED FLOOD PUMP STATION PROJECT LIST

Project Name	Watershed	CSO Controlled	Technology	Size (MG)	Capital Cost (2008 Dollars)	Completion Date
34th Street Flood Pump Station L_OR_MF_019_S_03_A_B	Ohio River	CSO019	Flow Control	N/A	$541,000	12/31/2012
4th Street Flood Pump Station L_OR_MF_022_S_03_A_A	Ohio River	CSO022, CSO023	Flow Control	N/A	$944,000	12/31/2012
27th Street Flood Pump Station L_OR_MF_019_S_03_A_A	Ohio River	CSO019	Flow Control	N/A	$476,000	06/30/2013
Shawnee Flood Pump Station L_OR_MF_189_S_03_A_A	Ohio River	CSO104, CSO105, CSO189	Flow Control	N/A	$411,000	06/30/2013
17th Street Flood Pump Station L_OR_MF_190_S_03_A_A	Ohio River	CSO190	Flow Control	N/A	$625,000	12/31/2014

4.1.3 Knee of the Curve Evaluation

An accepted method for evaluating alternatives is by constructing cost/performance curves. The evaluation can be done either by comparing similar alternatives over a range of designs (that is, a storage basin for a range of percent overflow reductions) or by comparing a range of control alternatives for a given design condition (that is, storage basin, treatment facility and sewer separation for a specific design condition). These curves, or comparisons, typically indicate that for lower levels of control, small increments of increased cost (investment) result in large increments of improved performance. As well, for higher levels of control, large increments of increased cost results in small increments of improved performance. Collectively, these points on the curve make up the cost/performance curve. The optimal point or "knee of the curve" is identified as the point where the incremental change in cost per increment of performance changes the most rapidly indicating that the slope of the curve is changing from shallow to steep or vice versa.

The knee of the curve analysis was used extensively to validate the level of control selected through the benefit-cost project size optimization analysis described in Chapter 3. Optimal points or knees of the curve were developed for many program performance factors. Each indicates that the recommended CSO LTCP level of control is supported by the knee of the curve analysis.

MSD utilized the Ohio River Water Quality Model and the Beargrass Creek Water Quality Tool (WQT) to calculate fecal coliform concentrations in the Kentucky side of the Ohio River and the three forks of the Beargrass Creek for various control scenarios using the typical rainfall. The CSS model was utilized to calculate the CSO wet weather percent capture for the preferred suite of projects using the typical rainfall. MSD also used the Project Cost Estimating Document discussed in Chapter 3 to calculate system-wide program planning-level capital costs for the preferred suite of projects corresponding to CSO level of control of zero, two, four, and eight overflows per year.

The graphs of this data, including water quality corresponding to baseline (no CSO controls) condition are shown in Figures 4.1.1 – 4.1.7 for each of the following:

- CSO Wet Weather Percent Capture vs. Capital Cost (Entire System)
- Fecal Coliform Peak vs. Percent Capture (Ohio River)
- Peak Fecal Coliform vs. Capital Cost (Ohio River)
- Monthly Maximum Non-Compliance - Recreation Season vs. Percent Capture (Ohio River)
- Fecal Coliform vs. Percent Capture (Beargrass Creek)
- Fecal Coliform Peak vs. Capital Cost (Beargrass Creek)
- Fecal Coliform Geometric Mean vs. Capital Cost (Beargrass Creek)

The results shown in these curves are presented for the Ohio River near shore segment just downstream of the Morris Forman WQTC and the mouth of Beargrass Creek where it enters the Ohio River.

FIGURE 4.1.1 CSO WET WEATHER PERCENT CAPTURE VS. CAPITAL COST (ENTIRE SYSTEM)

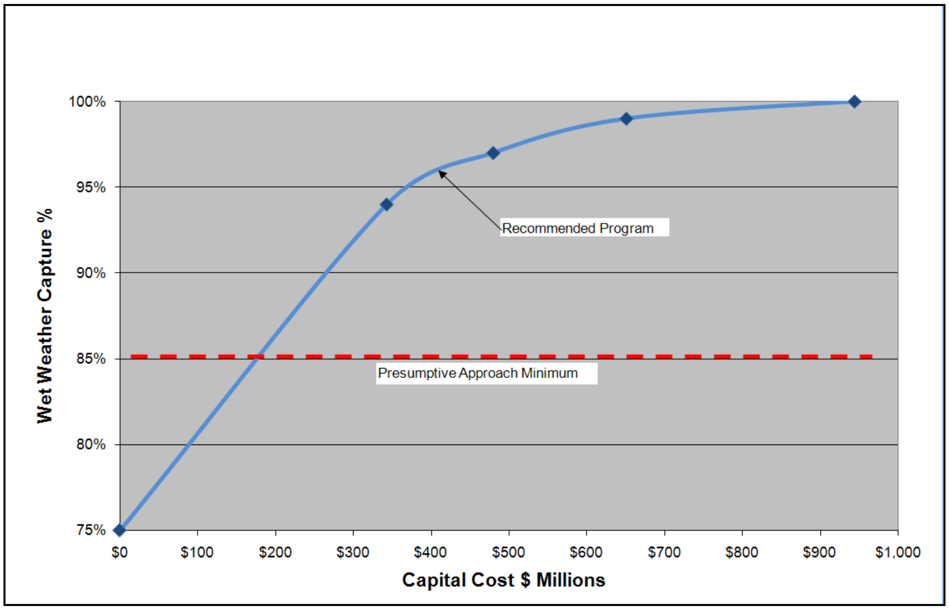


FIGURE 4.1.2 FECAL COLIFORM PEAK VS. PERCENT CAPTURE (OHIO RIVER)

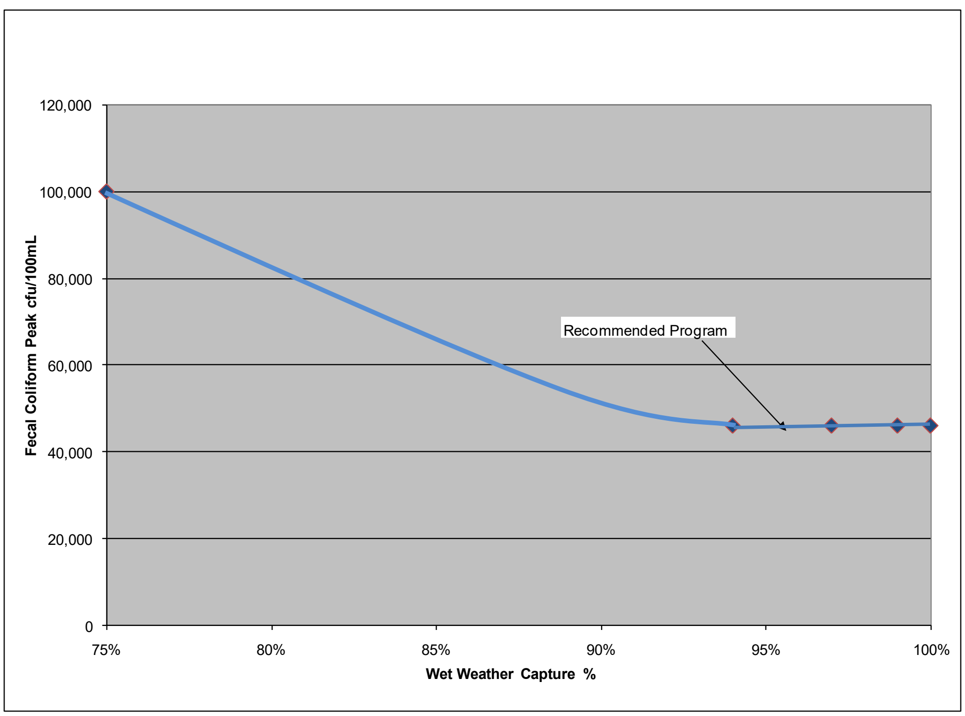


FIGURE.4.1.3 PEAK FECAL COLIFORM VS. CAPITAL COST (OHIO RIVER)

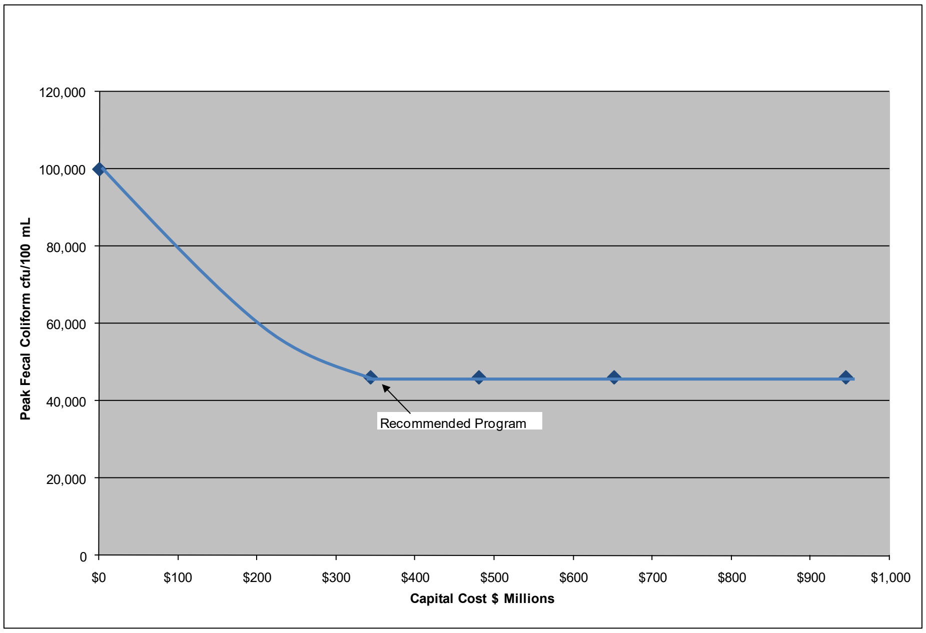


FIGURE 4.1.4 MONTHLY MAX. NON-COMPLIANCE-RECREATION SEASON VS. PERCENT CAPTURE (OHIO RIVER)

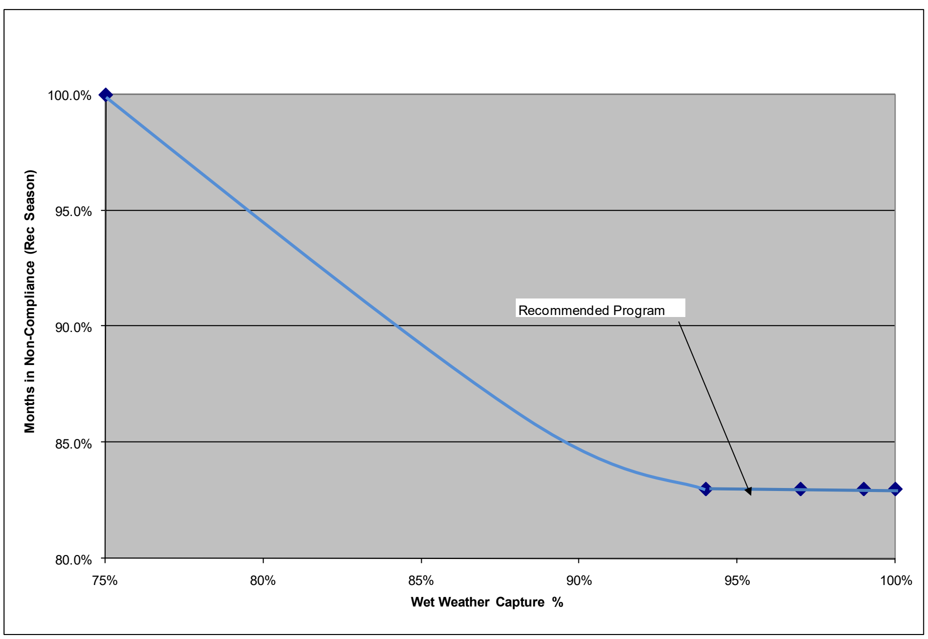


FIGURE 4.1.5 FECAL COLIFORM VS. PERCENT CAPTURE (BEARGRASS CREEK)

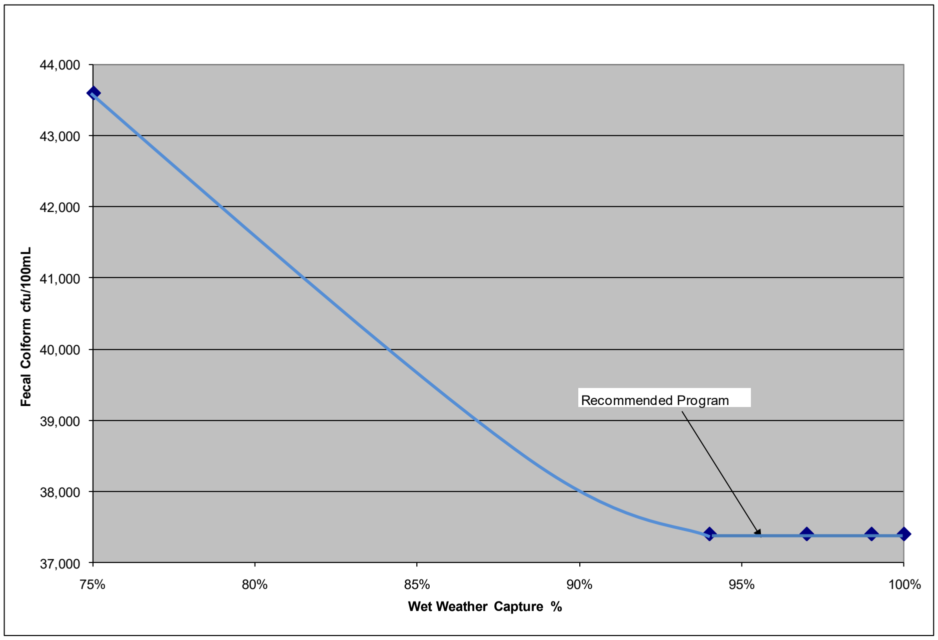


FIGURE 4.1.6 FECAL COLIFORM PEAK VS. CAPITAL COST (BEARGRASS CREEK)

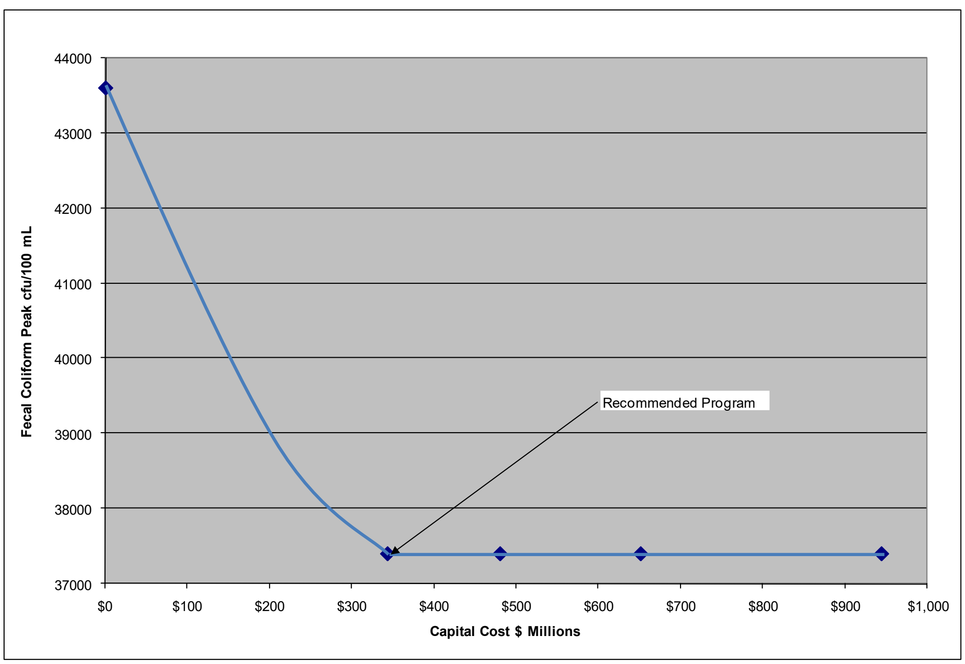
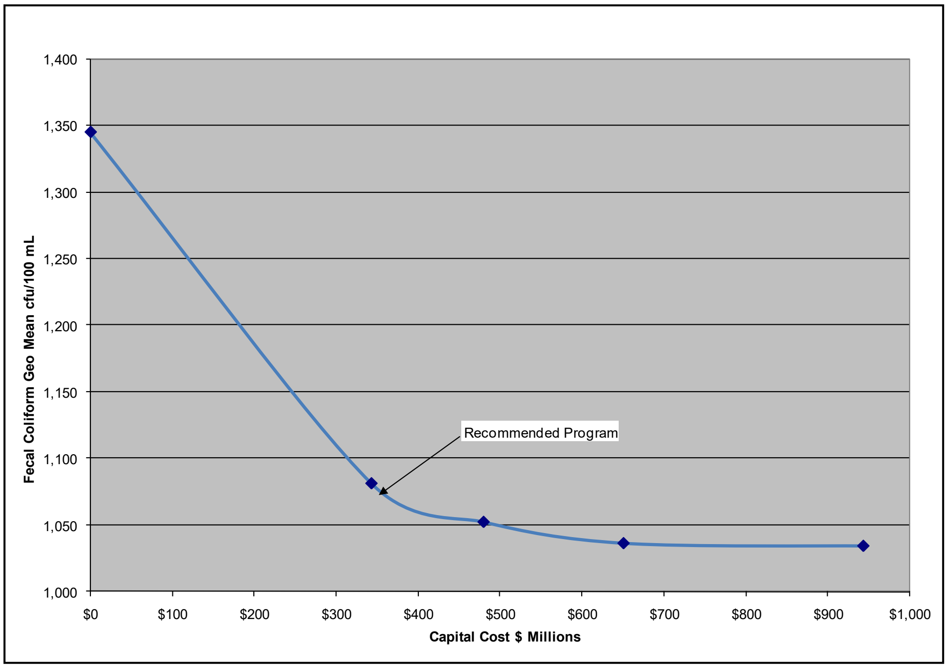


FIGURE 4.1.7 FECAL COLIFORM GEOMETRIC MEAN VS. CAPITAL COST (BEARGRASS CREEK)



4.1.4 Prioritization of Projects

The Ecological Reach Characterization Study presented in Chapter 2 Section 2.8 developed ecological ratings for each stream reach for each fork of Beargrass Creek. As detailed in the Ecological Reach Characterization Study, a stream reach is defined as the length between existing CSO discharge points.

In order to use the stream reach ratings for prioritizing the Final CSO LTCP projects, the ratings were re-compiled to include the collective ratings of all reaches contained within the project area. These re-compiled ratings were applied to finalize an implementation schedule for the Final CSO LTCP. Some minor reordering of the implementation schedule was performed to normalize cash flow.

Table 4.1.7 Ecological Reach Prioritization for the Final CSO LTCP presents the compiled stream reach rating along with the schedule for completion of construction for each of the Final CSO LTCP projects located in the Beargrass Creek watershed. Figure 4.1.8, Stream Reach Priority with Associated Projects Ecological Ranking, located at the end of the chapter, graphically presents the Beargrass Creek CSO control projects priority ranking overlaid against the stream reach priority ranking. This figure demonstrates how each project's priority compares against stream reach priority. Figure 4.1.9, the Final CSO LTCP schedule indicates good correlation between project ecological value versus the stream segment ecological improvement potential.

TABLE 4.1.7
ECOLOGICAL REACH PRIORITIZATION FOR THE FINAL LTCP

Project ID	Construction Completion	CSO	Reach ID	Individual Reach Rating	Score	Composite Ranking	Comment
L_SO_MF_108_S_09B_B_A_4	2010	CSO108	S108	Highest	101		Scheduled per score and quick implementation (bending weir).
				SCORE	**101**	**High**	
L_MI_MF_206_S_08_A_A_0	2013	CSO206	M206	Highest	110		Scheduled per score and length of program (public/private separation program).
				SCORE	**110**	**High**	
L_MI_MF_127_M_09B_B_A_8	2014	CSO127	MI127	Medium	79		Middle Fork natural stream, good ecological improvement potential.
	2014	CSO126	MI126	High / Medium	82		
	2014	CSO125	MI125	Medium	76		
	2014	CSO166	MI166	Medium	79		
				SCORE	**79**	**Medium**	
L_SO_MF_093_S_08_A_A_0	2015	CSO093	S093	Medium	70		Scheduled for the opportunity to eliminate CSO (Sewer Separation).
				SCORE	**70**	**Medium**	
L_MI_MF_140_S_08_A_A_0	2015	CSO140	MI140	Medium	57		Scheduled for the opportunity to eliminate CSO (Sewer Separation).
				SCORE	**57**	**Medium**	
L_SO_MF_130_S_09B_B_A_8	2016	CSO130	S130	Medium	64		Scheduled per score
				SCORE	**64**	**Medium**	
L_SO_MF_097_M_09B_B_D_8	2017	CSO151	S151	Medium / Low	37		3 of 6 CSOs currently discharge into stream, approximately 1/4 mile upstream of improved channel; short reach ecological improvement potential.
	2017	CSO106	S106	High / Medium	89		
	2017	CSO137	S137	High / Medium	94		
	2017	CSO110	S110	Lowest	36		
	2017	CSO111148	S111/148	Medium / Low	39		
	2017	CSO097	S097	High / Medium	93		
				SCORE	**65**	**Medium**	
L_SO_MF_092_M_09B_B_D_8	2017	CSO117	S117/149/179	Lowest	30		Scheduled per score/Improved Channel.
	2017	SBR	S142	Lowest	33		
	2017	CSO146147	S146/147	Lowest	23		
	2017	CSO091	S091	Medium / Low	43		
	2017	CSO092	S092	Medium / Low	41		
	2017	CSO152	S152	Lowest	36		
	2017	CSO113	S113	Medium / Low	37		
				SCORE	**35**	**Lowest**	
L_MU_MF_154_M_09B_B_A_8	2018	CSO154	MU132/154/167	Medium / Low	44		Muddy Fork habitat poor, as a result of Ohio River backwater influence.
				SCORE	**44**	**Medium / Low**	

Project ID	Construction Completion	CSO	Reach ID	Individual Reach Rating	Score	Composite Ranking	Comment
L_SO_MF_083_M_09B_B_A_8	2020	CSO082	S082	Lowest	32		Scheduled per score/Improved Channel.
	2020	CSO153	S153	Lowest	32		
	2020	CSO121	S121	Lowest	31		
	2020	CSO141	S141	Lowest	32		
	2020	CSO120	S120	Lowest	26		
	2020	CSO084	S084	Lowest	27		
	2020	CSO119	S119	Lowest	33		
	2020	CSO083118	S083/118	Lowest	21		
				SCORE	**29**	**Lowest**	
	LEGEND						
	Range:	**95-130**	Highest Priority				
		80-94	High / Medium Priority				
		46-79	Medium Priority				
		37-45	Medium / Low Priority				
		13-36	Lowest Priority				

4.1.5 Implementation Schedule to Comply with Consent Decree Requirements

The Consent Decree requires that the Final CSO LTCP program be completed as soon as practical but no later than December 31, 2020. A schedule and timetable for completion of the Final CSO LTCP program is presented in Figure 4.1.9 at the end of the chapter.

Project Fact Sheets and Maps for Green Infrastructure Demonstration Projects, Gray Infrastructure Projects, and Flood Pump Station Projects detailing project specifics are at the end of this chapter. Each fact sheet includes a project description for the abatement solution, associated capital cost and benefit-to-cost ratio, and focuses on CSOs addressed by the project solution. Detailed project maps for each of the Final CSO LTCP projects specify project location and type of solutions.

Final Recommended Project Cost Estimates, Benefits, and Ground Truthing documents are located in Appendices 4.1.2, 4.1.3, and 4.1.4 respectively.

4.2 PUBLIC PARTICIPATION

As defined by the EPA CSO LTCP Guidance, the development of the CSO LTCP should involve citizens in the development of alternatives solutions to protect local waterways and to consider the financial impacts to the community. Additionally, the Consent Decree requires that a public participation process be incorporated into the plan. This section recaps the public involvement process throughout the development of the Final CSO LTCP.

Early in the IOAP development stage, MSD specifically engaged the WWT, comprised of community stakeholders and the technical team, to develop the overall program for an IOAP that takes into account community values. The interactive process, with the essential engagement of the WWT Stakeholder Group, was critical because not only did it improve the Final CSO LTCP, but it also clarified values and performance measures used to guide investment and infrastructure choices.

A review of the steps of the values-based decision making process is as follows:

- WWT stakeholders defined values and relative weights for the values;
- The technical team developed draft performance measures and scales based on the "focus areas" or objectives WWT stakeholders identified for the values;
- WWT stakeholders reviewed and helped refine the performance measurement scales;
- The technical team used the performance scales to evaluate alternatives; and
- WWT stakeholders reviewed the results and refined scoring considerations.

During the course of 22 Stakeholder Group meetings, numerous ideas for specific education programs and potential overflow abatement solutions were identified. Records of the ideas were distributed to the technical team for consideration as the potential solutions were identified and evaluated.

Broad-based group of community stakeholders identified and prioritized values.

The work of the WWT was essential to define the goals and objectives of the IOAP infrastructure programs and the public program. With the goals and objectives in hand, the technical team conceptualized and prepared approaches for the broader public to review and provide comment at public meetings. MSD and the WWT believed it would be valuable to have frequent contact with the public to validate the guidance provided by the WWT Stakeholder Group. As a result, there were four rounds of public meetings; each at a specific phase of the planning process when decisions and selection of priorities was needed.

- The first two rounds of public meetings, held in the Spring and Fall of 2007, focused on defining the Project WIN (Waterway Improvements Now) purpose and preparing the public for what was to come in the future related to infrastructure and rate increases.
- The third round of public meetings, in the Spring of 2008, was specifically designed to give the public and impacted neighborhoods details of the types, locations, and size of facilities that were being considered. The purposes were to provide public notice that the facilities were under serious consideration; to engage the public in discussion about these facilities and the proposed schedule for construction; and to inform the public of the remaining steps of the process.
- The fourth round of public meetings, in November 2008 during the public comment period, was specifically designed to present to the public the IOAP program in a forum that allowed questions and answers with the public. The presentations included an overview of the program, including project lists, budgets, schedules, and potential rate impacts.

Lastly, the draft IOAP was distributed for public review 30 days before the public hearing was held December 2, 2008. The public notice was published in the local community newspaper *The Courier-Journal* announcing the availability of the draft plan, the public hearing date, time and location, and the deadline for the acceptance of comments on the plan. The deadline for accepting comments on the plan was 30 days after the notice of the plan availability.

In addition to the 2008 public meetings, a public hearing was held December 2, 2008. See Appendix 4.2.1 for a copy of the Public Notice. The purpose of the public hearing was to receive formal comments from the public about the content of the IOAP. Comments and questions received during the hearing were formally responded to in the Responsiveness Document included in Volume 1, Chapter 3. The Public Involvement component for both the 2009 approved IOAP and the 2012 Modification are discussed in full detail in Volume 1, Chapter 3.

4.3 ENVIRONMENTAL BENEFIT OF RECOMMENDED PROGRAM

Environmental benefits were a critical component of the performance measures used for selecting the recommended plan to reduce CSOs. No overflow control program will be acceptable to the community unless it meets appropriate environmental standards. This section focuses on determining and measuring the environmental benefits of the Final CSO LTCP.

Through the Stakeholder process, the WWT developed a list of project-specific values (in addition to programmatic values) determined to be important to the community.

FIVE VALUES

1. Asset Protection
2. Eco-friendly Solutions
3. Environmental Enhancement
4. Public Health
5. Regulatory Performance

Built upon these values, the benefit-cost analysis tool was used to score projects. This tool provided the means to track and rate the environmental benefits of each solution. The benefit-cost analysis tool also provided a list of criteria that could not be violated (fatal flaws) regardless of any cost advantage, such as constructed facilities that impair habitat for threatened or endangered species.

Environmental Benefits of the Final CSO LTCP, Table 4.3.1, provides an overview of how the program performs when measured with these five values.

TABLE 4.3.1
ENVIRONMENTAL BENEFITS OF THE FINAL CSO LTCP

Value		CSO LTCP Measure
Asset Protection	Eliminating or reducing basement back-ups and/or surface flooding	For sewer separation projects, the recurrence of surface flooding and basement backups will be reduced as the stormwater flow will be removed from the combined sewer system.
Eco-Friendly Solutions	Non-Renewable Energy Consumption	Use of eco-friendly solutions is maximized through the Green Infrastructure Program.
	Use of Natural Systems	The Green Infrastructure Program will address the use of natural systems.
	Multiple Use Facilities	Eco-friendly solutions will primarily focus on adding green space where none or little exists. Examples include covered concrete tanks where the cover can be green space; unless an existing facility exists that must be restored to original use.
	Source Control of sub- watershed pollutant loads	The Green Infrastructure Program will reduce stormwater runoff from impervious surfaces through various technologies such as green roofs, bioswales, etc.
	Non –Obtrusive Construction Techniques	Neighborhood impacts resulting from construction of final recommended projects on traffic, noise and dust were considered and will be minimized, working with neighborhood associations
	Consistent Land Use	Project features will be consistent with the area. Effort will be made to restore the top surface area of covered storage basins to be consistent with the area or replaced with community amenities.
	Impermeable Surfaces	The Green Infrastructure Program will include permeable pavement or other means to reduce imperviousness. For covered storage basins, an improved use on top of the basin will be pursued.
	Leadership in Energy and Environmental Design (LEED) Performance	LEED standards are applicable to alternatives that include above ground building structures. Opportunities for LEED certification in treatment plant and storage basin projects will be sought.
Environmental Enhancements	Aquatic and Terrestrial Habitat Protection	Final CSO LTCP projects will have minimal affect on both aquatic and terrestrial habitat through changes in base flow, peak flow, water quality, tree cover, channel shape, and characteristics, etc.
	Aesthetics - Solids and Floatables (S&F)	Most Final CSO LTCP projects will have some form of enhanced S&F control. Improvements in current capture rates can be expected with screening or other advanced treatment options
	Aesthetics - Odor and Air Emissions	Odors and air emissions were estimated and addressed as part of the project development. No increase in nuisance odors.
	Dissolved Oxygen Impacts	Dissolved oxygen deficiencies (less than 2 mg/l) in Beargrass Creek will improve marginally. The Final CSO LTCP will have no effect on dissolved oxygen levels in the Ohio River.
	Downstream Impacts	The Final CSO LTCP measures are calculated to reduce pollutant and bacteria loads, resulting in improved downstream water quality.
	Stream Flow Impacts (Peak Flows)	High peak flows within Beargrass Creek will be lowered as a portion of the flow during rain events will be stored in basins.
	Stream Flow Impacts (DWF only)	No project affects dry weather stream flow conditions.
Public Health	Potential for Human Contact with Suspected Disease-Causing Organisms	Fecal coliform bacteria counts are predicted to be decreased in Beargrass Creek and the Ohio River, and the number of overflow events that create the potential for human contact with raw sewage will be greatly reduced
Regulatory Performance	Untreated CSO AAOV and Frequency	1. Exceeded the criteria established within the EPA CSO Guidance of 85% capture of volume, to an increase in percent capture and treatment of volume by 96% system-wide 2. Reductions of CSS overflow occurrences from approximately 5,476 in 1993, to 2,246 in 2008 and to 91 upon completion of the Final CSO LTCP. All values calculated applying the 2001-year rainfall data.

4.4 MEASURES OF SUCCESS

Traditional measures of success, such as reduction of CSOs, reduction of CSO volume and meeting water quality criteria within Beargrass Creek and Ohio River, etc., are defined in EPA's Guidance Document for preparing LTCPs (EPA, 1995). Additionally, various environmental measures of success were defined as part of the WWT process. These environmental measures of success and how the Final CSO LTCP compares to these measures were presented in Section 4.3. The following sections describe the benefits of the Final CSO LTCP in terms of percent capture and reduction in overflow volume and water quality benefits to different portions of Beargrass Creek and the Ohio River.

4.4.1 Percent Capture and Reduction in Overflow Volume

The presumptive approach as defined by EPA Guidance Document is a level of control that meets a criterion of no more than four overflows per year, or elimination or capture of 85 percent by volume of the combined sewage collected by the CSS, or elimination or capture of 85 percent by mass load of pollutant. As presented in Chapter 3, the presumptive approach was applied to initially size control alternatives (at four overflows per year) for the CSOs. As shown in Table 4.4.1, the final recommended projects in conjunction with the application of the programmatic elements captures and treats 96 percent of the volume of combined sewage collected in the CSS during a defined wet weather period as analyzed using the typical year rainfall data. This 96 percent capture far exceeds the minimum volume capture (85 percent) defined by the presumptive approach requirements. Table 4.4.2 shows the breakdown of the percent capture and AAOV reduction by watershed. Additionally, Figure 4.4.1 shows the projected AAOV capture for various milestones of the program. Finally, Figure 4.4.2 shows the reduction for each receiving water at the beginning of the program and at the completion of the program.

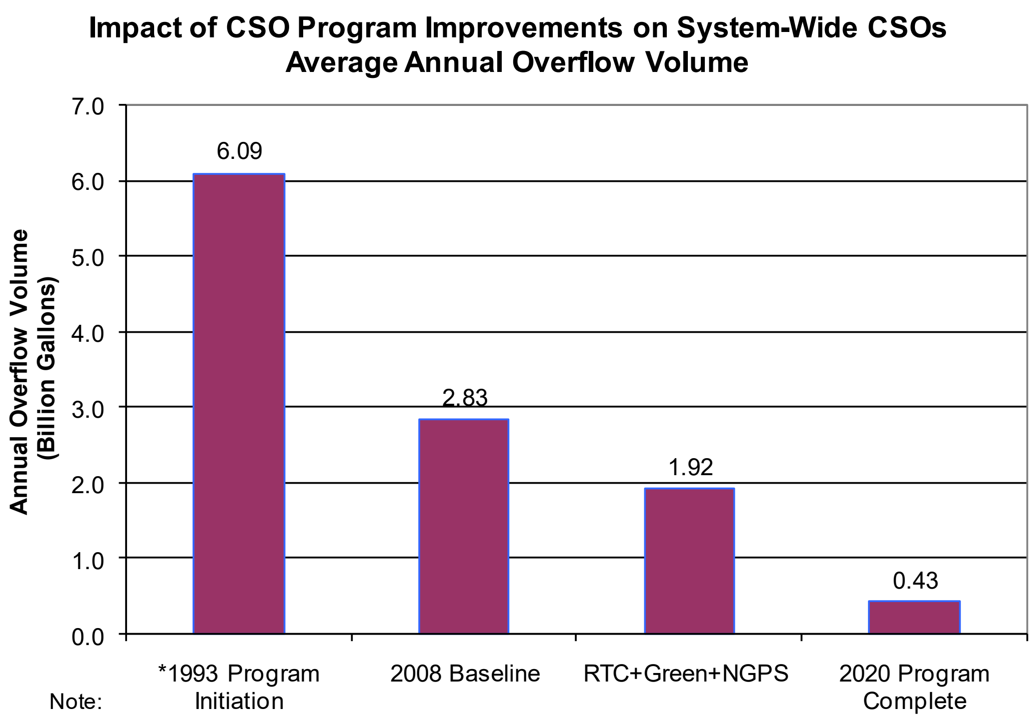
TABLE 4.4.1
CSS PERCENT CAPTURE

	No Additional Control (2008 Baseline)	Recommended Final CSO LTCP
Volume of combined sewage collected in the CSS during precipitation events (MG)	11,369	11,369
Volume of combined sewage captured or treated (MG)	8,536	10,944
% of volume captured or treated	**75%**	**96%**
Volume of remaining CSOs (MG)	2,833	425
% of CSO remaining	25%	4%

TABLE 4.4.2
CSS PERCENT CAPTURE BY WATERSHED

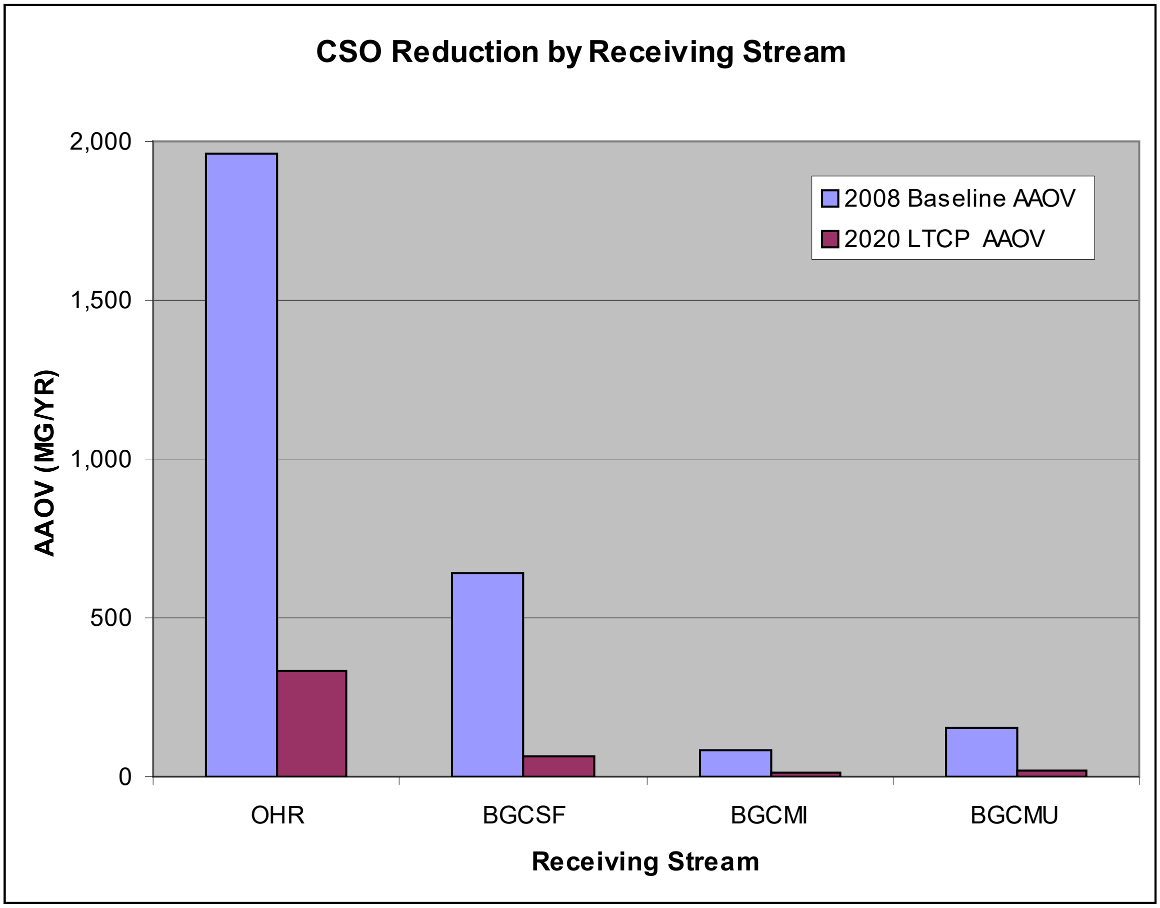
Watershed	2008 Baseline AAOV (MG/YR)	2008 Baseline Percent Capture	2020 LTCP AAOV (MG/YR)	2020 LTCP Percent Capture
Ohio River	1,941	77%	328	96%
BGCMI	81	80%	8	98%
BGCMU	153	54%	18	95%
BGCSO	658	65%	71	96%
Entire CSS	**2,833**	**75%**	**425**	**96%**

FIGURE 4.4.1 PROJECTED IMPACT OF CSO PROGRAM IMPROVEMENTS



Note:
1. 1993 AAOV from 1997 Draft LTCP Report (Using EPA SWMM model) using regression equations developed with 10 historical reference storms.
2. All the other AAOV predicted by InfoWorks CS ver 8.0
3. RTC+Green+NGPS- Value with the folloring controls in place: Real time Control, Green Infrastructure Program and Nightingale Pump Station Replacement

FIGURE 4.4.2 CSO REDUCTION BY RECEIVING STREAM



Legend: OHR – Ohio River; BGCSF - Beargrass Creek South Fork; BGCMI - Beargrass Creek Middle Fork, BGCMU – Beargrass Creek Muddy Fork

The success of this Final CSO LTCP, in meeting the Consent Decree compliance requirements will be measured incrementally as the plan is implemented and upon completion in December 2020:

- The performance of the green demonstration projects and comprehensive Green Infrastructure Program will be measured to determine if source reduction goals are being achieved. As the first set of green infrastructure demonstration projects is built, the controls will be monitored and data on the effectiveness in reducing stormwater runoff will be generated and analyzed.

  Since engineering design of gray infrastructure projects will parallel reporting of green performance, any impact to gray solutions performance requirements will be integrated, including design characteristics to incorporate future modifications or retrofits. MSD will use the schedule developed for the design and construction of gray projects to assist in targeting the location selection for green projects in an attempt to implement and monitor efficacy of green projects before implementing gray projects. When possible, green projects will be constructed and system monitoring data collected before gray infrastructure projects move into the final design phase. After the green monitoring results have been analyzed, a sizing evaluation, using the CSS hydraulic model, will be performed to determine the efficacy of green controls (or system changes) that have taken place since the original sizing of the gray control. The gray projects will be sized to provide the committed level of protection based upon this analysis.

- The performance evaluation of both green technologies and gray technologies will be an on-going process under the Post Construction Compliance Monitoring program. If the result of the green controls performance proves to be ineffective for a particular basin, then MSD will ensure that the design of the gray project reflects the size needed to achieve the necessary level of control. MSD will downsize the gray project if the green controls prove to be more cost-effective for a particular basin.
- As performance metrics are established and data collected, any modifications to the Final CSO LTCP will be executed through adaptive management techniques to modify controls as necessary to bring operation of the CSS into compliance with the CWA and CSO Control Policy requirements, and the Consent Decree.

Future conditions may require a higher level of CSO control than is provided for in this Final CSO LTCP. Higher levels of control may be obtained through expansion of existing controls (where space allows), addition of facilities such as supplemental storage in other locations, or retrofitting modifications to existing facilities (such as making process additions, for example coagulant addition and disinfection to convert storage basins to discharging equivalent primary treatment under some flow conditions). Other opportunities to modify the level of CSO controls may include enhancement or expansion of the Green Infrastructure Program should monitoring indicate cost-effective source runoff reduction.

4.4.2 Beargrass Creek Water Quality Benefit

Beargrass Creek is an urban stream with a diverse watershed. Wet weather discharges from CSOs have significant impacts on the stream's water quality, as measured from monitoring results and modeling with the Beargrass Creek Water Quality Tool (WQT). The IOAP will significantly improve water quality in Beargrass Creek. The modeling simulation from the WQT predicts that CSOs alone would cause exceedances of the fecal coliform criteria less than two percent of the time, if other sources of bacteria (stormwater and groundwater) could be controlled.

The CSS has a profound effect on the hydrology and water quality of the Beargrass Creek watershed and stream. Runoff that previously infiltrated into the soils and flowed more slowly through surface waterways is now collected in the combined sewers and transported out of the basin for many storm events, with some portion reaching the stream when the sewers overflow.

The results of this major redirection of runoff are:

- Reduced groundwater recharge because of reduced infiltration into the soil, resulting in lower dry weather or base flow rates;
- Reduced volume of runoff reaching Beargrass Creek, also lowering stream base flow;
- Increased runoff flow rates during wet weather because the sewer system routes flow quickly and directly to the stream, resulting in high peak flows; and
- Increased pollutant loads (biological, chemical, and physical) from lack of runoff pollutant removal and mixing with sanitary sewage.

4.4.2.1 Hydrologic Effects

One hydrologic effect of the CSS is the increase in peak flows because watershed runoff is rapidly delivered to the stream by the CSO and stormwater outfalls. These discharges can cause several problems including erosion, damage to the aquatic habitat in the stream, and recreational use impacts. The proposed Final CSO LTCP reduces the CSO discharge amounts and frequencies and therefore the effects of higher peak flow rates during wet weather. At the same time, the Green Infrastructure Program increases the amount of stormwater that infiltrates into the groundwater. Much of this shallow groundwater will eventually discharge into the surface water, increasing base flows and positively impacting water quality in a number of ways.

Another hydrologic change related to CSS is the reduced base flow in Beargrass Creek during dry weather. The Final CSO LTCP includes sewer separation projects, which will route more runoff water to Beargrass Creek, water that currently is routed out of the basin in the combined sewer.

4.4.2.2 Dissolved Oxygen

Biochemical oxygen demand and nutrients in CSO and stormwater discharges may reduce in-stream dissolved oxygen below the water quality criteria. The Kentucky Department of Environmental Protection (KDEP) has developed a Total Maximum Daily Load (TMDL) that identifies large reductions needed in pollutant loads from multiple sources.

CSOs affect the in-stream dissolved oxygen concentration in Beargrass Creek in several ways. During discharge, the CSOs can add oxygen-depleted water to the stream, potentially reducing in-stream dissolved oxygen levels. Following a discharge event, the oxygen-demanding pollutants released by the CSO will consume dissolved oxygen as the pollutants decompose. The pollutants also accumulate in the lower stream reaches where flow velocities are lower due to Ohio River backwater effects. Dissolved oxygen problems in these backwater areas are therefore more significant than other areas of Beargrass Creek. As the accumulated pollutants in the sediments decay over time, a demand on dissolved oxygen is exerted (i.e., sediment oxygen demand). This demand can lower dissolved oxygen for days or weeks during periods of low flow. CSOs can also contribute nutrients to the stream that may increase algal populations, leading to high dissolved oxygen levels during the day (due to photosynthesis) and low dissolved oxygen levels at night (due to algal respiration).

Immediate impacts of CSOs are believed to be small due to reaeration and dilution with high stream flows, and field monitoring staff have communicated that in-stream dissolved oxygen during discharge events is not always depressed. However, flow from CSOs can start prior to the arrival of the flood wave from the upstream watershed, so short-lived impacts may occur at the beginning of CSO events. Overall, the Final CSO LTCP reduces the amount and frequency of CSOs and as a result should improve compliance with the dissolved oxygen criteria in Beargrass Creek.

4.4.2.3 Fecal Coliform

CSOs, SSOs, and stormwater may cause large increases in the in-stream concentration of fecal coliform bacteria that is an indicator of pathogenic organisms and the basis of the water quality criteria for recreational use. Even after a wet weather event, sediment in the stream can hold coliform bacteria that continue to grow and are re-suspended in the water column by animal or human activity or in the next high flow event. The proposed Final CSO LTCP reduces the number and amount of CSOs and, therefore, the fecal coliform load to Beargrass Creek.

Table 4.4.3 shows the percent noncompliance with the fecal coliform criteria during the "Typical Year" (represented by data from calendar year 2001) at selected locations in Beargrass Creek for three scenarios:

- The current conditions (baseline),
- Conditions after implementation of the proposed IOAP projects, and
- A scenario in which the IOAP projects are implemented and CSOs are the only source of fecal coliform (isolating their effects from other sources of bacteria such as stormwater and baseflow).

Table 4.4.3 demonstrates that sources other than CSOs provide most of the fecal coliform loadings to Beargrass Creek. Noncompliance percentages do not changes significantly from the "Baseline" condition to the "IOAP" condition. In contrast, the "IOAP (CSOs only)" condition shows full compliance with WQS if background loads are removed.

TABLE 4.4.3
PERCENT NONCOMPLIANCE WITH WATER QUALITY STANDARDS IN TYPICAL YEAR[1]

Station	Period	Geometric Mean Criterion			Instantaneous Maximum Criterion		
		Baseline (2001)	IOAP	IOAP (CSOs Only)	Baseline (2001)	IOAP	IOAP (CSOs Only)
SF1 South Fork at Trevilian Way	All Data	40%	39%	0%	27%	27%	0%
	Winter	0%	0%	0%	22%	22%	0%
	Rec Season	79%	78%	0%	33%	32%	0%
SF2 South Fork at Winter Avenue	All Data	62%	61%	0%	49%	48%	0%
	Winter	27%	24%	0%	23%	23%	0%
	Rec Season	97%	97%	0%	75%	72%	0%
South Fork At Mouth / Confluence With Middle Fork	All Data	65%	64%	0%	59%	48%	0%
	Winter	32%	31%	0%	25%	25%	0%
	Rec Season	97%	97%	0%	92%	72%	0%
SF6 South Fork at Flood Pumping Station	All Data	67%	66%	0%	62%	55%	0%
	Winter	36%	35%	0%	31%	31%	0%
	Rec Season	97%	97%	0%	93%	78%	0%
MI2 Middle Fork at Old Cannons Lane	All Data	54%	54%	0%	36%	35%	0%
	Winter	10%	10%	0%	21%	21%	0%
	Rec Season	97%	97%	0%	50%	50%	0%
MI4 Middle Fork at Lexington Road	All Data	63%	58%	0%	48%	41%	0%
	Winter	27%	18%	0%	23%	23%	0%
	Rec Season	97%	97%	0%	74%	59%	0%
Middle Fork at Mouth / Confluence with South Fork	All Data	64%	62%	0%	46%	42%	0%
	Winter	31%	28%	0%	24%	25%	0%
	Rec Season	97%	97%	0%	68%	58%	0%
MU2 Muddy Fork at Indian Hills Trail	All Data	46%	46%	0%	30%	30%	0%
	Winter	0%	0%	0%	20%	20%	0%
	Rec Season	92%	92%	0%	39%	39%	0%
MU4 Muddy Fork at Mockingbird Valley Road	All Data	48%	48%	0%	32%	31%	0%
	Winter	0%	0%	0%	22%	22%	0%
	Rec Season	95%	95%	0%	42%	41%	0%
Muddy Fork at Mouth / Confluence With Beargrass Creek	All Data	65%	65%	0%	53%	52%	0%
	Winter	34%	33%	0%	31%	30%	0%
	Rec Season	96%	96%	0%	74%	74%	0%
Beargrass Creek at Mouth / Confluence With Ohio River	All Data	72%	70%	0%	67%	60%	0%
	Winter	48%	44%	0%	40%	39%	0%
	Rec Season	96%	95%	0%	94%	81%	0%

Typical year presented by data from calendar year 2001

Table 4.4.4 shows the average annual geometric mean and peak fecal coliform concentrations for the current conditions (baseline), under the Final CSO LTCP assuming all other sources of bacteria were eliminated. The table is not a measure of regulatory compliance, but an illustration of relative changes. As shown, the Final CSO LTCP will reduce bacteria concentrations and the CSOs alone will result in annual geometric mean concentrations less than one colony forming units (cfu) per 100 mL and peak fecal coliform concentrations that are orders of magnitude smaller than current conditions. These results are shown graphically in Figures 4.4.3 and 4.4.4. The results for the mouth of Beargrass Creek for the three simulations are shown in Figures 4.4.5 and 4.4.6.

TABLE 4.4.4
TYPICAL YEAR[1] FECAL COLIFORM CONCENTRATIONS (CFU/100 ML)

Station	Annual Geometric Mean			Annual Peak		
	Baseline (2001)	IOAP	IOAP (CSOs Only)	Baseline (2001)	IOAP	IOAP (CSOs Only)
SF1 South Fork at Trevilian Way	224	223	0	196,830	196,830	0
SF2 South Fork at Winter Avenue	507	471	0	261,340	166,510	7,003
Upstream of Mouth at Middle Fork	896	701	0	170,000	145,000	20,400
SF6 South Fork at Beargrass Flood Pumping Station	1,069	813	0	104,000	87,100	6,560
MI2 Middle Fork at Old Cannons Lane	342	341	0	181,250	181,250	0
MI4 Middle Fork at Lexington Rd	477	422	0	172,650	156,480	0
Upstream Of Confluence With South Fork	547	455	0	145,000	142,000	28,200
MU2 Muddy Fork at Indian Hills Trail	258	256	0	228,540	228,540	0
MU4 Muddy Fork at Mockingbird Valley	281	278	0	233,210	233,210	0
Upstream Of Confluence With BGC	547	455	0	90,500	90,400	8,920
Upstream Of Confluence With Ohio River	1,381	1,033	0	44,300	38,000	1,860
Typical year presented by data from calendar year 2001						

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 4.4.3 GEOMETRIC MEAN STANDARD IN SOUTH FORK STATIONS

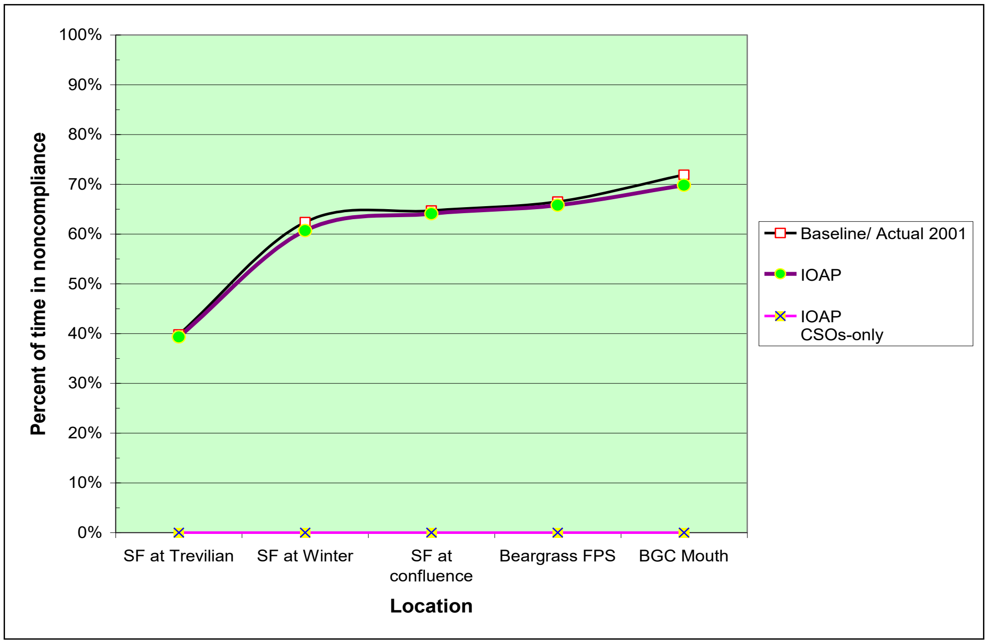
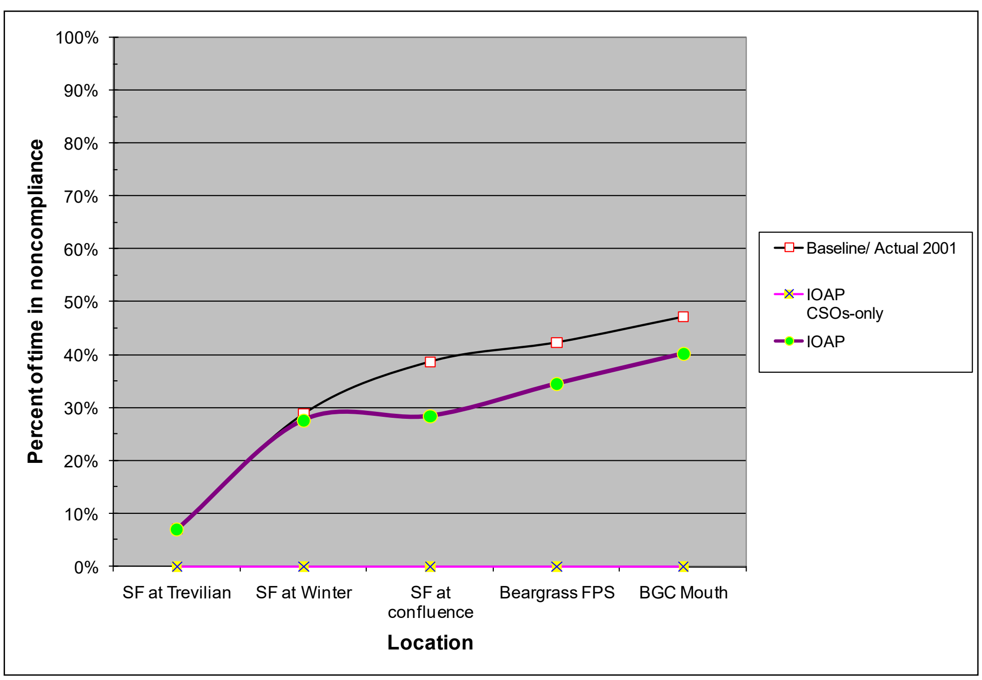


FIGURE 4.4.4 MAXIMUM STANDARD IN SOUTH FORK STATIONS



Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

FIGURE 4.4.5 NONATTAINMENT OF GEOMETRIC MEAN STANDARD AT MOUTH OF BEARGRASS CREEK

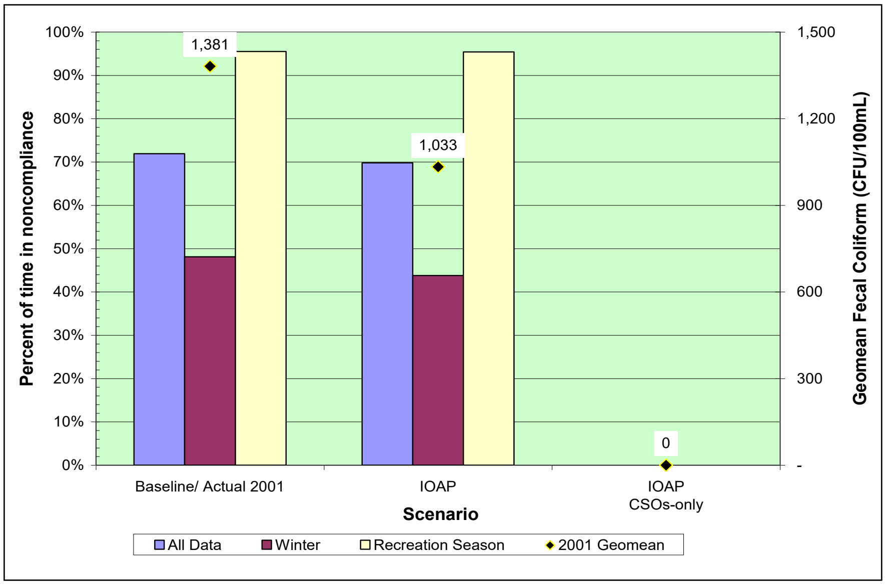
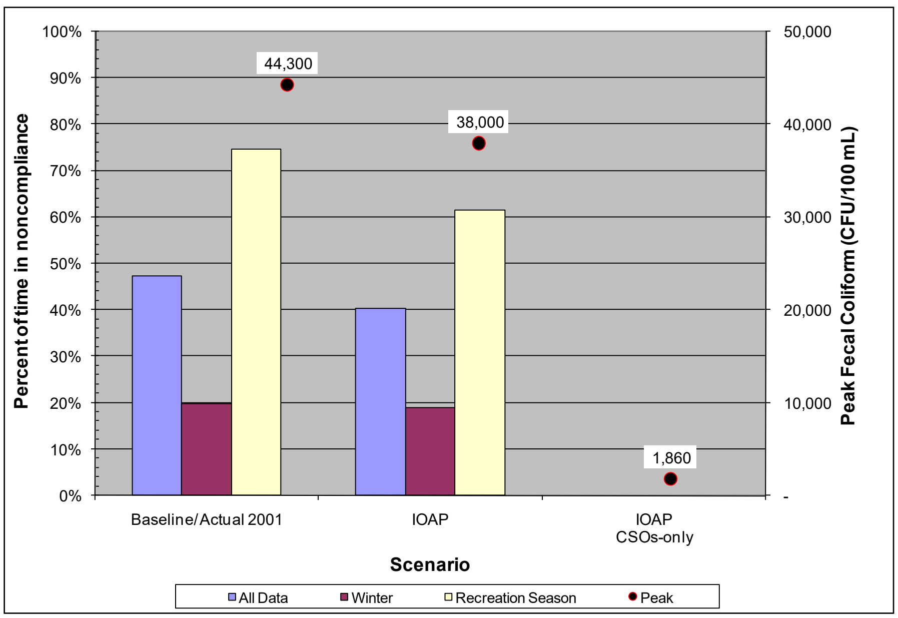


FIGURE 4.4.6 NONATTAINMENT OF MONTHLY MAXIMUM STANDARD AT MOUTH OF BEARGRASS CREEK



4.4.3 Ohio River Water Quality Benefits

The Ohio River is also affected by CSOs, both from direct discharges to the river and indirectly from CSO discharges to Beargrass Creek that eventually flows into the Ohio River. Because the size of the Ohio River watershed upstream of Louisville Metro is so large, CSO impacts on the Ohio River are not as significant as the effects are on Beargrass Creek. In fact, CSOs have shown relatively little hydrologic affect on the Ohio River nor is there a noticeable effect on dissolved oxygen. However, CSOs do have an effect on instream concentrations of fecal coliform bacteria in the Ohio River. Wet weather monitoring data demonstrate significant increases fecal coliform concentrations in response to CSO events, especially in areas closer to shore and immediately downstream of overflow locations. The IOAP will therefore improve water quality in the Ohio River, but not as significantly as in Beargrass Creek. The Ohio River Water Quality Model calculates that the CSOs resulting from the IOAP will result in 100% compliance with both the geometric mean and peak representation of the fecal coliform criteria, if other sources of bacteria (upstream and tributary) could be controlled.

The Final CSO LTCP reduces the number and amount of CSOs and, therefore, the fecal coliform load to the Ohio River. The following tables and figure show that the Ohio River Water Quality Model predicts improved compliance in the near shore (Kentucky-side) areas with the monthly maximum recreational water quality criterion and reduced geometric mean and peak fecal coliform concentrations as a result of the IOAP projects. There is 100 percent compliance with the geometric metric criterion under both current (baseline) conditions and the IOAP. This is because of the significant dilution provided by the river and the assignment of the upstream concentrations of bacteria during the 2001 simulations.

The IOAP increases compliance with the monthly maximum criterion, with the maximum benefit seen in downtown Louisville Metro where the rate of non-compliance decreases from 100 percent under baseline conditions to 33 percent under the IOAP (Table 4.4.5 and Figure 4.4.7). The simulations also show that if CSOs were the only source of bacteria to Beargrass Creek and the Ohio River, that the CSOs would not cause violations of the fecal coliform criteria in the Ohio River.

TABLE 4.4.5
PERCENT NONCOMPLIANCE WITH OHIO RIVER WATER QUALITY STANDARDS IN TYPICAL YEAR

Station	Geometric Mean Criterion			Monthly Maximum Criterion		
	Baseline (2001)[1]	IOAP	IOAP (CSOs Only)	Baseline (2001)[1]	IOAP	IOAP (CSOs Only)
Upstream	0%	0%	0%	33%	33%	0%
Above Beargrass	0%	0%	0%	33%	33%	0%
I-65	0%	0%	0%	33%	33%	0%
Downtown	0%	0%	0%	100%	33%	0%
Morris Forman	0%	0%	0%	100%	83%	0%
Salt River	0%	0%	0%	67%	67%	0%
Typical year presented by data from calendar year 2001						

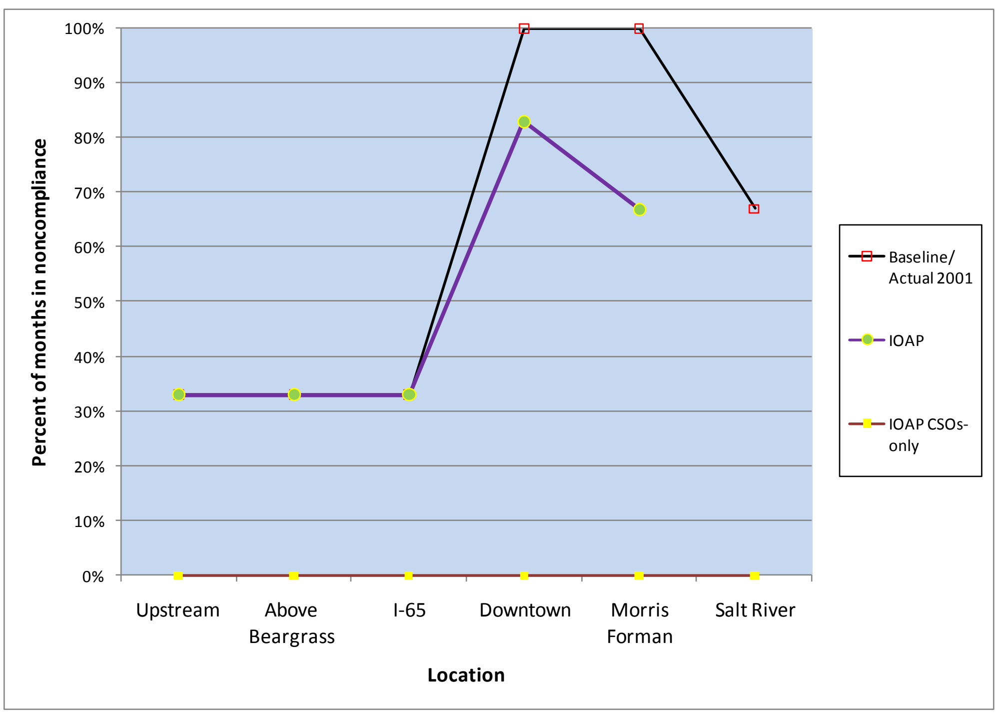
Average and maximum fecal coliform concentrations are also decreased by the IOAP when compared to baseline conditions. The largest benefit in geometric mean concentrations is observed in downtown Louisville Metro, where concentrations decrease from 74 to 34 cfu/ 100 ml. The largest benefit in maximum concentrations is observed below the Morris Forman WQTC, where concentrations decrease from 100,000 to 46,000 cfu/ 100 ml (Table 4.4.6). The table is not a measure of regulatory compliance, but an illustration of relative changes.

TABLE 4.4.6
TYPICAL YEAR[1] OHIO RIVER FECAL COLIFORM RECREATIONAL SEASON CONCENTRATIONS (CFU/100 ML)

Station	Geometric Mean			Maximum		
	Baseline (2001)[1]	IOAP	IOAP (CSOs Only)	Baseline (2001)[1]	IOAP	IOAP (CSOs Only)
Upstream	86	86	0	650	650	0
Above Beargrass	22	22	0	9900	9900	0
I-65	27	29	0	6600	6700	9
Downtown	74	34	0	6900	5300	3,230
Morris Forman	82	51	0	100,000	46,000	13,100
Salt River	69	55	0	56,000	57,000	4,380

Typical Year Presented By Data From Calendar Year 2001

FIGURE 4.4.7 NONATTAINMENT OF MAXIMUM STANDARD IN OHIO RIVER



Chapter 5 is new to Volume 2 for the 2012 Modification.

CHAPTER 5: LONG-TERM CONTROL PLAN 2012 MODIFICATION

TABLE OF CONTENTS

SUPPORTING INFORMATION

Appendix 3.2.14 Drywell Rule Authorization Form

Appendix 5.3.1 2012 IOAP Project Modification Justification
Appendix 5.3.2 2012 Revised Benefit Costs Analyses

CHAPTER 5: LONG-TERM CONTROL PLAN 2012 MODIFICATION

5.1 LTCP IMPLEMENTATION UPDATE

As of May 2013, MSD has completed and certified 24 LTCP projects, including committed green demonstration projects. Several projects, including the first green project suite to replace a gray storage basin, are currently under construction. Bell's Lane Wet Weather Treatment Facility and Logan Street Storage Basin, significant CSO reduction projects, are under design with various others in the initial design phase. Completed projects are listed in Table 5.1.1 on the next page.

TABLE 5.1.1

COMPLETED LTCP PROJECTS AS OF MAY 2013

CERTIFICATION DATES FOR LTCP PROJECTS			
(Sorted By ACD Date, 5/31/13)			
ACD Project Number	**Project Name**	**Date Completed**	**ACD Date**
L_SO_MF_121_S_12_A	BILLY GOAT STRUT (formerly CAMPBELL AND MAIN) PERMEABLE ALLEY	8-Oct-10	31-Dec-10
L_OR_MF_015_S_12_A	W. GAULBERT & W. HILL (formerly SEVENTEENTH AND W. HILL) PERMEABLE ALLEY	15-Oct-10	31-Dec-10
L_OR_MF_053_S_12_A_C	2300 BLOCK OF CONGRESS STREET (formerly SEVENTH AND MARKET) PERMEABLE ALLEY	11-Nov-10	31-Dec-10
ADDITIONAL RAIN GARDEN PROJECT	CLIFTON TRIANGLE AREA RAIN GARDEN	11-Nov-10	31-Dec-10
ADDITIONAL RAIN GARDEN PROJECT	BRANDIES APARTMENTS RAIN GARDEN	15-Nov-10	31-Dec-10
L_OR_MF_053_S_12_A_A	MSD MAIN OFFICE PARKING LOT BIOSWALE	3-Dec-10	31-Dec-10
L_OR_MF_198_S_12_A	THIRD AND ORMSBY BIOFILTRATION SWALES	12-Dec-10	31-Dec-10
L_OR_MF_022_S_12_A	6TH & MARTIN LUTHER KING (formerly SIXTH AND MUHAMMAD ALI) GREEN PARKING LOT	28-Dec-10	31-Dec-10
L_SO_MF_108_S_09A_B_A_4	CSO 108 DAM MODIFICATIONS	30-Dec-10	31-Dec-10
L_OR_MF_028_S_12_A	HOUSING AUTHORITY GREEN ROOF (formerly SIXTH AND BROADWAY RAIN GARDEN)	30-Dec-10	31-Dec-10
L_OR_MF_208_S_12_A	SCHOLAR HOUSE GREEN PARKING LOT (formerly TWELFTH AND JEFFERSON)	30-Dec-10	31-Dec-10
L_OR_MF_053_S_12_A_B	SEVENTH AND CEDAR GREEN PARKING LOT	30-Dec-10	31-Dec-10
L_OR_MF_181_S_12_A	SWIFT COMPANY GREEN PROJECT (formerly SECOND AND BROADWAY GREEN PARKING LOT)	30-Dec-10	31-Dec-10

TABLE 5.1.1

COMPLETED LTCP PROJECTS AS OF MAY 2013

CERTIFICATION DATES FOR LTCP PROJECTS			
(Sorted By ACD Date, 5/31/13)			
ACD Project Number	**Project Name**	**Date Completed**	**ACD Date**
L_OR_MF_019_S_12_A	EAST WASHINGTON @ ADAMS STREET GREEN DEMONSTRATION PROJECT (formerly I-264 ON-RAMP DRY WELL)	19-Dec-11	31-Dec-11
L_OR_MF_191_S_12_A_B	3RD STREET AND CAMPBELL VENTURES GREEN PROJECT (formerly JFK MONTESSORI AREA DRY WELL)	20-Dec-11	31-Dec-11
ADDITIONAL RAIN GARDEN PROJECT	GERMAN/PARISTOWN GREEN STREET RAIN GARDEN	20-Dec-11	31-Dec-11
L_OR_MF_191_S_12_A_A	GRAWEMAYER HALL PARKING LOT (formerly the I-264 AND GIBSON DRY WELL)	20-Dec-11	31-Dec-11
L_OR_MF_189_S_12_A	SPEED ART MUSEUM INFILTRATION TRENCH (formerly the I-264 OFF-RAMP DRY WELL)	20-Dec-11	31-Dec-11
ADDITIONAL RAIN GARDEN PROJECT	BROWN-FORMAN GREEN ROOF PROJECT (formerly BARDSTOWN RD PRESBYTERIAN CHURCH GREEN PARKING LOT)	30-Dec-11	31-Dec-11
L_OR_MF_191_S_12_A_C	WILSON CROSSINGS GREEN PARKING LOT (formerly THE RUSSELL LEE DRIVE DRY WELL)	30-Dec-11	31-Dec-11
L_OR_MF_019_S_03_A_B	34TH STREET FPS DWO ELIMINATION	11-Jun-12	31-Dec-12
L_OR_MF_022_M_03_A_A	4TH STREET FPS DWO ELIMINATION	15-Jun-12	31-Dec-12
L_OR_MF_172_S_09B_B_A_0	ADAMS STREET SEWER SEPARATION	28-Nov-12	31-Dec-12
L_MI_MF_123_S_08_A_A_0	CSO 123 DOWNSPOUT DISCONNECTION	30-Dec-12	31-Dec-12

5.2 2012 LONG TERM CONTROL PLAN MODIFICATION

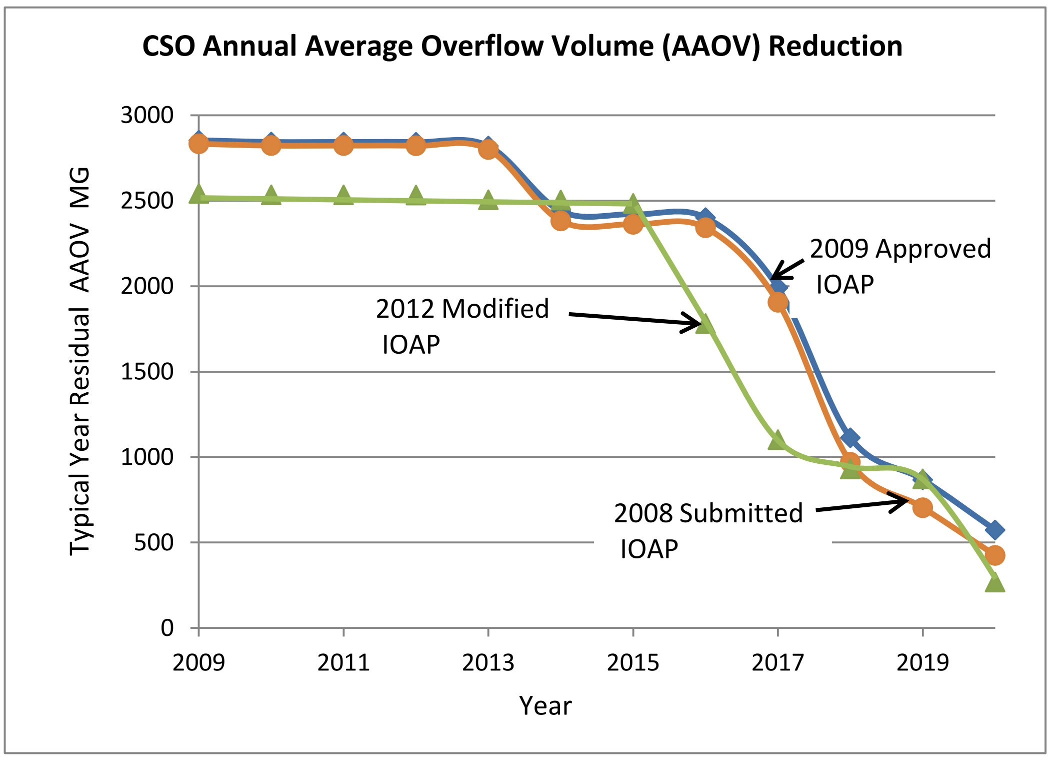
As part of the adaptive management approach outlined in the approved 2009 Integrated Overflow Abatement Plan (IOAP), the Louisville and Jefferson County Metropolitan Sewer District (MSD) has been expanding the monitoring network throughout its sewer system.

MSD has been utilizing data from this network to recalibrate the hydrologic and hydraulic models used to size overflow abatement projects and refine individual project approaches and sizes based on an improved understanding of the sewer system operation and the relationship of certain overflows to one another. This chapter outlines the project modifications resulting from this effort along with program updates for the green infrastructure program. A detailed description of the project modification process is outlined in Volume 1, Chapter 6.5.3.7.

5.3 FINAL SELECTION OF THE 2012 RECOMMENDED PLAN

The project Table 5.3.1, at the end of this chapter summarizes the level of control results for each project within the 2012 project suite, both those proposed for modification and those remaining the same as proposed in the 2009 plan. A final, 2012 LTCP project suite is also provided in Table 5.3.2 along with a revised project schedule.

FIGURE 5.3.1 - CSO AAOV REDUCTION THRU 2020



Note that Figure 5.3.1 shows three different CSO reduction curves. The curve labeled "2008 Submitted IOAP" illustrates the timing of AAOV reductions from the plan submitted in December 2008. The curve labeled "2009 Approved IOAP" illustrates a slightly different curve resulting from minor refinements made to a number of projects through the review, revision, and re-submittal process that occurred during January through September 2009. These minor refinements were documented in the project fact sheets submitted with the 2009 IOAP, but were not consistently reflected in the text. This 2012 IOAP Modification corrects the tables showing the 2009 IOAP and the 2012 IOAP Modification.

Justification for individual project modifications can be found in Appendix 5.3.1 along with a countywide project map. All benefit analyses and costs analyses can be found in Appendix 5.3.2.

5.4 GREEN INFRASTRUCTURE ADAPTIVE MANAGEMENT

In Volume 2, Chapters 3 and 4, MSD outlined its initial approach and justification for the utilization of green infrastructure technology. Green technologies such as rain gardens, bioswales, infiltration trenches, green roofs, pervious paving applications and rain barrels are discussed in detail. The following section provides an update on the green program following three years of implementation.

The primary purpose of MSD's green infrastructure initiative is to implement a program that reduces CSO frequency, duration and volume using alternative technologies. These environmentally sensitive techniques capture rainfall at the source and more closely mimic natural hydrologic processes when compared to more traditional "gray" infrastructure solutions that are typically employed in CSO control programs. Gray infrastructure solutions for CSO control typically consist of large pipes, storage tanks, tunnels, and high rate treatment facilities.

Green Infrastructure Program

- Achieve multiple objectives and benefits beyond reduction of sewer overflows
- Improve air and water quality
- Increase green space and wildlife habitat
- Reduce heat island effect in the urban core
- Reduce overflow volume and frequency
- Beautify community

Although conventional engineering alternatives such as high rate treatment, sewer separation, and remote storage facilities represent the core elements of MSD's wet weather overflow control program, opportunities to supplement, downsize or replace these conventional engineering solutions with green infrastructure are present. Since green infrastructure solutions capture and store rainwater where it falls before running off into the sewer system, the potential exists for overflow reduction, reduced flows and reduced treatment costs at the WQTC.

MSD is strategically evaluating viable CSO drainage areas for green infrastructure potential versus the alternative gray solutions, or balanced implementation of both technologies.

5.4.1 Green Infrastructure Background

The terms of this Consent Decree require elimination of SSOs and minimization of CSOs to specific levels of control. MSD regulators and its Wet Weather Team (WWT) Stakeholder Group encouraged the exploration of innovative techniques and practices such as Low Impact Development (LID) and green infrastructure to reduce CSO discharges.

Traditional gray solutions will play a major role in the Final CSO LTCP; however, MSD is committed to maximizing the use of green infrastructure elements in the overall solution matrix.

5.4.1.1 Green Infrastructure Philosophy

Model simulations indicate that the CSS discharges approximately three billion gallons of untreated sewage and stormwater to local waterways in a typical year prior to IOAP implementation, though this volume estimate varies as the combined system hydraulic model is improved. As MSD developed the overflow abatement plan to minimize these discharges and comply with the terms of the Consent Decree, MSD acknowledged that a considerable amount of local ratepayers' dollars were to be invested in pipes, storage, and treatment facilities throughout the community.

Considering the significant community resources that will be directed toward CSO mitigation, the WWT Stakeholder Group decided to explore mitigation approaches that maximize the benefits, through overflow reduction and beyond, to the community and rate payers for the dollars invested. Using a strategic approach in the pursuit and placement of green infrastructure, certain CSO drainage areas demonstrated a higher potential for green impacts and overflow reduction than others did. See Figure 5.3.1 for a depiction of the green infrastructure impact analysis.

5.4.1.2 Green Infrastructure Demonstration Projects

An initial list of 19 demonstration projects with potential locations was included in the 2009 IOAP. The locations of the projects moved in some cases. Several locations did not prove viable for green practice implementation, once a more detailed engineering analysis was performed. In a few cases, the regulatory permitting and cost of project monitoring proved to be too expensive for green technology implementation. Table 5.4.1 on the next page provides a list of 19 demonstration projects that have been completed.

TABLE 5.4.1

FINAL CONSTRUCTED GREEN DEMONSTRATION PROJECT LIST

Project Name	Location	CSO Controlled	Original Project and Technology	Technology	Gallons Removed Annually (MG)	Capital Cost	Cost per Gallon Removed	Completion Date
MSD Main Office Parking Lot Bioswale	Ohio River	CSO053	MSD Main Office Parking Lot Bioswale	Biofiltration Technique	1.4	648,506	$0.09	12/31/2010
Seventh and Cedar Green Parking Lot	Ohio River	CSO022	Seventh and Cedar Green Parking Lot	Biofiltration Technique	1.4	450,000	$0.46	12/31/2010
Scholar House Green Parking Lot	South Fork	CSO146	Second and Broadway Green Parking Lot	Biofiltration Technique	1.2	108,000	$0.09	12/31/2010
Third and Ormsby Biofiltration Swales	Ohio River	CSO198	Third and Ormsby Biofiltration Swales	Biofiltration Technique	1.80	117,187	$0.07	12/31/2010
Sixth and MLK (Federal Building) Parking Lot	Ohio River	CSO026	Sixth and Muhammad Ali Green Parking Lot	Biofiltration Technique	1.2	235,000	$0.20	12/31/2010
Housing Authority Green Roof at 801 Vine Street	Ohio River	CSO084	Sixth and Broadway Rain Garden	Biofiltration Technique	0.27	$60,000	$0.22	12/31/2010
W. Gaulbert and W Hill Permeable Alley	Ohio River	CSO015	Seventeenth and W Hill Permeable Alley	Permeable Alley	1.74	72,000	$0.04	12/31/2010
2300 Congress Permeable Alley	Ohio River	CSO053	Seventh and Market Permeable Alley	Permeable Alley	0.25	40,000	$0.05	12/31/2010
Billy Goat Strut Permeable Alley	South Fork	CSO121	Campbell and Main Permeable Alley	Permeable Alley	0.84	40,000	$0.05	12/31/2010
Swift Parking Lot Bioswale	Ohio River	CSO130	Twelfth and Jefferson Green Street	Biofiltration Technique	1.05	57,000	$0.05	12/31/2010
Speed Art Museum Infiltration Trench	Middle Fork	CSO211	I-264 Off-Ramp Dry Well	Biofiltration Technique	2.60	252,000	$0.10	12/31/2011
CSO 130 Green Street	Middle Fork	CSO130	I-264 On-Ramp Dry Well	Green Street	7.67	364,096	$0.10	12/31/2011
University of Louisville – Grawemayer Hall Green Parking Lot	Ohio River	CSO191	I-264 and Gibson Dry Well	Biofiltration Technique	9.74	$207,093	$0.02	12/31/2011
Wilson Crossings- Green Parking Lot	Ohio River	CSO015	Russell Lee Drive Dry Well	Biofiltration Technique	0.15	$30,000	$0.20	12/31/2011
3rd Street Ventures	Ohio River	CSO211	JFK Montessori Area Dry Well	Biofiltration Technique	1.84	$154,452	$0.08	12/31/2011

TABLE 5.4.1

FINAL CONSTRUCTED GREEN DEMONSTRATION PROJECT LIST

Project Name	Location	CSO Controlled	Original Project and Technology	Technology	Gallons Removed Annually (MG)	Capital Cost	Cost per Gallon Removed	Completion Date
Clifton Triangle Rain Garden	Muddy Fork	CSO132	Additional Rain Garden Site	Biofiltration Technique	0.035	$10,000	$0.29	12/31/2010
Brandeis Apartments Rain Garden	Ohio River	CSO105	Additional Rain Garden Site	Biofiltration Technique	0.075	$10,000	$0.13	12/31/2010
German/Paristown Green Street/Rain Garden	South Fork	CSO146	Additional Rain Garden Site	Green Street/ Biofiltration Technique	1.45	$91,000	$0.063	12/31/2011
Brown Forman Green Roof	Ohio River	CSO 015	Additional Rain Garden Site	Biofiltration Technique	1.0	$42,000	$0.042	12/31/2011
TOTAL					**35.71 MG**	**$2,988,000**	**$0.08**	

5.4.1.3 Dry Well Update

MSD considered dry wells to have high potential for offloading surface water runoff from the CSS in the central and western portions of the CSS area. Dry wells generally have a relatively high infiltration capacity and low construction cost compared to other green infrastructure techniques, and they typically are used in areas where surficial fine-grained clays and silts reduce shallow infiltration rates and prohibit the effective use of methods like bioswales and green streets.

The construction of dry wells requires an Underground Injection Control (UIC) permit. In Kentucky, the Underground Injection Control permitting process is administered through EPA - Region 4 in Atlanta. The agency requires that an application be completed detailing the location of the proposed dry well, the type of construction and documentation on any known sources of contamination in the area, or any vicinity-wide plumes of contamination. The data is reviewed to determine if the feature will be introducing any new contaminants into the aquifer or will be attenuating any existing plumes of contamination. If EPA determines that the dry well does not pose a significant risk to the quality of the aquifer, a rule authorization is granted. See Appendix 3.2.14 Drywell Rule Authorization Form for a copy of the required form.

Throughout the course of 2011, MSD engaged EPA UIC staff in discussions on the level of permitting required for this technology type. Due to the need to develop pilot project areas to examine the short and long-term effects of stormwater injection into the aquifer under the CSS, an extensive amount of study would need to be performed prior to the issuance of permits or a streamlined permitting process. This dry well pilot area data collection process made the construction of the five demonstration dry well projects impossible to accomplish prior to December 31, 2011. Moving forward, the process and peripheral issues associated with the permitting and sampling requirements of installing dry wells makes the use of the technology expensive and time-consuming and; therefore, seemingly infeasible to use as a cost effective component of the green program. However, should the permitting and monitoring requirements for dry wells change and become more cost-effective, MSD may reconsider their use within its green program.

The following Table 5.4.2 shows demonstration project alternatives were constructed to replace the five dry well demonstration projects:

TABLE 5.4.2 – UPDATE OF DRY WELL PROJECT MODIFICATIONS

CERTIFICATION DATES FOR IOAP PROJECTS				
Budget ID	**IOAP Project Number**	**Original IOAP Project Name**	**Actual Green Demonstration Project Location**	**Certification Date**
H09444	L_OR_MF_191_S_12_A_A	I-264 AND GIBSON DRY WELL	University of Louisville - Grawemayer Hall Green Parking Lot	31-Dec-11
H09442	L_OR_MF_189_S_12_A	I-264 OFF-RAMP DRY WELL	Speed Art Museum - Infiltration Trench	31-Dec-11
H09443	L_OR_MF_019_S_12_A	I-264 ON-RAMP DRY WELL	CSO 130 - Green Street	31-Dec-11
H09446	L_OR_MF_191_S_12_A_B	JFK MONTESSORI AREA DRY WELL	3rd Street Ventures	31-Dec-11
H09445	L_OR_MF_191_S_12_A_C	RUSSELL LEE DRIVE DRY WELL	Wilson Crossings - Green Parking Lot	31-Dec-11
TBD	Add. Rain Garden Project	TBD	German/Paristown - Green Street/Rain Garden	31-Dec-11
H11044	Bardstown Rd Presbyterian Church Green Parking Lot	TBD	Brown-Forman Green Roof	31-Dec-11

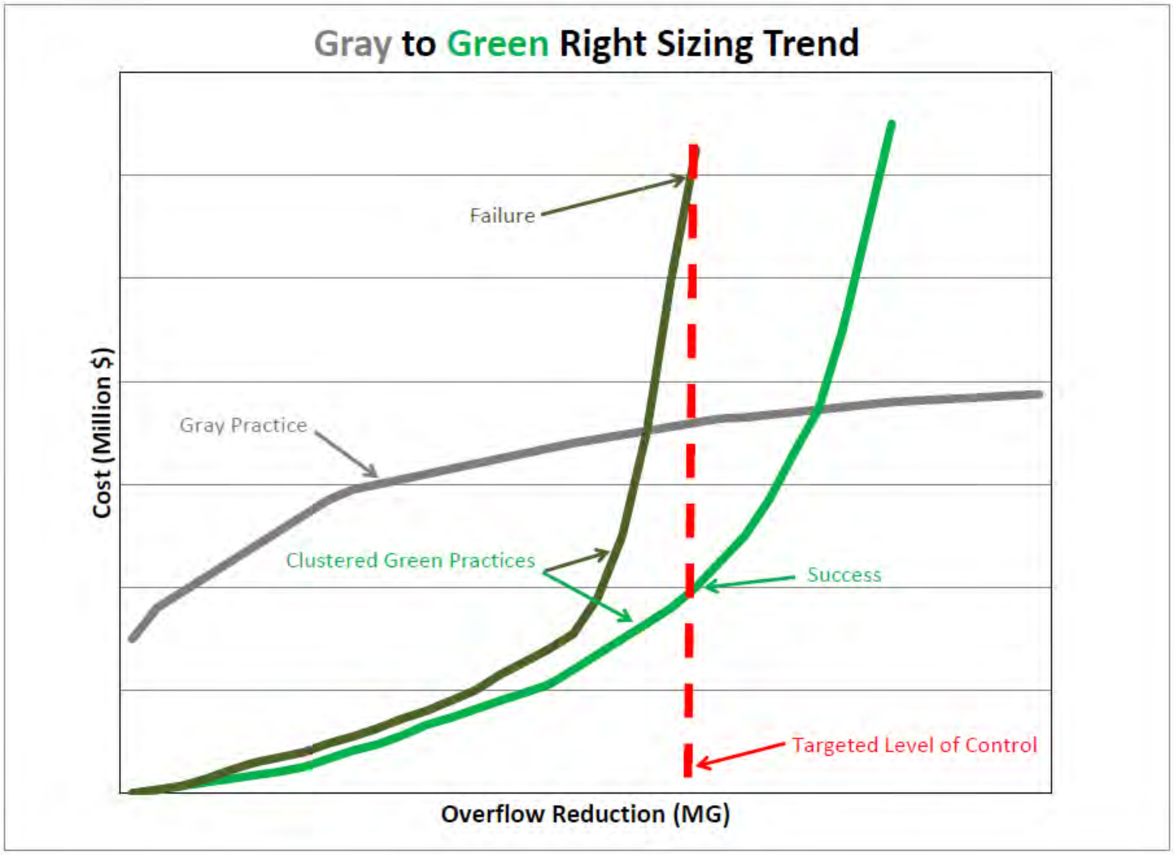
The 19 green demonstration projects cost approximately $3 million to implement and remove an estimated 35 million gallons of stormwater from the CSS in a typical year. More importantly, these projects represented an opportunity to demonstrate various green techniques, develop more accurate and locally based cost information and monitor their performance.

5.4.1.4 Focused Implementation Strategy

MSD recognized that while many communities had successfully implemented green infrastructure elements targeting CSO control, few, if any, had developed comprehensive Green Infrastructure Programs during the initial phases of their LTCPs. With the possible green technologies established, MSD created a strategic approach for the development of the Green Infrastructure Program. MSD viewed this as an opportunity to maximize the role of green infrastructure and the associated benefits to the community.

During development of the green management strategy, MSD developed Figure 5.4.1 to outline which project areas would have the best opportunity for green infrastructure to cost-effectively reduce overflow volumes and gray project sizes. In some cases, gray infrastructure projects may even be effectively eliminated.

FIGURE 5.4.1 – POSSIBLE GREEN VS. GRAY PROJECT SCENARIOS



In the chart above, a typical gray project cost curve is presented having initial costs associated with mobilization, land purchase, and permitting regardless of project size. As the gray project becomes larger, the cost per gallon of storage becomes more cost-effective. Therefore, the cost savings associated with a small reduction in gray basin size by utilizing green infrastructure in the upstream drainage area is minimal. For this reason, in many cases, cost-effectively downsizing a gray project using green is difficult.

Green projects curve in the opposite direction, due to the pursuit of the most cost effective projects first. Two green project suites are presented below. The first represents a suite of projects that meet the same level of control as the gray, but is more costly. In this scenario, green would not be as advantageous to pursue. The second suite of green projects meets the same level of control as the gray project at a much lower cost. This suite provides the most water quality and community benefit at lower cost to ratepayers. This scenario appears viable; however, careful identification of obstacles for implementation and long-term maintenance should be the next step.

MSD has been programmatically evaluating various CSO drainage areas to determine where green project suites may cost effectively outperform gray projects, with several evaluations completed to date. Using the following principles, CSO areas will be prioritized:

- Gray project areas that originally had separations as the technology selection,
- Smaller drainage areas and overflow volumes with a manageable project suite size, and
- Large proportion of impervious drainage area in relation to the low flow capacity.

Butchertown Right-Sizing Example

An example of utilizing the adaptive management approach to incorporate concentrated green infrastructure to eliminate the need for a proposed storage basin is in the Butchertown neighborhood near CSO130. The graphic below shows the project area. This drainage area includes a mix of residential, commercial, and industrial properties over 17 acres.

Butchertown Green Projects Map - Drainage Boundary In Yellow

The recalibrated project to address the level of control rain event for the drainage area was an 80,000 gallon overflow storage basin. Through a rigorous monitoring and modeling analysis of the area, MSD determined that the gray project can be replaced with a suite of green practices, such as infiltrating tree wells and pervious paver strips and achieve the same or better overflow reductions and the combined sewer outfall.

Table 5.4.3 below shows that at the same level of control, the green suite of projects not only is more cost effective, but captures more overflow due to its effectiveness during smaller events and at the beginning of overflows.

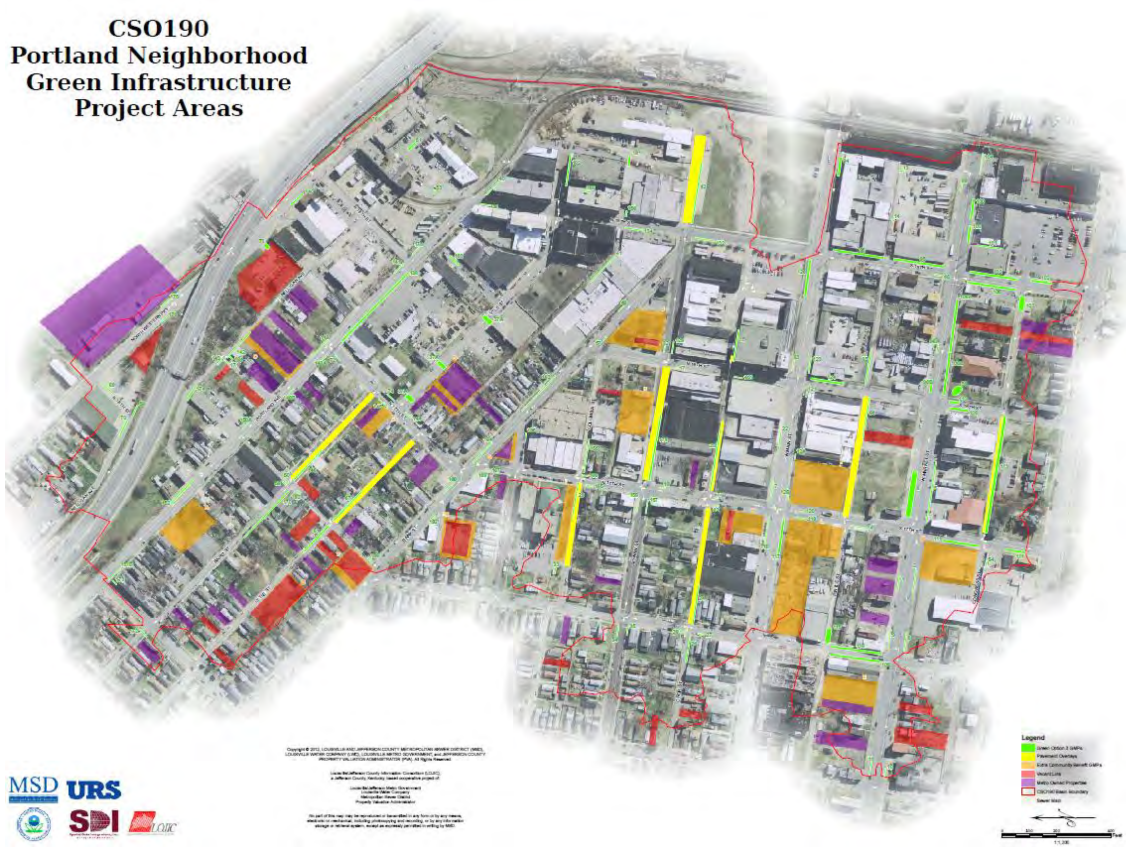
TABLE 5.4.3
BUTCHERTOWN GREEN TO GRAY COST COMPARISON

Option Approach	Residual Overflow Volume	Residual Number of Overflows Per Year	20-Yr Life Cycle Cost
Gray Only	0.67 MG	8	$1,717,653
Green Only	0.28 MG	8	$938,000

Based on these findings, MSD determined that other CSO areas may offer the same opportunity for green infrastructure implementation to provide a more cost effective alternative to the gray project selected in the IOAP using a similar approach as outlined in the green strategy section. As such, MSD submitted a project modification to alter the technology to control CSO130 using green practices rather than gray, which has been subsequently approved by regulators.

Portland Right-Sizing Example

Following the right-sizing effort performed in the Butchertown area, MSD decided to select a larger CSO drainage area to perform the same analysis. MSD chose a 128-acre drainage area associated with CSO190 in the Portland neighborhood with a mixture of residential, commercial and industrial land-use as seen in the aerial image below.



Similar to the Butchertown analysis, MSD developed a suite of green projects projected to achieve the same, if not better, level of overflow control than the proposed storage basin sited near CSO190. Given the much larger size of the drainage area and number of proposed practices, MSD focused more intently on implementation issues and comparison of long-term operations and maintenance as well as life-cycle costs of the two alternative methods. Tables 5.4.4 through 5.4.7 below demonstrate this cost comparison. The green project suite is projected to have a lower life cycle cost than the gray storage basin by a margin of $1.1 million over a 20-year period.

TABLE 5.4.4

PORTLAND GREEN TO GRAY COST COMPARISON

Overflow Volume and Cost Comparison

	CSO 190 Existing Conditions	Gray Storage Basin	Green Streets w/ Community Enhancements
Overflow Volume	35.92 MG	3.65 MG	0.70 MG
Number of Overflows / Year	54	8	8
	Capital Cost	$5.32 M	$4.11 M
	Annual O&M	$38,900	$90,000
	Annual Treatment Cost	$32,125	
	Total Annual O&M	$71,025	$90,000
	20-Year Total Present Worth	$5.76 M	$5.23 M
	Total Life Cycle Cost*	$6.32 M	$5.25 M

Total Life Cycle Cost Includes 10-Yr Equipment/Practice Replacement

In considering these costs, the green project suite, consisting of 150 decentralized practices, again indicates a superior level of overflow control for CSO190 for both present worth and life cycle costs. The intensive modeling and cost analysis led the analytical team to conclude that green technologies can be used cost effectively compared to traditional gray, at least at this scale. However, implementation complexity, schedule and necessary partnerships needed to implement this large number of practices in the area are still under review.

Note: UIG stands for Underground Infiltration Gallery

TABLE 5.4.5

GREEN SUITE SUMMARY

Overflow Alternatives

Number of Green Management Practices by Type	
Targeted Tree Planting	6
Rain Garden	5
Infiltration Trench	8
Infiltration Trench and Tree Planting	1
UIG	115
UIG w/ overlay	15
Total	**150**
Gray Storage Basin Size	
1.39 MG Off-line Storage Basin	

TABLE 5.4.6

STORAGE BASIN MAINTENANCE

Gray Maintenance Calculations & Assumptions

Annual O & M Calculations	
Off Line Storage	
Event Maintenance	
Estim. Number of Annual Storage Events	54
Number of Overflows Per Yr	8
Labor Cost Per Hr	$36.35
Total Event Maintenance Cost	$15,702
Fixed Maintenance	
Total Hrs Per Yr	416
Labor Cost Per Hr	$36.35
Total Fixed Maintenance Cost	$15,121
Total Off Line Storage Cost	$30,823
Pumping	
Energy	
Energy Consumption (kwh/yr)	13,057
Electricty Cost Per kwh	$0.035
Total Energy Cost	$457
Fixed Maintenance	
Hours Per Wk	4
Weeks Per Yr	52
Labor Cost Per Hr	$36.35
Total Fixed Maintenance	$7,560
Total Pumping Cost	$8,017
Total Annual O & M Cost	**$38,840**

Annual Treatment Calculations	
Annual Volume Treated (millions of gallons)	140
Annual Treatment ($/mg)	$229.53
Total Annual Treatment Cost	**$32,135**

The storage basin maintenance costs were calculated using the costing tool that serves as the basis for the capital costs for projects within the IOAP. Annual operations and maintenance costs are approximated. Source control of stormwater reduces flow at the WQTC; therefore, annual treatment savings from reduced chemical and power usage are realized.

TABLE 5.4.7

GREEN TECHNOLOGY MAINTENANCE

Green Streets & Community Enhancements
External Maintenance Calculations & Assumptions

Tree Maintenance & Mortality Calculations	
Hours Per Yr	0.5
Labor Cost	$40
Number of Trees	200
10% Mortality Per Yr	20
Cost Per Tree (incl. installation)	$500
Total Maintenance Cost	**$14,000**

Mowing Maintenance Calculations	
Number of Lots	20
Number of Times Per Yr	30
Cost Per Lot	$50
Total Maintenance Cost	**$30,000**

Infiltration Trench Maintenance Calculations	
SF of Infiltration Trench	400
Cost Per SF	$0.50
Forebay Cleaning Cost (2X Per Yr)	$320
Total Maintenance Cost	**$520**

Rain Garden Maintenance Calculations	
Labor Hrs Needed Per 5,000 SF	3
Number of Cleanings Per Yr	4
SF of Rain Garden	21,700
Labor Cost	$45
Cost to Replace 10% of Plants & Mulch	$4,340
Total Labor Cost	$2,385
10% Tool Markup	$673
Forebay Cleaning (2X Per Yr)	$320
Total Maintenance Cost	**$7,718**

UIG Maintenance Calculations	
Hrs per cleaning	0.5
Number of cleanings Per Yr	2
Number of Catch Basins	236
Vac Truck Cost Per Hr	$70
Crew Operator Per Hr	$32
Crew Techs Per Hr	$29
Number of Crew Tech's	2
Cost Per Cleaning	$160
Total Maintenance Cost	**$37,760**

Green maintenance costs are outlined above and, at this level of implementation, indicate a higher cost than those projected for the storage basin. However, when capital construction costs are considered with maintenance, equipment replacement and green practice life cycle costs, the green project suite is significantly more cost-effective. The analysis also seems to indicate, when reviewing even larger CSO drainage areas, that the sole use of green infrastructure may prove unwieldy and difficult to implement, particularly on the schedule dictated within the LTCP. At this time, MSD has not made the final decision to implement green solutions rather than the current gray solution in this basin. However, the combined use of green infrastructure and gray storage may prove to be viable. The most cost effective green opportunities within each drainage area will need to be defined to determine if the combined use of these technologies is viable.

Green Encouragement and Requirement for Private Developments

The 2009 IOAP submittal called for the creation and execution of a private property incentives program to encourage green infrastructure. In August 2011, a policy was adopted to incentivize green on new and redevelopment in Louisville Metro as a change to the rates, rentals, and charges resolution for drainage. This policy allowed financial incentives to be provided in two ways:

1. A construction cost offset at the completion of construction, and/or
2. A credit on the non-residential property owner's monthly drainage fee.

In the combined sewer area, this incentive is calculated based on impervious areas directed away from the combined sewer system. Table 5.4.8 shows the incentive values for various green infrastructure control technologies. These values are based on impervious surfaces that are captured by the controls and, in the CSS, the projects have been required to capture the volume from a 1-inch rainfall event over the impervious surface.

Applicants must sign a ten-year agreement that stipulates the owner must maintain the green performance of the facility over the contract period. The Property Owner is required to self-report on the installed controls' performance annually, and MSD will perform construction and follow-up inspections throughout that ten-year window.

TABLE 5.4.8
GREEN INFRASTRUCTURE INCENTIVE VALUES

Green Infrastructure Technique	Unit Value to MSD ($ / controlled sq .ft.)	75% of Unit Value ($ / controlled sq .ft.)
Rain Gardens & Bioswales	$2.00	$1.50
Pervious Pavement (Pavers)	$2.00	$1.50
Vegetated Roofs (Tray Systems)	$3.00	$2.25
Vegetated Roofs (Intensive Systems)	$5.00	$3.75
Infiltration Drains	$2.00	$1.50

Since the adoption of the incentives program, MSD has provided nearly $14 million in funding to support the following projects listed in Table 5.4.9.

TABLE 5.4.9
BOARD APPROVED GREEN PROJECTS

Board Approval Date	Project	Address	MSD Cost	Typical Year Gallons Removed Annually	Impervious Area Captured (SF)
28-Jun-10	Warren Alley Project	Warren Alley between Expressway Ave. and W. Florence Ave.	$ 74,689.05	902,209	27,099
26-Jul-10	Louisville Metro Housing Authority	801 Vine Street	$ 60,000.00	274,819	15,138
23-Aug-10	Hill Street Alley Project	Alley between Hill and Gaulbert W of McCloskey Ave	$ 71,780.39	1,741,479	91,106
27-Sep-10	Office of Employment-Green Demonstration Project	600 Cedar St	$ 648,506.00	1,400,000	126,718
27-Sep-10	Ramano L. Mazzoli Federal Building Green Demonstration Project	600 Dr Martin Luther King Pl	$ 235,000.00	1,200,000	132,634
8-Nov-10	Downtown Scholar House, LLP	NE Blk of S. 1st & Breckinridge St.	$ 107,959.00	1,204,000	71,973
8-Nov-10	3rd Street Ventures, LLC	3rd Street & Cardinal Blvd	$ 154,451.50	1,838,000	102,968
25-Apr-11	E. Ormsby Avenue Alley and Sewer Extension Project	Alley N of Ormsby and W of Floyd St	$ 117,187.25	1,801,340	46,446
23-May-11	SAL Louisville, LLC	3030 Wilson Ave	$ 146,904.00	4,646,338	145,686
23-May-11	Speed Art Museum	2035 S 3rd St	$ 251,954.00	2,596,655	125,977
23-May-11	University of Louisville (UofL)		$ 817,516.00	16,776,448	533,569
	Speed Museum Infiltration Trench			1,943,807	94,304
	Grawemayer Hall (Oval Lawn) Infiltration Trench			5,904,908	103,468
	Grawemayer Hall Pervious Pavers			3,831,485	78,580
	Ekstrom Library Infiltration Trench and Rain Garden			5,096,248	132,406

TABLE 5.4.9
BOARD APPROVED GREEN PROJECTS

Board Approval Date	Project	Address	MSD Cost	Typical Year Gallons Removed Annually	Impervious Area Captured (SF)
27-Jun-11	UofL for Green Infrastructure Project		$ 371,320.00	4,946,789	184,718
	Student Activity Center Pervious Pavers			110,335	4,120
	University Towers Apts. Pervious Pavers			389,652	14,550
	Dental School Pervious Pavers			231,888	8,659
	Business School Infiltration Trench and Green Roof			2,403,790	89,760
	UPDC Infiltration Trench			1,811,124	67,629
27-Jun-11	Highland Ave Alley Project	Between Highland Ave and Morton Ave	$ 143,654.11	1,296,749	44,479
8-Aug-11	Shakes Run Section 5B,LLC	Off Shakes Creek Drive	$ 143,551.00	5,445,000	249,164
22-Aug-11	Second & Breck, LLC, for Spaulding Student Suites	901 S. Second St.	$ 38,611.50	617,142	25,741
22-Aug-11	Jefferson Development Group for Outer Loop Retail Site Phase I	5101 Outer Loop	$ 176,995.50	3,215,202	117,997
22-Aug-11	Young Adult Development In Action (aka Youthbuild)	812 S. Preston St.	$ 47,659.50	761,760	31,773
22-Aug-11	Ursuline Society and Academy of Education and Sacred Heart Schools	3175 Lexington Rd.	$ 464,500.50	7,424,526	309,667
12-Sep-11	UofL for Belknap Campus		$ 1,110,644.00	15,227,170	555,322
	Bioretention Eastern Parkway			1,754,908	64,000
	Speed School of Engineering Infiltration Trench			7,954,750	290,103
	UofL Laboratories Infiltration Trench			5,517,512	201,219

TABLE 5.4.9 BOARD APPROVED GREEN PROJECTS					
Board Approval Date	**Project**	**Address**	**MSD Cost**	**Typical Year Gallons Removed Annually**	**Impervious Area Captured (SF)**
12-Sep-11	Ford Motor Company Louisville Assembly Plant	Off Fern Valley Rd	$ 1,282,950.00	17,152,208	855,300
26-Sep-11	Paris/Germantown Rain Garden Green Demonstration Project	Intersection Swan St and Ellison Ave	$ 91,043.00	1,449,360	58,850
10-Oct-11	Downtown Edge, LLC/Liberty Green	401, 403, 405, 407, 409, 413, 415 Hancock St.	$ 25,088.00	407,300	16,725
10-Oct-11	JCPS Roosevelt Elementary School	1606 Magazine St.	$ 48,954.00	1,426,400	32,636
10-Oct-11	Stoddard Johnson Scholar House	2301 Bradley Ave.	$ 64,661.30	1,033,600	43,108
10-Oct-11	Louisville Metro; Fire Station #10 (Ashland)	501 Ashland Ave.	$ 50,186.00	802,100	33,457
10-Oct-11	JCPS Lincoln Elementary	930 East Main St.	$ 20,636.00	543,100	13,757
19-Oct-11	Green Demonstration Project - Permeable Pavement Along Adams St		$ 49,252.00	804,558	34,853
24-Oct-11	Nucleus Med Center 3	201 E. Jefferson St.	$ 152,896.21	2,549,912	101,931
24-Oct-11	Cardinal Town Phase 2	1812 S. Third St.	$ 55,441.50	798,034	36,961
24-Oct-11	Assumption	2170 Tyler Ln.	$ 157,070.00	2,494,534	104,713
24-Oct-11	St. Bartholomew	2042 Buechel Bank Rd.	$ 48,903.00	653,801	32,602
24-Oct-11	Masonic Homes	330 Masonic Homes Drive	$ 110,823.00	3,336,142	73,882
14-Nov-11	Masonic Homes (Saplings)	330 Masonic Homes Drive	$ 88,904.00	3,228,734	59,269
14-Nov-11	Kentucky Center	501 W. Main Street	$ 114,523.00	1,669,877	60,899
14-Nov-11	Sojourn	1201 S. Shelby Street	$ 35,960.00	481,304	15,982
14-Nov-11	Magnolia Avenue Infiltration Trench	Alley running N and S of Magnolia between 2nd and 3rd	$ 209,740.00	5,093,939	332,384

Refer to Volume 2, Chapter 5, and Volume 3 Chapter 5 for detailed overflow volume, frequency and project information

TABLE 5.4.9
BOARD APPROVED GREEN PROJECTS

Board Approval Date	Project	Address	MSD Cost	Typical Year Gallons Removed Annually	Impervious Area Captured (SF)
28-Nov-11	UPS Terminal 32 Phase 1	802 Grade Lane	$ 130,350.00	6,225,800	259,678
28-Nov-11	Flavorman	809 S. 8th Street	$ 67,164.00	1,073,500	44,776
28-Nov-11	Fairdale Library	10620 West Manslick Road	$ 39,381.00	573,800	26,254
28-Nov-11	Liberty Green – Louisville Metro Housing Authority	Marshall & South Hancock Streets	$ 25,569.00	408,700	17,046
28-Nov-11	Hyatt Regency	320 W. Jefferson Street	$ 49,070.00	712,731	32,713
28-Nov-11	Bike Courier Bike Shop	2132 Frankfort Avenue	$ 7,920.00	118,144	5,280
9-Jan-12	Spalding University	845 S 3rd St	$ 492,513.00	8,837,990	328,342
23-Jan-12	Eyedia Design It Again	1631 Mellwood Avenue	$ 24,306.00	366,833	16,204
23-Jan-12	Cobalt Ventures, LLC	310 E. Market Street	$ 52,206.00	954,341	34,804
29-May-12	Fairdale High School	1001 Fairdale Road	$ 440,000.00	6,133,443	251,380
29-May-12	JBS Swift Co.	1200 Story Avenue	$ 57,486.00	1,045,060	38,711
29-May-12	Kentucky Center for the Arts	501 West Main Street	$ 22,500.00	274,204	10,000
29-May-12	Advance Properties	1875 McCloskey Avenue	$ 338,454.00	5,500,468	225,636
25-Jun-12	Butchertown Green Project, CSO 130 Mitigation		$ 792,115.00	7,673,093	345,090
9-Jul-12	Edward T. Davis Living Trust	7420 Distribution Dr	$ 38,025.00	600,495	25,350
9-Jul-12	Parallel Products of KY	1620 Bernheim Lane	$ 397,345.50	8,024,559	264,897
9-Jul-12	Stevens Family Realty	820-832 S. 6th St.	$ 56,314.50	947,606	37,543

TABLE 5.4.9 BOARD APPROVED GREEN PROJECTS					
Board Approval Date	**Project**	**Address**	**MSD Cost**	**Typical Year Gallons Removed Annually**	**Impervious Area Captured (SF)**
9-Jul-12	Southern Star Missionary Baptist Church	2304 Algonquin Pkwy	$ 73,876.00	1,180,784	49,251
9-Jul-12	Louisville Metro Preston Hwy – Green Project	2412-2430 Preston Hwy	$ 246,955.50	3,547,036	164,637
23-Jul-12	Louisville Metro Archive Center	635 Industry Rd	$ 149,281.50	2,301,363	92,021
23-Jul-12	Caperton Lofts, LLC	564 S 4th St	$ 27,847.50	438,456	18,288
23-Jul-12	Park Edge at Liberty Green	425 S Hancock St	$ 25,209.00	407,300	16,806
23-Jul-12	Stevens Family Realty Phase 2	831 S 6th St	$ 15,262.50	255,473	10,175
24-Sep-12	Tube Turns, Inc.	3001 W Broadway	$ 77,000.00	1,234,871	51,640
24-Sep-12	Louisville Metro Government	315-460 W Oak St	$ 20,631.00	377,141	13,754
24-Sep-12	Family and Children's Place	512 W. Kentucky St	$ 90,000.00	2,649,030	98,559
24-Sep-12	Falls City Lofts	415 E Market St	$ 23,634.00	418,790	15,756
24-Sep-12	Parking Authority of River City	120 S 6th St	$ 42,637.50	374,890	28,425
10-Oct-12	Süd-Chemie Inc.	1600 West Hill St	$ 77,804.00	1,492,454	61,886
10-Oct-12	Louisville Metro Housing Authority - Sheppard Square Hope VI Revitalization – Block B	519 E. Jacob St	$ 67,848.00	1,323,275	45,232
26-Nov-12	Louisville Metro Government West Market St Improvements – Pilot Project	3800-3900 W Market St	$ 70,965.00	1,290,708	47,310
26-Nov-12	Signature Healthcare Four Courts	2100 Millvale Road	$ 158,912.00	2,589,039	105,941
26-Nov-12	Family Scholar House, Inc.-Parkland Scholar House	1309 Catalpa Street	$ 27,490.00	1,250,003	49,658

TABLE 5.4.9
BOARD APPROVED GREEN PROJECTS

Board Approval Date	Project	Address	MSD Cost	Typical Year Gallons Removed Annually	Impervious Area Captured (SF)
26-Nov-12	Habitat for Humanity –Restore	1631 Rowan Street	$ 23,000.00	452,932	16,518
11-Feb-13	Signature Healthcare Four Courts– Additional Area	2100 Millvale Road	$ 13,896.00	141,471	9,264
11-Feb-13	Eli Brown & Sons, Inc.	416-430 W Liberty St	$ 76,400.00	1,222,218	54,812
11-Feb-13	LG&E Parking Center	215 W Market St	$ 51,813.00	619,794	34,542
22-Apr-13	Tube Turns, Inc. - EMA Building and Steel Laydown Yard	2820 West Broadway	$ 523,500.00	9,188,205	349,000
6-May-13	Louisville Metro Government 4th Street Improvements	4th St between Chestnut and Muhammad Ali	$ 6,417.00	117,305	4,278
24-Jun-13	Portland Avenue Presbyterian Church	3126 Portland Ave	$ 165,953.00	2,714,116	110,635
24-Jun-13	William Mazzian	736 E. Market St	$ 6,951.00	124,219	4,634
24-Jun-13	Nulu Wayside, LLC	216 S. Shelby St	$ 8,721.00	129,747	5,814
24-Jun-13	Most Blessed Sacrament Senior Apartments, LLLP	1128 Berry Blvd	$ 27,377.23	593,971	22,651
8-Jul-13	UofL – Soccer Complex	2525 S Floyd St	$ 200,000.00	5,861,641	193,938
8-Jul-13	Tube Turns, Inc. - EMA Building and Steel Laydown Yard Phase 2	2820 West Broadway	$ 170,266.00	2,973,159	127,050
23-Sep-13	UofL– Recreational Facility	1900 S 4th St	$ 389,869.50	7,718,294	259,913
23-Sep-13	Southern Baptist Theological Seminary	2825 Lexington Rd	$ 629,917.75	25,608,654	608,098
23-Sep-13	Papillon Property Group – Angel's Envy	101 S Jackson St	$ 19,879.00	1,301,853	39,758
23-Sep-13	UofL – Chevron Property	1710 S 5th St	$ 201,047.00	10,221,991	402,093
16-Dec-13	Village Manor Partners, LTD	105 Fenley Ave	$ 266,539.50	4,714,095	185,000

TABLE 5.4.9
BOARD APPROVED GREEN PROJECTS

Board Approval Date	Project	Address	MSD Cost	Typical Year Gallons Removed Annually	Impervious Area Captured (SF)
16-Dec-13	Dupont Manual Apartments, LLC	1201 Brook St	$ 24,741.00	436,964	16,494
16-Dec-13	Portland Properties, Inc.	3130 Portland Ave	$ 23,220.00	407,688	15,480
16-Dec-13	Louisville Metro Government (Oak Street Streetscape)	3rd Street to Garvin Place	$ 52,935.00	967,667	35,290
Pending	Southern Baptist Theological Seminary - Phase 2	2825 Lexington Rd	$ 781,560.25	34,442,819	849,420
Pending	Hunt Properties LLC		$ 263,971.50	4,242,542	175,981
Pending	Sheppard Square Hope VI Revitalization - Block A, C and D		$ 124,834.50	3,386,377	83,223
		TOTALS	**$10,885,912.74**	**342,380,038**	**12,431,211**

The approved MS4 permit for stormwater control includes a pending proposal for mandatory inclusion of green practices in new and re-developed areas through a revision to MSD's Wastewater Discharge Regulations (WDRs) to capture 1-inch of rainfall in the CSS and 0.6 inches in the Separate Sewer Area. When MSD board approval of these revisions is finalized, MSD may enhance the existing private property incentive program to provide a financial incentive for those partners that capture additional volumes to what is required. This incentive may align with capturing the level of control event for the CSO basin in which the green project is located.

Finally, a Green BMP manual was developed and published in 2011. This guidance was adopted as Chapter 18 of the MSD Design Manual. It includes design details, standard drawings, and calculations for impacts of a variety of green controls. This document is available online at http://www.msdlouky.org/insidemsd/standard-drawings.htm. The BMP manual is reviewed annually, and updated as appropriate as a result of that review.

Illicit Connection Program

Source control measures related to removing illicit connections from MSD's sewer system, both in the combined and separate systems, can play a vital role in reducing sewer overflows and protecting, lowering the risk of basement backups and reducing treatment costs. MSD currently offers a voluntary program for plumbing modification on private property to protect against backups and remove illicit connections such as downspouts and sump pumps. MSD's WDRs provide a framework around which a more extensive policy regarding the removal of these connections from MSD's system will be developed for consideration by MSD's Board. Additional detail regarding this effort can be found in Volume 1, Chapter 4.5 regarding source control.

Performance Evaluation

To collect data and analyze the long-term performance of various green practice types, MSD is working with the EPA Office of Research and Development (ORD) and the University of Louisville (U of L) Center for Infrastructure Research (CIR) to install instrumentation in green practices. The analysis will determine both the individual performance of these practices over time as well as establish the collected effectiveness of using green technologies in achieving projected sewer overflow reductions. Maintenance effects on performance are also being studied in order to determine the best methods, equipment and frequency. This information will then be use to set up best practices for green implementation, operations and maintenance.

The objective of the 19 demonstration projects and work with EPA ORD and the University of Louisville is for MSD to build and monitor the variety of green techniques during the initial years of the Final CSO LTCP in order to develop and refine effective design standards and operation and maintenance information to incorporate into changes to the Green BMP Manual. In addition, MSD will use information gathered from the first several demonstration projects to refine specific design and construction standards, and operation and maintenance information for inclusion in future updates of the manual, to be evaluated annually.

Operation and maintenance of green BMPs will be very site specific. As MSD partners with other Louisville Metro public agencies or entities, specific operation and maintenance agreements will be developed for each BMP. These agreements will establish the roles and responsibilities for both MSD and the partner for the specific BMP. As operation and maintenance techniques are refined, updates will be made to the BMP manual.

MSD developed a tracking program through the HANSEN asset management software to monitor locations of green controls, assign inspectors, and created a container for project files (plans, inspection reports, etc.). Training on this management system occurred in 2012. As new demonstration projects, partner opportunities, and private property programs are constructed and implemented the locations and information for the green controls will be added to Hansen on an annual basis. Using updated Hansen information, a GIS layer will be generated annually showing locations of green controls in the Louisville Metro area including; downspout disconnects, rain barrels, green roofs, porous pavements, and rain gardens. MSD will utilize the information gathered from the initial demonstration projects to refine administrative tracking and inspection practices, triggers for maintenance, as well as specific maintenance procedures for the different types of green controls being implemented in Louisville. These tracking mechanisms will allow for easier transition of locations and data into hydraulic models for assessment of impacts on downstream gray controls.

MSD worked with Louisville Metro to evaluate and review current regulations, for example the Land Development Code for Jefferson County, with the goal of promoting green infrastructure throughout the community. Comments and recommendations were provided as part of this process, with many of the recommendations being incorporated into the code. Going forward, recommendations for revisions to local regulations will be continually submitted to the appropriate agencies in order for green infrastructure to be made widely incorporated in the Louisville Metro area. However, it is important to understand that MSD can only make recommendations regarding revisions to ordinances, manuals and codes outside of its own jurisdiction and cannot commit to a date for adoption of said recommendations. When the Land Development Code is reviewed in the future, MSD will review and supply comments on the promotion and inclusions of green controls into development.

Parallel to the IOAP, MSD staff is implementing programs for compliance with the MS4 permit for stormwater. Many of these efforts provide reciprocal benefits in the CSS by reducing storm flows, public awareness, and best management practices that also reduce overflows. Throughout the course of IOAP and MS4 implementation, staff will work together to provide solutions to stormwater management and overflow reduction through these programs.

TABLE 5.3.1
2012 LTCP REVISED LEVEL OF CONTROL ANALYSIS

								0 Overflows/YR		2 Overflows/YR		4 Overflows/YR		8 Overflows/YR							Cost Difference	
Project Name	**IOAP Number**	**Receiving Stream**	**2009 Overflows Controlled**	**2009 LTCP LOC (Overflows per Year)**	**2009 LTCP Size (MG)**	**2009 LTCP Cost**	**2009 Completion Date**	**Size (MG) or Rate (mgd)**	**Present Worth Benefit-Cost**	**Size (MG) or Rate (mgd)**	**Present Worth Benefit-Cost**	**Size (MG) or Rate (mgd)**	**Present Worth Benefit-Cost**	**Size (MG) or Rate (mgd)**	**Present Worth Benefit-Cost**	**2012 Overflows Controlled**	**2012 LTCP LOC (Overflows per Year)**	**2012 Re-assessment Size (MG)**	**2012 LTCP / Re-assessment Cost**	**2012 Completion Date**	**2012 Re-assessment Cost vs. 2009 LTCP Cost**	**Comments**
Adams Street Sewer Separation	L_OR_MF_172_S_09B_B_A_0	Ohio River	CSO172	0	0.12	$983,000	12/31/2012	-	-	-	-	-	-	-	-	CSO172	0	N/A	$20,000	12/31/2012	($963,000)	Project modification request to revise this project to a sewer separation has been previously submitted and accepted. Upon inspection of the sewer system, all but two catch basins were found to have been separated already during recent redevelopment.
CSO058 In-line Storage and Green Infrastructure	L_OR_MF_058_S_08_A_A_0	Ohio River	CSO058	0	Sewer Separation	$1,361,000	12/31/2014	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	N/A (overflows caused by surcharging)	CSO058	8	Weir Modifications as Part of 13th & Rowan Solution	N/A	12/31/2014 (Weir Modification) 12/21/2020 (w/ 13th & Rowan Solution)	($1,361,000)	The overflow from this CSO will be addressed in the 13th & Rowan storage basin. Modeling indicates that the overflow is caused by interceptor surcharging. Separation of the small drainage area upstream of the CSO would be ineffectual. Weir modifications for CSO058 will be performed in 2014. Costs associated with modifications and CSO058 are included in the 13th & Rowan solution.
CSO093 Structural Modifications & Green Infrastructure	L_SO_MF_093_S_08_A_A_0	South Fork	CSO093	0	Sewer Separation	$952,000	12/31/2015	-	91.53	-	91.53	-	91.53	-	91.53	CSO093	0	0	$488,000	12/31/2015	($464,000)	The project modification involves the re-construction of the CSO structure to replace the existing leaping weir with a more conventional overflow weir.
CSO140 In-Line Storage & Green Infrastructure Controls	L_MI_MF_140_S_08_A_A_0	Middle Fork	CSO140	0	Sewer Separation	$3,150,000	12/31/2015	-	367.21	-	367.21	-	367.21	-	367.21	CSO140	0	0	$574,000	12/31/2015	($2,576,000)	The project modification involves the re-construction of the CSO structure to increase the low flow line to a 42-inch diameter opening which will increase the conveyance capacity.
CSO160 In-Line Storage & Green Infrastructure Controls	L_OR_MF_160_S_08_A_A_0	Ohio River	CSO160	0	Sewer Separation	$237,000	12/31/2015	-	684.49	-	257.67	-	-40.54	-	-1538.46	CSO160	0	0	$231,000	12/31/2015	($6,000)	The project modification involves the creation of in-line storage provided by a combination of raising the existing overflow weir and installing 88 feet of 72-inch diameter pipe.
I-64 and Grinstead Drive Storage Basin	L_MI_MF_127_M_09B_B_A_8	Middle Fork	CSO125, CSO126, CSO127, CSO166	8	2.74	$12,950,000	12/31/2014	22.8	17.71	17.7	17.94	15.33	19.25	12.56	16.88	CSO125, CSO126, CSO127, CSO166	4	15.33	$48,591,000	12/31/2020	$35,641,000	Public comments received requested serious consideration for green infrastructure utilization in the basin drainage area along with intensive public involvement. Due to the size of the drainage area and the increased size and cost of the basin, additional time is needed to evaluate green infrastructure opportunities and right-size this project appropriately.
Bells Lane Wet Weather Treatment Facility (formerly Paddy's Run)	L_OR_MF_015_M_13_B_B_8	Ohio River	CSO015, CSO191	8	50 MGD	$24,940,000	12/31/2014	100 MGD/37 MG	9.11	50 MGD/44 MG	6.88	50 MGD/41 MG	6.02	50 MGD/25 MG	9.31	CSO015, CSO191	8	50 MGD/25 MG	$68,472,000	12/31/2016	$43,532,000	Optimization of flow through Morris Forman's Main Diversion Structure and MSD's Real Time Control strategy added storage volume requirements. Additional time for construction is being requested due to size increase, moving the site, offline storage and integration of Southwestern Pump Station.
Story Avenue and Main Street Storage Basin	L_OR_MF_020_S_09B_B_A_8	Ohio River	CSO020	8	0.13	$1,580,000	12/31/2013	16.58	11.81	9.79	13.99	7.12	18.45	5.42	20.37	CSO020	8	5.42	$12,576,000	12/31/2020	$10,996,000	Story and Main & 13th and Rowan basins are linked together functionally. Story & Main grew substantially in size due to more conservative operational assumptions for Starkey PS. MSD proposes to split out and accelerate the schedule of CRD/CSO 22/CSO 23/CSO054 projects using green infrastructure and localized storage. Additional time is requested to right size the Story/Main and 13th/Rowan basins once the impacts of green infrastructure and upstream storage are realized and monitored.
Story Avenue and Spring Street Green Infrastructure	L_SO_MF_130_S_09B_B_A_8	South Fork	CSO130	8	0.01	$1,077,000	12/31/2016	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	NA - Green Practices Sized to Achieve 2009 LOC	CSO130	8	NA (Green Projects)	$896,000	12/31/2016	($181,000)	A project modification to use a suite of green infrastructure projects in lieu of the storage basin was previously approved and has been constructed. Overflow reduction performance is being evaluated. No schedule change for overflow reduction is anticipated.
13th Street and Rowan Street Storage Basin	L_OR_MF_155_M_09B_B_B_4	Ohio River	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO155 and Central Relief Drain CSO's (11 total w/ AAOV)	4	14.44	$49,680,000	12/31/2020	11.75	45.54	8.78	41.17	6.44	47.83	4.36	51.31	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO058, CSO150, CSO155	8	4.36	$27,863,000	12/31/2020	($21,817,000)	MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule. CSO 58 will also be included with this project and weir modifications for CSO 58 are included with the revised cost.
Southern Outfall In-line Storage at 43rd Street (SOR1)	L_OR_MF_211_M_13_B_A_8	Ohio River	N/A	N/A	NA	NA	N/A	12.66 + 16.1 (Inline Storage)	52.93	7.82 + 16.1 (Inline Storage)	56.08	0.81 + 16.1 (Inline Storage)	78.64	16.1 (Inline Storage)	113.96	CSO016/210	8	11.4	$3,544,000	12/31/2018	$3,544,000	New stand-alone project. Optimized operating rules between Bells Lane WWWTF and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Relief 1 and Southern Outfall Relief 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.
Southern Outfall In-line Storage at 12th Street & Wilson Avenue (SOR2)	L_OR_MF_211_M_13_B_A_8	Ohio River	N/A	N/A	NA	NA	N/A	12.66 + 16.1 (Inline Storage)	52.93	7.82 + 16.1 (Inline Storage)	56.08	0.81 + 16.1 (Inline Storage)	78.64	16.1 (Inline Storage)	113.96		8	4.7	$3,544,000	12/31/2018	$3,544,000	New stand-alone project. Optimized operating rules between Bells Lane WWTF and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Relief 1 and Southern Outfall Relief 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.
Algonquin Parkway Storage Basin	L_OR_MF_211_M_13_B_A_8	Ohio River	CSO016, CSO210, CSO211	8	4.84	$17,300,000	12/31/2018	-	-	-	-	-	-	-	-	N/A	N/A	N/A	N/A	Eliminated	($17,300,000)	Offline storage eliminated. Optimized operating rules between Bells Lane WWTF and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Relief 1 and Southern Outfall Relief 2. MSD proposes to eliminate the Algonquin storage basin portion of the project.

TABLE 5.3.1
2012 LTCP REVISED LEVEL OF CONTROL ANALYSIS

								0 Overflows/YR		2 Overflows/YR		4 Overflows/YR		8 Overflows/YR							Cost Difference	
Project Name	IOAP Number	Receiving Stream	2009 Overflows Controlled	2009 LTCP LOC (Overflows per Year)	2009 LTCP Size (MG)	2009 LTCP Cost	2009 Completion Date	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	Size (MG) or Rate (mgd)	Present Worth Benefit-Cost	2012 Overflows Controlled	2012 LTCP LOC (Overflows per Year)	2012 Re-assessment Size (MG)	2012 LTCP / Re-assessment Cost	2012 Completion Date	2012 Re-assessment Cost vs. 2009 LTCP Cost	Comments
Beargrass Creek South Fork Parallel Interceptor	L_SO_MF_097_M_13_A_A_8	South Fork	N/A	N/A	N/A	$12,994,000	12/31/2017	-	-	-	-	-	-	-	-	N/A	N/A	N/A	N/A	Eliminated	($12,994,000)	Consolidation of Calvary/Creekside Basin with Logan Street Basin makes the parallel interceptor unnecessary.
Central Relief Drain (CRD) CSO In-line Storage, Green Infrastructure & Distributed Storage	L_OR_MF_155_M_09B_B_B_4	Ohio River	N/A	N/A	N/A	N/A	N/A	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	NA - Storage and Green Practices Sized to Achieve 2009 LOC	Central Relief Drain CSOs (13 total with an AAOV: CSO028, CSO029, CSO034, CSO036, CSO178, CSO181, CSO193, CSO195, CSO196, CSO197, CSO199, CSO200, CSO202)	8	Diversion, Weir Modifications & Green Infrastructure	$2,184,000	12/31/2020	$2,184,000	New project. MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule.
Clifton Heights Storage Basin	L_MU_MF_154_M_09B_B_A_8	Muddy Fork	CSO132, CSO154, CSO167	8	6.55	$13,870,000	12/31/2018	7.86	62.27	5.43	66.45	4.28	76.85	3.09	73.97	CSO088, CSO131, CSO132, CSO154, CSO167	4	4.28	$14,166,000	12/31/2018	$296,000	No changes are proposed for this project schedule.
Lexington Road and Payne Street Storage Basin	L_SO_MF_083_M_09B_B_A_8	South Fork	CSO082, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	8	7.31	$25,200,000	12/31/2020	8.18	75.16	6.73	65.1	5.95	70.26	4.03	73.08	CSO082, CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	0	8.18	$25,904,000	12/31/2020	$704,000	No changes are proposed for this project schedule.
Logan Street and Breckinridge Street Storage Basin	L_SO_MF_092_M_09B_B_D_8	South Fork	CSO091, CSO113, CSO117, CSO146, CSO149, CSO152	8	Logan 11.83 Calvary 3.46 Combined 15.29	Logan - $30,320,000 Calvary - Combined - $44,040,000	12/31/2017	34.2	50.29	26.71	50.93	20.96	60.48	16.6	61.19	CSO091, CSO097, CSO106, CSO110, CSO111, CSO113, CSO117, CSO137, CSO146, CSO148, CSO149, CSO151, CSO152	8	16.6	$48,243,000	12/31/2017	$4,203,000	A review of project approach and benefit/cost results eliminated the Calvary Creekside basin, consolidating storage to the Logan Street basin location. No changes to schedule are proposed.
Nightingale Pump Station Offline Storage and Pump Station Upgrade	L_SO_MF_018_S_03_A_A	South Fork	CSO018	0	60 MGD/0 MG	$15,710,000	12/31/2016	33 MGD/7.7 MG	9.92	33 MGD/2.54 MG	7.58	33 MGD/2.03 MG	8.07	33 MGD/0.45MG	3.99	CSO018	0	33 MGD/7.7 MG	$22,123,000	12/31/2016	$6,413,000	
18th and Northwestern Pkwy Storage Basin	L_OR_MF_190_S_09B_B_A_8	Ohio River	CSO190	8	1.31	$4,514,000	12/31/2017	2.06	53.14	1.88	47.22	1.76	49.09	1.24	54.33	CSO190	8	1.24	$5,039,000	12/31/2017	$525,000	Project slightly smaller, green infrastructure being considered to replace basin.
Southwestern Parkway Storage Basin	L_OR_MF_105_M_13_B_A_0	Ohio River	CSO104, CSO105, CSO189	0	5.08	$17,620,000	12/31/2018	11.07	24.06	8.4	22.54	7	22.59	5.08	19.39	CSO104, CSO105, CSO189	0	11.07	$30,937,000	12/31/2018	$13,317,000	No changes are proposed for this project schedule.
NO CHANGE																						
CSO108 Dam Modification	L_SO_MF_108_S_09A_B_A_4	South Fork	CSO108	4	-	$150,000	12/31/2010	-	-	-	-	-	-	-	-	CSO108	NA	NA	$150,000	12/31/2010	$0	Completed
CSO123 Downspout Disconnection	L_MI_MF_123_S_08_A_A_0	Middle Fork	CSO123	NA	-	$315,000	12/31/2012	-	-	-	-	-	-	-	-	CSO123	NA	NA	$315,000	12/31/2012	$0	Completed
CSO206 Sewer Separation	L_MI_MF_206_S_08_A_A_0	Middle Fork	CSO206	NA	-	$3,842,000	12/31/2013	-	-	-	-	-	-	-	-	CSO206	NA	NA	$3.842,000	12/31/2013	$0	Completed
Portland Wharf Storage Basin	L_OR_MF_019_S_13_B_A_8	Ohio River	CSO019	8	6.37	$20,000,000	12/31/2019	-	-	-	-	-	-	-	-	CSO019	8	6.37	$20,000,000	12/31/2019	$0	

TABLE 5.3.2 2012 FINAL LTCP PROJECT SUITE AND REVISED PROJECT SCHEDULE

ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_172_S_09B_B_A_0	**Adams Street Sewer Separation**	Ohio River	CSO172	0	0.12	$983,000	CSO172	0	Sewer Separation	$20,000	12/31/2012	12/31/2012	Project modification request to revise this project to a sewer separation has been previously submitted and accepted. Upon inspection of the sewer system, all but two catch basins were found to have been separated already during recent redevelopment. Project Completed - Monitoring Ongoing
L_OR_MF_058_S_08_A_A_0	**CSO058 In-line Storage and Green Infrastructure**	Ohio River	CSO058	0	Sewer Separation	$1,361,000	N/A	8	Weir Modifications As Part of 13th & Rowan Solution	N/A	12/31/2014	12/31/2014 (Weir Modification) 12/21/2020 (w/ 13th & Rowan Solution)	The overflow from this CSO will be addressed in the 13th & Rowan storage basin. Modeling indicates that the overflow is caused by interceptor surcharging. Separation of the small drainage area upstream of the CSO would be ineffectual. Weir modifications for CSO058 will be performed in 2014. Costs associated with modifications and CSO058 are included in the 13th & Rowan solution.
L_SO_MF_093_S_08_A_A_0	**CSO093 Structural Modifications & Green Infrastructure**	South Fork	CSO093	0	Sewer Separation	$952,000	CSO093	0	Structural Modifications & Green Infrastructure	$488,000	12/31/2015	12/31/2015	The project modification involves the re-construction of the CSO structure to replace the existing leaping weir with a more conventional overflow weir.
L_MI_MF_140_S_08_A_A_0	**CSO140 In-Line Storage & Green Infrastructure Controls**	Middle Fork	CSO140	0	Sewer Separation	$3,150,000	CSO140	0	Pipe upgrade & Green Infrastructure	$574,000	12/31/2015	12/31/2015	The project modification involves the re-construction of the CSO structure to increase the low flow line to a 42-inch diameter opening which will increase the conveyance capacity.
L_OR_MF_160_S_08_A_A_0	**CSO160 In-Line Storage & Green Infrastructure**	Ohio River	CSO160	0	Sewer Separation	$237,000	CSO160	0	Inline Storage & Weir Modifications	$231,000	12/31/2015	12/31/2015	The project modification involves the creation of in-line storage provided by a combination of raising the existing overflow weir and installing 88 feet of 72-inch diameter pipe.
L_MI_MF_127_M_09B_B_A_8	**I-64 and Grinstead Drive Storage Basin****	Middle Fork	CSO125, CSO126, CSO127, CSO166	8	2.74	$12, 950,000	CSO125, CSO126, CSO127, CSO166	4	8.5 plus stormwater diversions	$38,590,000	12/31/2014	12/31/2020	Public comments received requested serious consideration for green infrastructure utilization in the basin drainage area along with intensive public involvement. Due to the size of the drainage area and the increased size and cost of the basin, additional time is needed to evaluate green infrastructure opportunities and right-size this project appropriately.
L_OR_MF_015_M_13_B_B_8	**Bells Lane Wet Weather Treatment Facility (formerly known as Paddy's Run)**	Ohio River	CSO015, CSO191	8	50 MGD	$24,940,000	CSO015, CSO191	8	50 MGD/ 25 MG Storage	$68,472,000	12/31/2014	12/31/2016	Optimization of flow through Morris Forman's Main Diversion Structure and MSD's Real Time Control strategy added storage volume requirements. Additional time for construction is being requested due to size increase, moving the site, offline storage and integration of Southwestern Pump Station.
L_OR_MF_020_S_09B_B_A_8	**Story Avenue and Main Street Storage Basin**	Ohio River	CSO020	8	0.13	$1,580,000	CSO020	8	5.42	$12,576,000	12/31/2013	12/31/2020	Story and Main & 13th and Rowan basins are linked together functionally. Story & Main grew substantially in size due to more conservative operational assumptions for Starkey PS. MSD proposes to split out and accelerate the schedule of CRD/CSO 22/CSO 23/CSO054 projects using green infrastructure and localized storage. Additional time is requested to right size the Story/Main and 13th/Rowan basins once the impacts of green infrastructure and upstream storage are realized and monitored.
L_SO_MF_130_S_09B_B_A_8	**Story Avenue and Spring Street Storage Basin**	South Fork	CSO130	8	0.01	$1,077,000	CSO130	8	Green Infrastructure	$896,000	12/31/2016	12/31/2016	A project modification request to use a suite of green infrastructure projects in lieu of the storage basin is anticipated in early 2012. No schedule change for overflow reduction is anticipated.
L_OR_MF_155_M_09B_B_B_4	**13th Street and Rowan Street Storage Basin**	Ohio River	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150, CSO155 and Central Relief Drain CSO's (11 total w/ AAOV)	4	14.44	$49,680,000	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO058, CSO150, CSO155	8	4.36	$27,863,000	12/31/2020	12/31/2020	MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule. CSO 58 will also be included with this project and weir modifications for CSO 58 are included with the revised cost.
L_OR_MF_211_M_13_B_A_8	**Southern Outfall In-line Storage (SOR1) at 43rd Street**	Ohio River	N/A	N/A	NA	NA	CSO016/210	8	11.4	$3,544,000	12/31/2018	12/31/2018	New stand-alone project. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.

TABLE 5.3.2 2012 FINAL LTCP PROJECT SUITE AND REVISED PROJECT SCHEDULE

ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_211_M_13_B_A_8	**Southern Outfall In-line Storage (SOR2) at 12th Street and Wilson**	Ohio River	N/A	N/A	NA	NA	CSO211	8	4.7	$3,544,000	12/31/2018	12/31/2018	New stand-alone project. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes eliminate the Algonquin storage basin portion of the project and complete the two inline storage basins by the original completion date. Costs of the total SOR1 and SOR2 projects combined were developed with the costing tool and split evenly amongst the 2 projects in this spreadsheet.
L_OR_MF_211_M_13_B_A_8	**Algonquin Parkway Storage Basin/In-line Storage**	Ohio River	CSO016, CSO210, CSO211	8	4.84	$17,300,000	N/A	N/A	N/A	N/A	12/31/2018	Eliminated	Offline storage eliminated. Optimized operating rules between Paddy's Run HRT and Morris Forman's Main Diversion Structure demonstrated that only inline storage was needed at Southern Outfall Retention 1 and Southern Outfall Retention 2. MSD proposes to eliminate the Algonquin storage basin portion of the project.
L_SO_MF_097_M_13_A_A_8	**Beargrass Creek Parallel Interceptor**	N/A	N/A	N/A	N/A	$12,994,000	N/A	N/A	N/A	N/A	12/31/2017	Eliminated	Consolidation of Calvary/Creekside Basin with Logan Street Basin makes the parallel interceptor unnecessary.
L_SO_MF_097_M_09B_B_D_8	**Calvary Creekside Storage Basin**	South Fork	CSO097, CSO106, CSO110, CSO111, CSO137, CSO148, CSO151	8	3.46	$13,720,000	N/A	N/A	N/A	N/A	12/31/2017	Eliminated	Basin volume now addressed through Logan Street. Project is proposed to be eliminated.
L_OR_MF_155_M_09B_B_B_4	**Central Relief Drain (CRD) CSO In-Line Storage, Green Infrastructure & Distributed Storage**	Ohio River	N/A	N/A	N/A	N/A	Central Relief Drain CSOs (13 total with an AAOV: CSO028, CSO029, CSO034, CSO036, CSO178, CSO181, CSO193, CSO195, CSO196, CSO197, CSO199, CSO200, CSO202)	8	Diversion, Weir Modifications & Green Infrastructure	$2,184,000	N/A	12/31/2018	New project. MSD proposes to split CRD & 13th and Rowan projects into separate projects. The storage basin and CRD projects are proposed to remain on the same schedule.
L_MU_MF_154_M_09B_B_A_8	**Clifton Heights Storage Basin**	Muddy Fork	CSO132, CSO154, CSO167	8	6.55	$13,870,000	CSO088, CSO131, CSO132, CSO154, CSO167	4	7	$19,575,000	12/31/2018	12/31/2018	No changes are proposed for this project schedule.
L_SO_MF_083_M_09B_B_A_8	**Lexington Road and Payne Street Storage Basin**	South Fork	CSO082, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	8	7.31	$25,200,000	CSO082, CSO083, CSO084, CSO118, CSO119, CSO120, CSO121, CSO141, CSO153	0	8.18	$25,904,000	12/31/2020	12/31/2020	No changes are proposed for this project schedule.
L_SO_MF_092_M_09B_B_D_8	**Logan and Breckinridge Street Storage Basin**	South Fork	CSO091, CSO113, CSO117, CSO146, CSO149, CSO152	8	11.83	$30,320,000	CSO091, CSO097, CSO106, CSO110, CSO111, CSO113, CSO117, CSO137, CSO146, CSO148, CSO149, CSO151, CSO152	8	16.6	$48,243,000	12/31/2017	12/31/2017	A review of project approach and benefit/cost results eliminated the Calvary Creekside basin, consolidating storage to the Logan Street basin location. No changes to schedule are proposed.
L_SO_MF_018_S_03_A_A	**Nightingale Pump Station Replacement & Storage**	South Fork	CSO018	0	60 MGD/0 MG	$15,710,000	CSO018	0	33 MGD/7.7 MG	$22,123,000	12/31/2016	12/31/2016	Pump Station size was reduced as a result of adding storage.
L_OR_MF_190_S_09B_B_A_8	**18th and Northwestern Pky. Storage Basin**	Ohio River	CSO190	8	1.31 MG	$4,514,000	CSO190	8	1.24	$4,486,000	12/31/2017	12/31/2017	Project slightly smaller
L_OR_MF_105_M_13_B_A_0	**Southwestern Parkway Storage Basin**	Ohio River	CSO104, CSO105, CSO189	0	5.08	$17,620,000	CSO104, CSO105, CSO189	0	11.07	$30,937,000	12/31/2018	12/31/2018	No changes are proposed for this project schedule.
	NO CHANGE												
L_SO_MF_108_S_09A_B_A_4	**CSO108 Dam Modification**	South Fork	CSO108	N/A	N/A	$150,000	CSO108	N/A	N/A	$150,000	12/31/2010	12/31/2010	Project Completed - Monitoring Ongoing
L_MI_MF_123_S_08_A_A_0	**CSO123 Downspout Disconnection**	Middle Fork	CSO123	N/A	N/A	$315,000	CSO123	N/A	N/A	$315,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_MI_MF_206_S_08_A_A_0	**CSO206 Sewer Separation**	Middle Fork	CSO206	N/A	N/A	$3,842,000	CSO206	N/A	N/A	$3,842,000	12/31/2013	12/31/2013	Project Completed - Monitoring Ongoing
L_OR_MF_019_S_13_B_A_8	**Portland Wharf Storage Basin**	Ohio River	CSO019	8	6.37 MG	$20,000,000	CSO019	8	6.37	$20,000,000	12/31/2019	12/31/2019	

TABLE 5.3.2 2012 FINAL LTCP PROJECT SUITE AND REVISED PROJECT SCHEDULE

ACD Project Number	Project Name	Receiving Stream	2009 Overflows Controlled	2009 Level of Control	2009 Size (MG)	2009 Cost	2012 Overflows Controlled	2012 LOC	2012 Revised Size (MG)	2012 Revised Cost (in 2008 dollars)	2009 Completion Date	Proposed Completion Date	Explanation for Proposed Revisions or Comments
L_OR_MF_019_S_03_A_B	**34th Street Flood Pump Station**	Ohio River	CSO019	N/A	N/A	$541,000	CSO019	N/A	N/A	$541,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_OR_MF_022_M_03_A_A	**4th Street Flood Pump Station**	Ohio River	CSO022, CSO023	N/A	N/A	$944,000	CSO022, CSO023	N/A	N/A	$944,000	12/31/2012	12/31/2012	Project Completed - Monitoring Ongoing
L_OR_MF_019_S_03_A_A	**27th Street Flood Pump Station**	Ohio River	CSO019	N/A	N/A	$476,000	CSO019	N/A	N/A	$476,000	6/30/2013	6/30/2013	Project Completed - Monitoring Ongoing
L_OR_MF_189_M_03_A_A	**Shawnee Flood Pump Station**	Ohio River	CSO104, CSO105, CSO189	N/A	N/A	$411,000	CSO104, CSO105, CSO189	N/A	N/A	$411,000	6/30/2013	6/30/2013	Project Completed - Monitoring Ongoing
L_OR_MF_190_S_03_A_A	**17th Street Flood Pump Station**	Ohio River	CSO190	N/A	N/A	$625,000	CSO190	N/A	N/A	$625,000	12/31/2014	12/31/2014	

Green
Demonstration

Gray Solutions

Beargrass Creek
Muddy Fork

CSO Project Fact Sheet
2012 IOAP Project Modification

Project Name: Clifton Heights Storage Basin

Project Number: L_MU_MF_154_M_09B_B_A_8

Project Type: Off-Line Storage

Rec Stream: Muddy Fork Beargrass Creek

Project Description: This projet includes a 7.0 MG storage basin and conveyance from each CSO to achieve 4 overflows in a typical year.

Design Assumption: Basin is designed to the 5th Overflow volume. Portions of the existing oveflow pipe from CSO 132 may be used for CSO conveyance depending on potential direct stormwater contibutions.

Capital Cost: $19,757,000

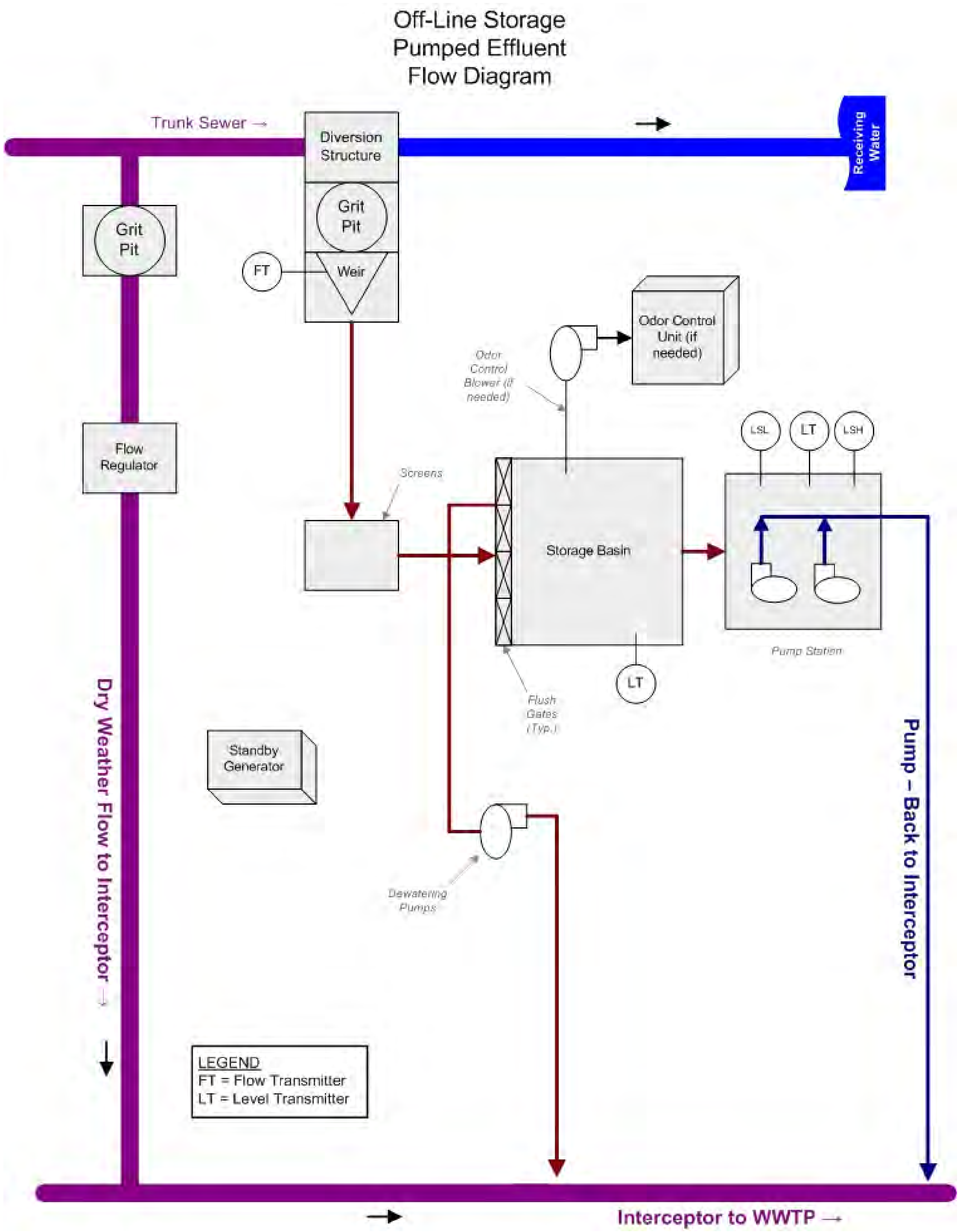
Capital Benefit/Cost: 68.88

Present Worth Benefit Cost: 76.85

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO088	MELLWOOD AVE INT	21.25	38	19.36	36
CSO131	REG NO 33 - MELWD & FRANKFORT	2.42	20	2.42	20
CSO132	REG NO 35 - BROWNSBORO	30.97	36	25.41	34
CSO154	MELLWOOD @ SCHOEFFEL	26.33	40	27.32	38
CSO167	BROWNSBORO LAT NO 2	0.00	1	0.00	0

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
Flush Gates (Typ.)
LT
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
Standby Generator
Dewatering Pumps
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →

Integrated Overflow Abatement Plan
Vol. 2 - Final CSO Long Term Control Plan

Muddy Fork Beargrass Creek

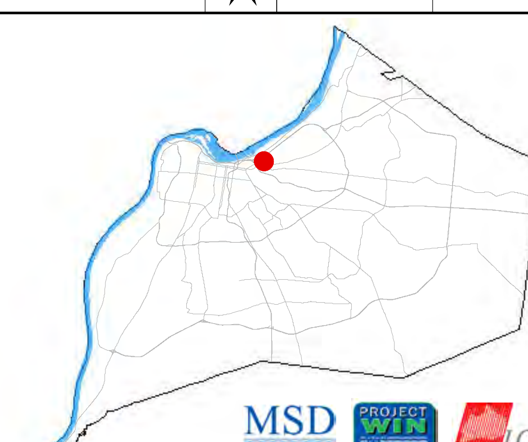
Clifton Heights Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- PS Proposed Pump Station Solution
- PS Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 14, 2014



MSD PROJECT WIN LOJIC

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\Clifton_Heights_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

Beargrass Creek South Fork

CSO Project Fact Sheet
2012 IOAP Project Modification

Project Name: CSO108 Dam Modification

Project Number: L_SO_MF_108_S_09A_B_A_4

Project Type: In-Line Storage

Rec Stream: South Fork Beargrass Creek

Project Description: This project includes the installation of a bending weir at CSO108 to increase the in-line storage capability at the twin 7 foot box culvert, located at Trevilian Way.

Design Assumption: The height of the bending weir is designed to reduce the number of overflows at CSO108 to 4 overflows / year.

Capital Cost: $150,000

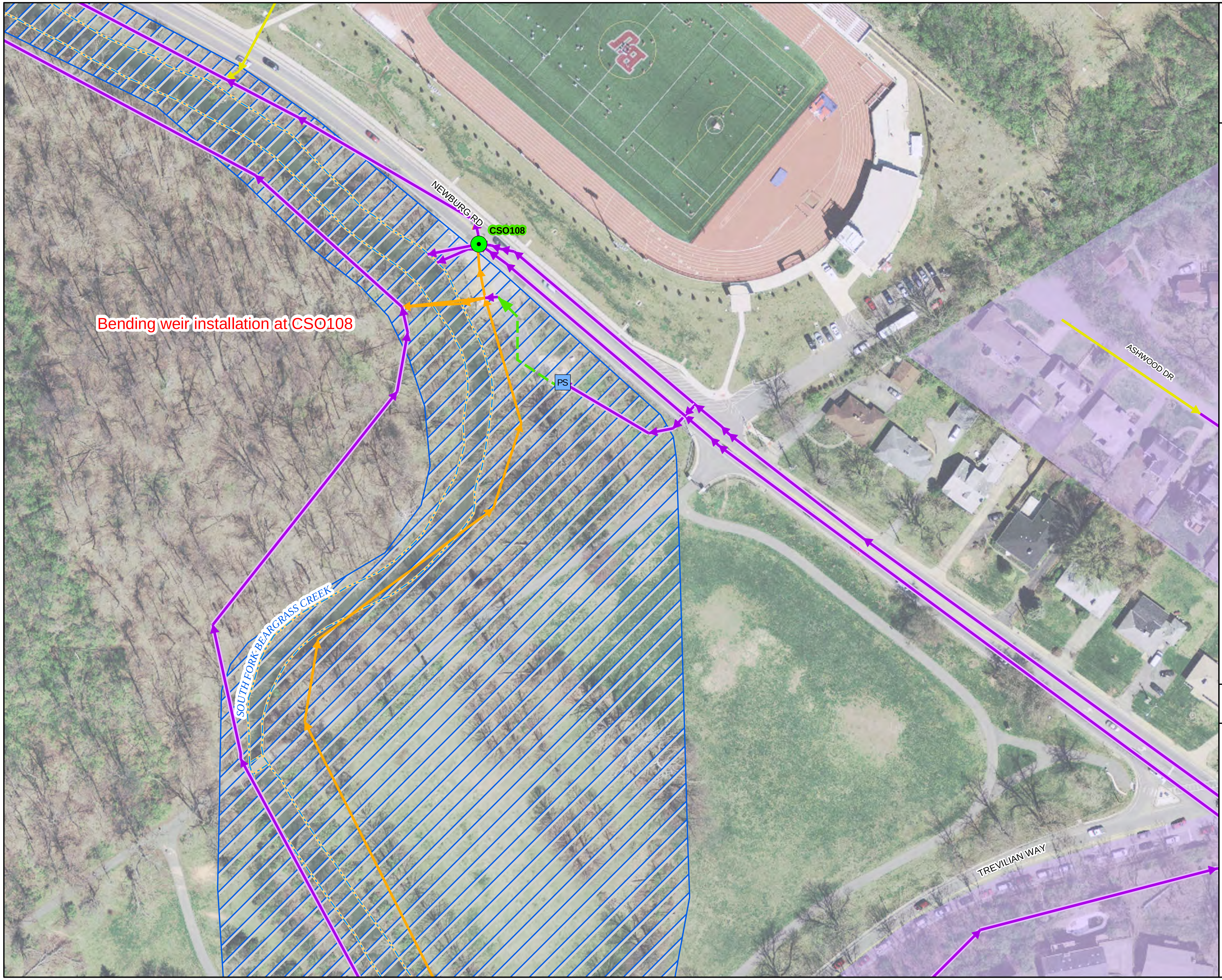
Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO108	REG N0 1 - NEWBURG	43.86	33	15.13	34

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

South Fork Beargrass Creek

CSO108 Dam Modification

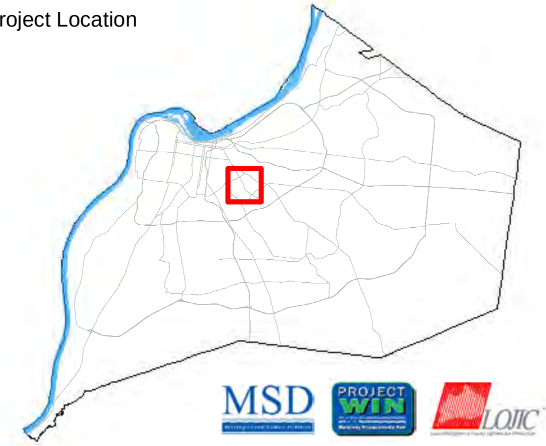
Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Haulop Locations
- Pump Stations
- MSD
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

Project Location



CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Nightingale Pump Station Replacement & Storage

Project Number: L_SO_MF_018_S_03_A_A

Project Type: Offline Storage/Pump Station Upgrade

Rec Stream: South Fork Beargrass Creek

Project Description: This project includes an upgrade of the Nightingale Pump Station (NGPS) to 33 MGD. It will also include a 7.7 MG storage basin with a conveyance line to the basin and both a conveyance line and pump station to pump out of the basin. As a result of a downstream bottleneck within the system, a 15" pipe will be constructed downstream of the pump station force main near Preston Highway and Manning Road to convey the increased flow from the pump station. A flow control structure will be built between the BGI and CSO018 overflow line.

Design Assumption: The project assumes the NGPS will pump at a rate of 33 MGD during wet weather flow. All overflow at CSO018 will be diverted to the 7.7 MG storage basin until it is filled. After the basin is filled, the flow control structure will keep any additional flow on the BGI from reaching the CSO018 overflow line.

Capital Cost: $22,123,000

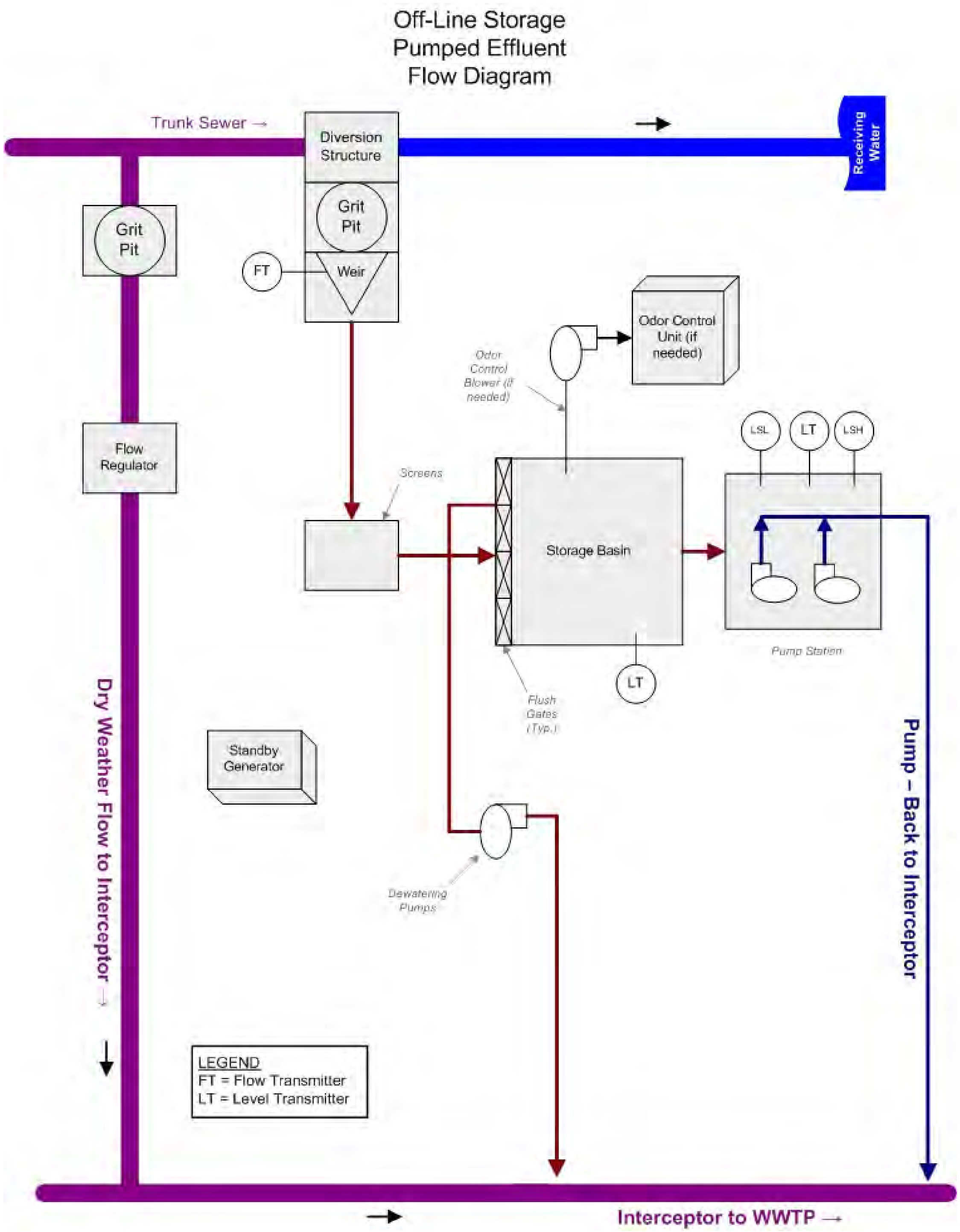
Capital Benefit/Cost: 9.51

Present Worth Benefit Cost: 9.92

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO018	NIGHTINGALE PS	107.04	23	18.70	16

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Standby Generator
Dewatering Pumps
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →

Integrated Overflow Abatement Plan

Vol. 3 - Sanitary Sewer Discharge Plan

South Fork Beargrass Creek

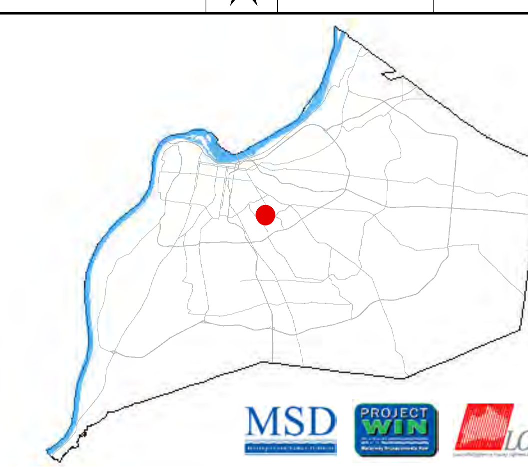
Nightingale Pump Station Replacement and Off-line Storage

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Documented SSO
- Suspected SSO
- Haulop Locations
- Proposed Pump Station Solution
- Pump Stations
- MSD
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Proposed Off-line Storage
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 200 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\NightingalePumpStationReplacement1.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet
2012 IOAP Project Modification

Project Name: Lexington Road and Payne Street Storage Basin

Project Number: L_SO_MF_083_M_09B_B_A_8

Project Type: Off-Line Storage

Rec Stream: South Fork Beargrass Creek

Project Description: This project includes an 8.18 MG off-line covered storage basin for CSO083, 84, 118, 119, 120, 121, 141, 153 & 082 to reduce overflows to zero overflows per typical year. The basin will require an 8.18 MGD PS to return the stored flow to the interceptor.

Design Assumption: Basins are designed to the largest overflow event volume, resulting in zero CSO overflows in a typical year. The peak flowrate is evaluated to compare gravity vs. pumped conveyance. Design for pump-back is 24 hours. Type of basin based on hydraulics and surroundings.

Capital Cost: $25,904,000

Capital Benefit/Cost: 67.61

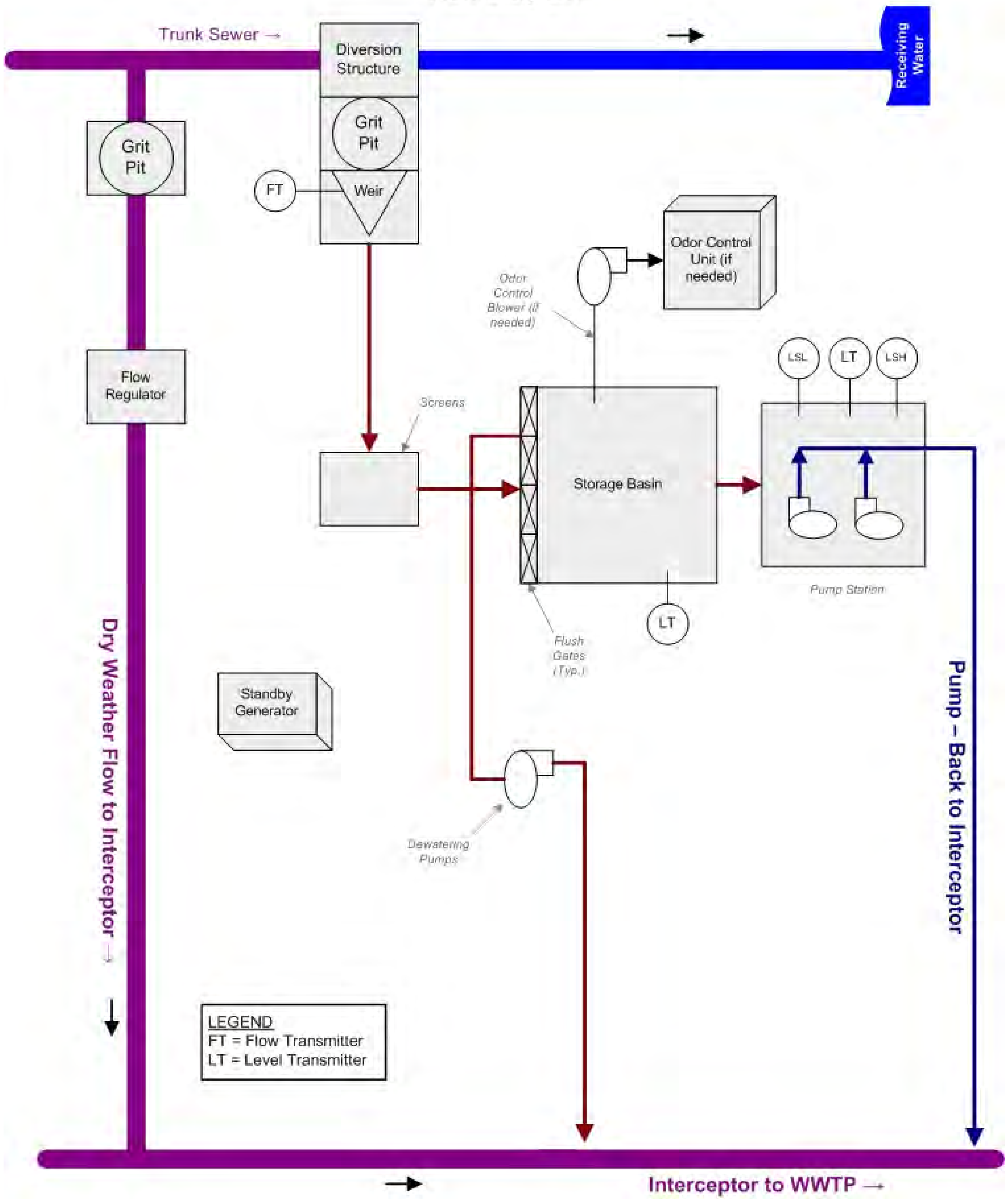
Present Worth Benefit Cost: 75.16

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO082	BGI AT BGC	25.31	39	7.11	31
CSO083	BRENT ST & BROADWAY CONNECT	0.00	0	0.00	0
CSO084	BRENT ST @ BGC	3.27	18	3.26	18
CSO118	REG NO 15 - E BRDWY	41.27	33	38.88	33
CSO119	BRENT STREET SEWER	4.24	29	4.02	29
CSO120	PHOENIX HILL SEWER	15.51	51	15.36	52
CSO121	REG NO 18 - GREEN ST	1.06	6	0.92	6
CSO141	BAXTER AVE @ BGC	0.36	38	0.36	38
CSO153	COOPER STREET	9.72	47	8.63	46

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

Off-Line Storage Pumped Effluent Flow Diagram



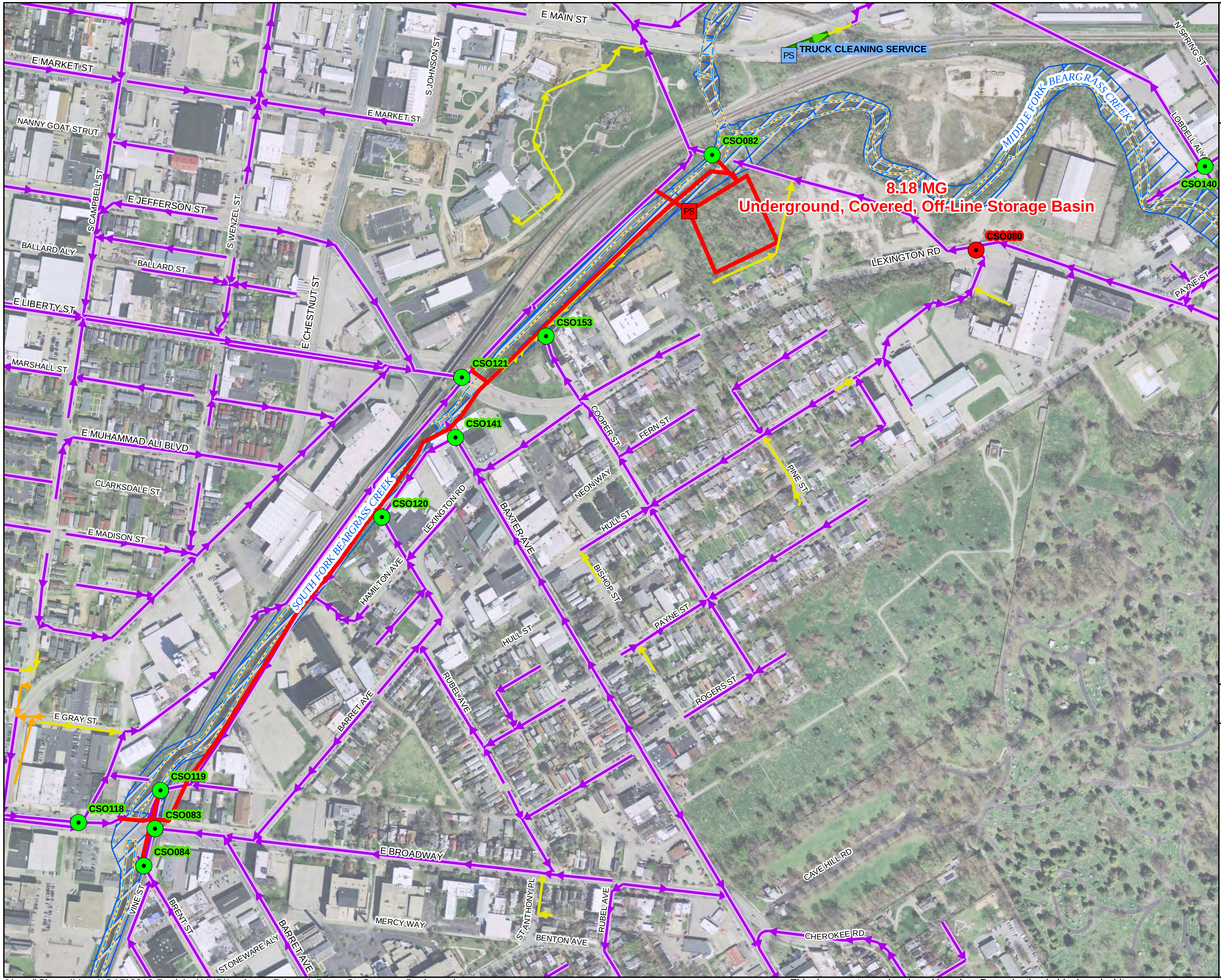
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

South Fork Beargrass Creek

Lexington Rd and Payne St Storage Basin

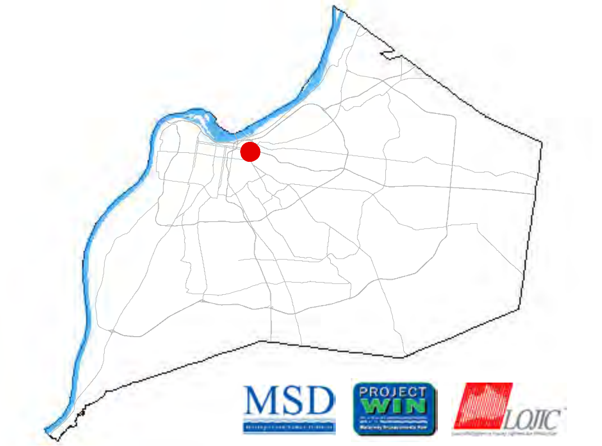
Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 400 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



MSD PROJECT WIN LOJIC

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\LexingtonRd_and_PayneSt_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Logan and Breckinridge Street Storage Basin

Project Number: L_SO_MF_092_M_09B_B_D_8

Project Type: Off-Line Storage

Rec Stream: South Fork Beargrass Creek

Project Description: This project includes a 16.6 MG underground covered storage basin to reduce overflows for a group of CSOs to 8 overflows per typical year.

Design Assumption: Basins are designed to the 9th overflow event volume, resulting in 8 CSO overflows per typical year. The 9th peak flowrate is evaluated to compare gravity vs. pumped conveyance. Design for pump-back is 24 hours. Type of basin based on hydraulics and surroundings.

Capital Cost: $48,243,000

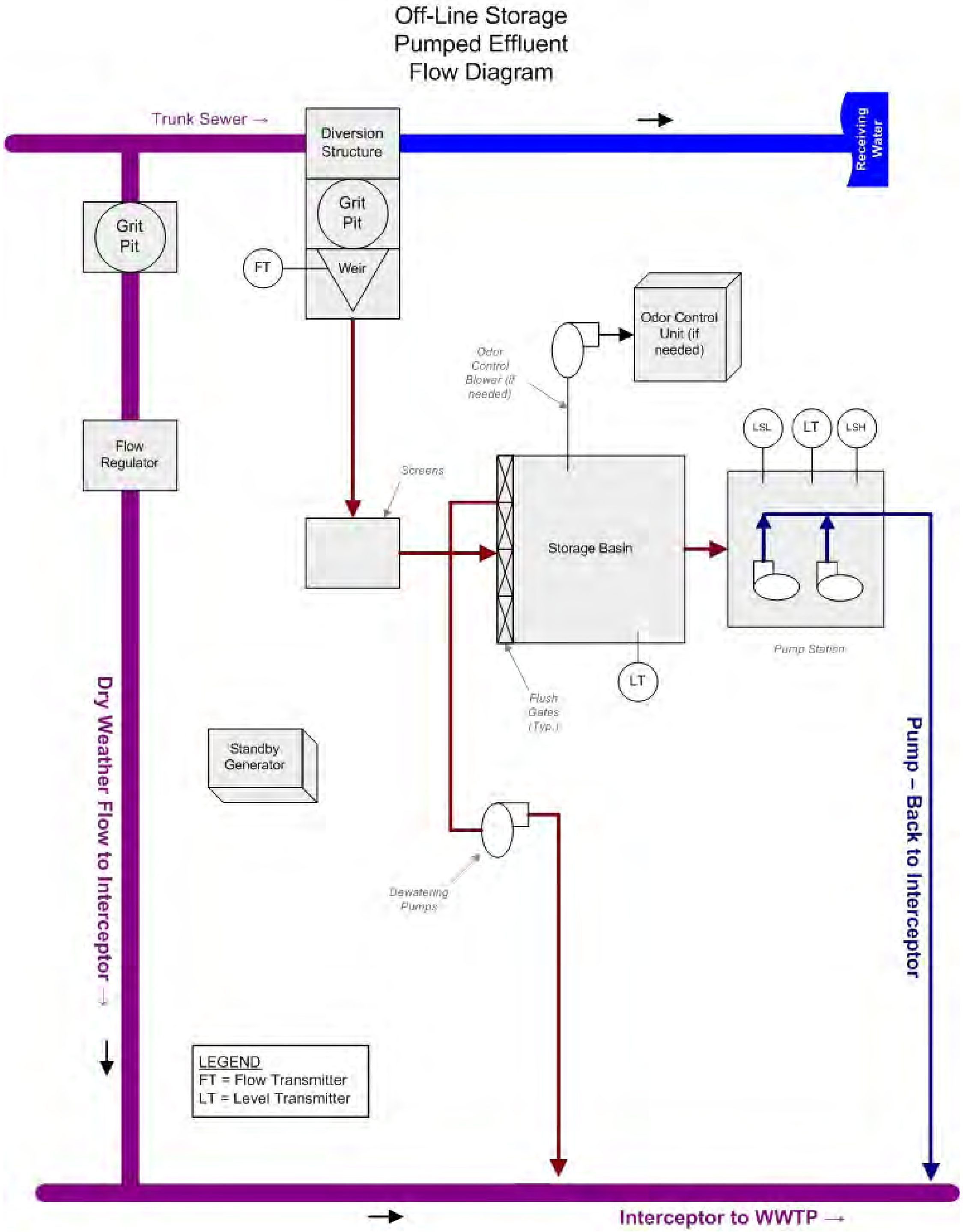
Capital Benefit/Cost: 55.09

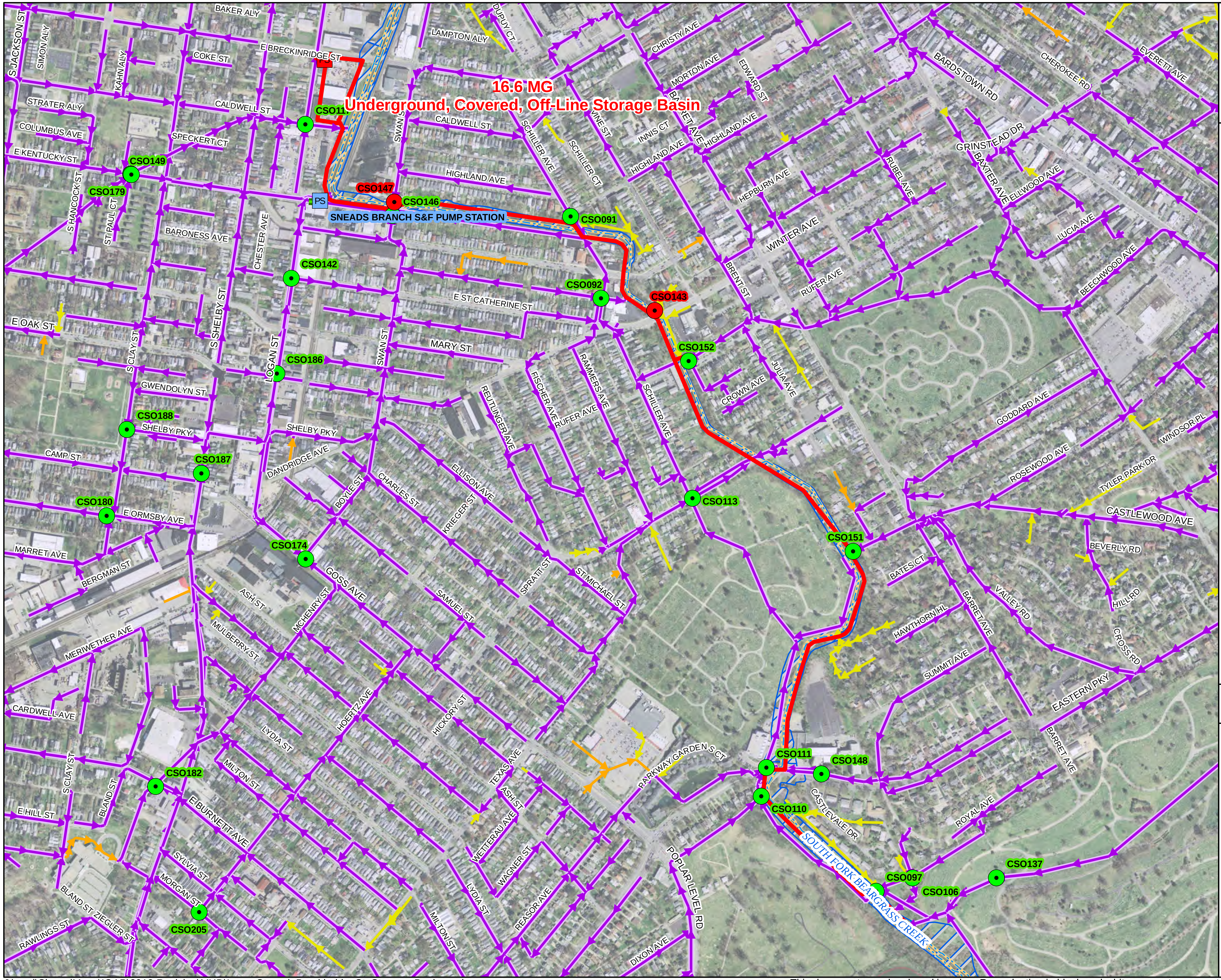
Present Worth Benefit Cost: 61.19

		Existing May 2012 [1]		Baseline May 2012 [2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO091	SCHILLER AVE OVFL	2.83	55	2.83	55
CSO097	CANTONMENT SIPHON NO 2	10.50	34	6.74	33
CSO106	ROYAL - NEFF	0.28	12	0.27	12
CSO110	REG NO 3 - GOSS AVE	9.56	33	7.45	33
CSO111	EMERSON STREET SEWER	9.27	34	9.00	33
CSO113	ELLISON AVENUE SEWER	4.79	19	4.71	18
CSO117	REG NO 11 - DRY RUN	47.87	35	46.66	35
CSO137	CALVARY CEMETARY	2.33	23	2.28	23
CSO146	SNEADS BRANCH DIVERSION	57.83	34	57.29	34
CSO148	EASTERN PKWY DIVERSION	1.11	22	1.10	22
CSO149	DRY RUN DIVERSION	45.77	29	44.82	29
CSO151	REG NO 5 - CASTLEWOOD	81.39	54	67.35	52
CSO152	REG NO 7 - SOUTHEASTERN	175.41	57	173.90	57

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.


Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Standby Generator
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
Dewatering Pumps
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

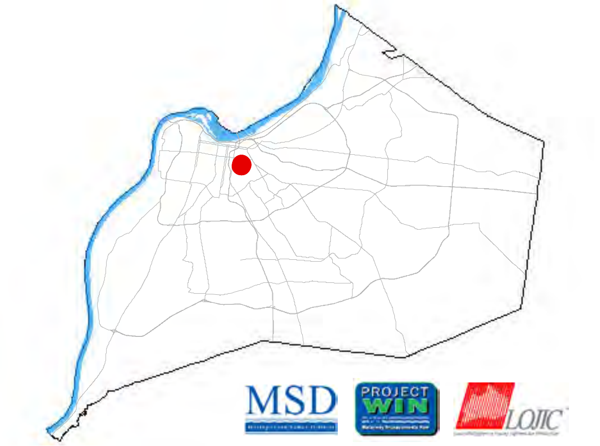
South Fork Beargrass Creek
SolutionID # L_SO_MF_092_M_09B_B_D_8
Logan St and Breckinridge St Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 700 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\LoganSt_and_BreckinridgeSt_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: CSO093 Structural Modifications & Green Infrastructure

Project Number: L_SO_MF_093_S_08_A_A_0

Project Type: Structural Modifications & Green Infrastructure

Rec Stream: South Fork Beargrass Creek

Project Description: Modify existing structure to eliminate the existing 'leaping weir'. Focused modeling and monitoring will be utilized to determine if the level of control is met. Green infrastructure within the drainage area will be constructed to reach the 0 overflow in a typical year of control to the entent that flow monitoring and modeling (conducted after the structural modifications are completed)indicate it is needed.

Design Assumption: Project will utilize the gray and green right-sizing process.

Capital Cost: $488,000

Capital Benefit/Cost: 81.97

Present Worth Benefit Cost: 91.53

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO093	SPRING STREET	0.00	0	0.00	0

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

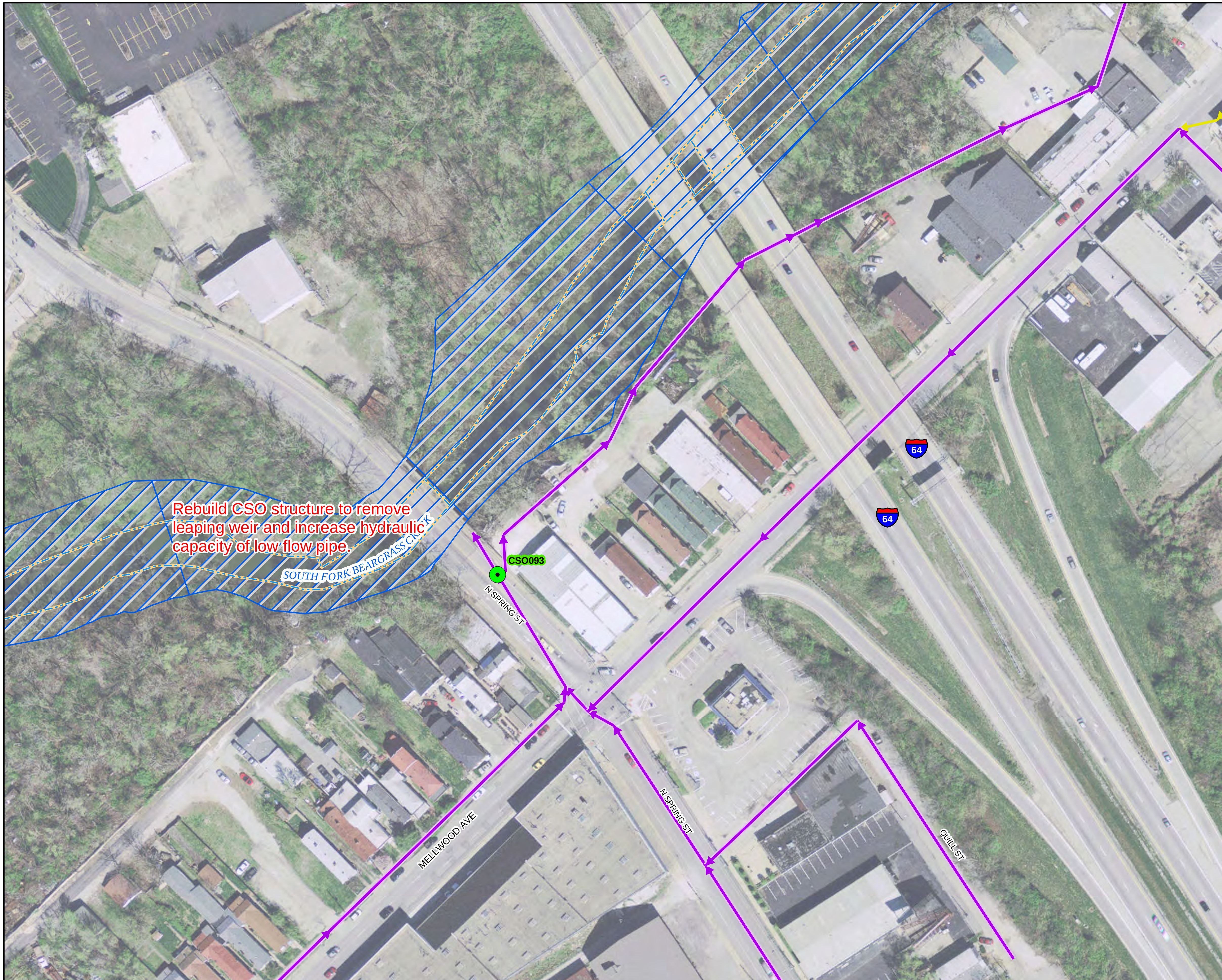
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

South Fork Beargrass Creek

CSO093 Inline Storage and Increased Dry Flow Capacity at CSO

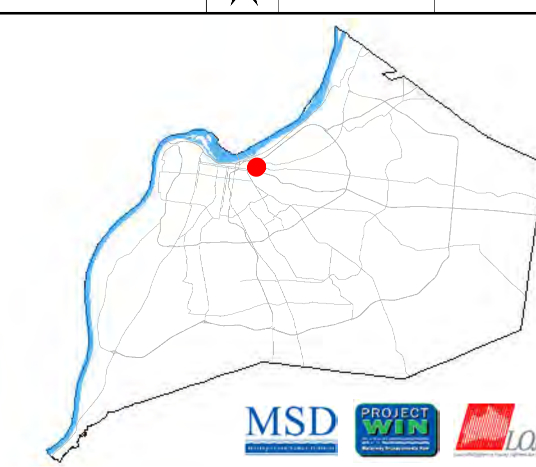
Preliminary - For Budget Development Only



Active CSO
Eliminated CSO
Haulop Locations
Proposed Pump Station Solution
Pump Stations
MSD
Combined Sewer Pipe
Force Main
Collector < 12"
Interceptor >= 12"
Streams
Floodway
Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



Project Name: Story Avenue and Spring Street Storage Basin

Project Number: L_SO_MF_130_S_09B_B_A_8

Project Type: Green Stormwater Infrastructure

Rec Stream: South Fork Beargrass Creek

Project Description: This project includes the construction of a suite of green infrastructure practices in the CSO130 contributing drainage area to achieve 0.08 MG in overflow reduction and mitigate the overflow to 8 overflows in a typical year.

Design Assumption: Green practices are designed to contain the 9th overflow event volume, resulting in 8 CSO overflows per typical year.

Capital Cost: $896,000

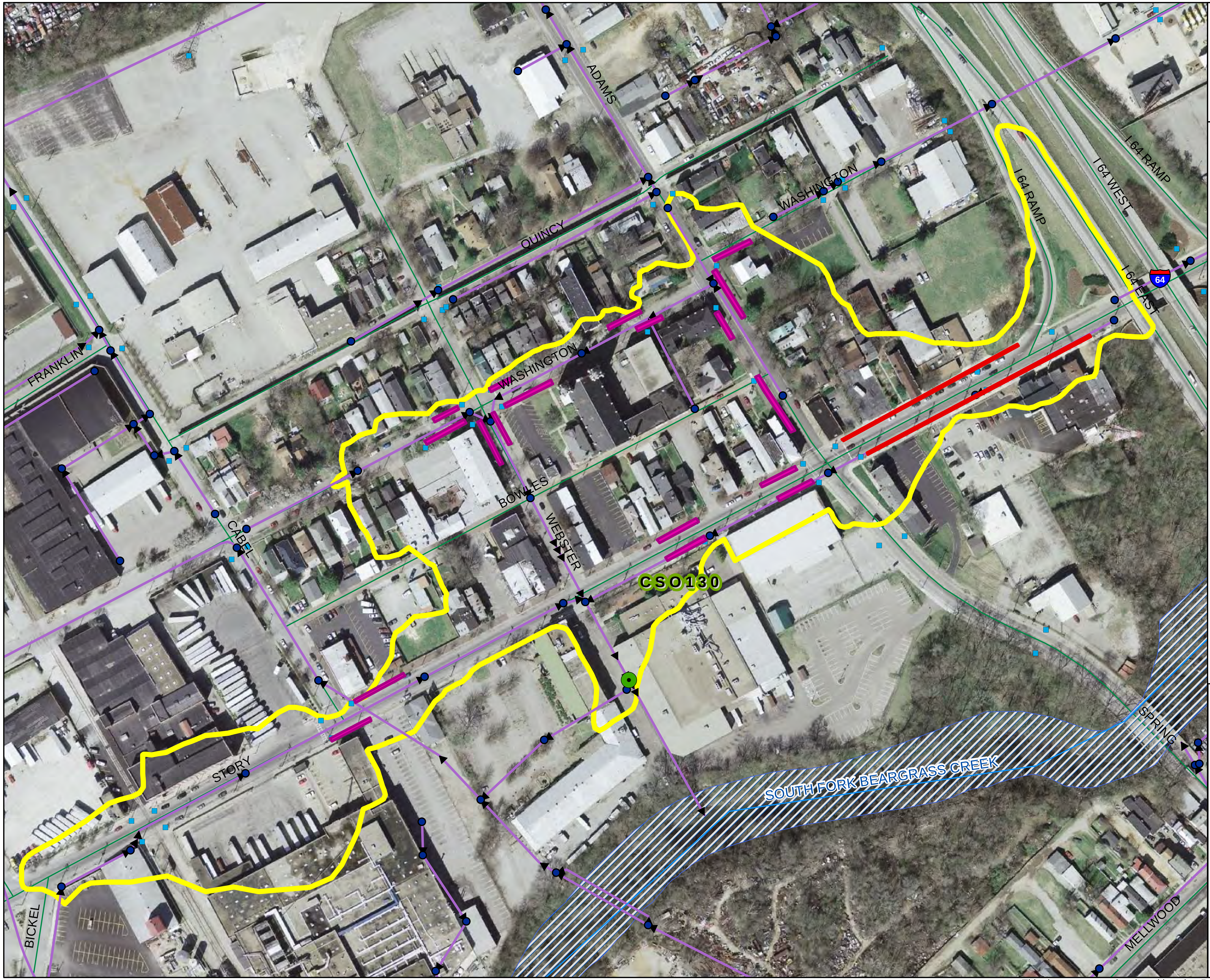
Capital Benefit/Cost: 131.70

Present Worth Benefit Cost: 125.80

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO130	WEBSTER STREET	6.87	34	1.96	20

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan
Vol. 2 - FInal CSO Long Term Control Plan

CSO 130
Green Infrastructure Solution

Legend

- Active CSO
- Existing Manhole
- Existing Catch Basin
- Streams
- Combined Sewer Pipe
- Floodway
- CSO 130 Drainage Boundary

CSO 130 Practices

Proposed Green Infrastructure Solutions

- Pervious Pavers
- Tree Boxes

General Representation of overflow abatement solutions are currently out for bid and may be altered during the construction process.

1 inch = 166 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
May 18, 2012

Aerial Date: 2007

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.

Beargrass Creek
Middle Fork

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: CSO123 Downspout Disconnection

Project Number: L_MI_MF_123_S_08_A_A_0

Project Type: Partial Sewer Separation

Rec Stream: Middle Fork Beargrass Creek

Project Description: Downspout disconnection. CSO was already below minimum level of control boundary condition. Downspout diconnection program intended to further reduce CSO events at very reasonable cost. No level of control analysis or benefit cost evauation was performed. Project substantially complete in December 2012.

Design Assumption:

Capital Cost: $325,000

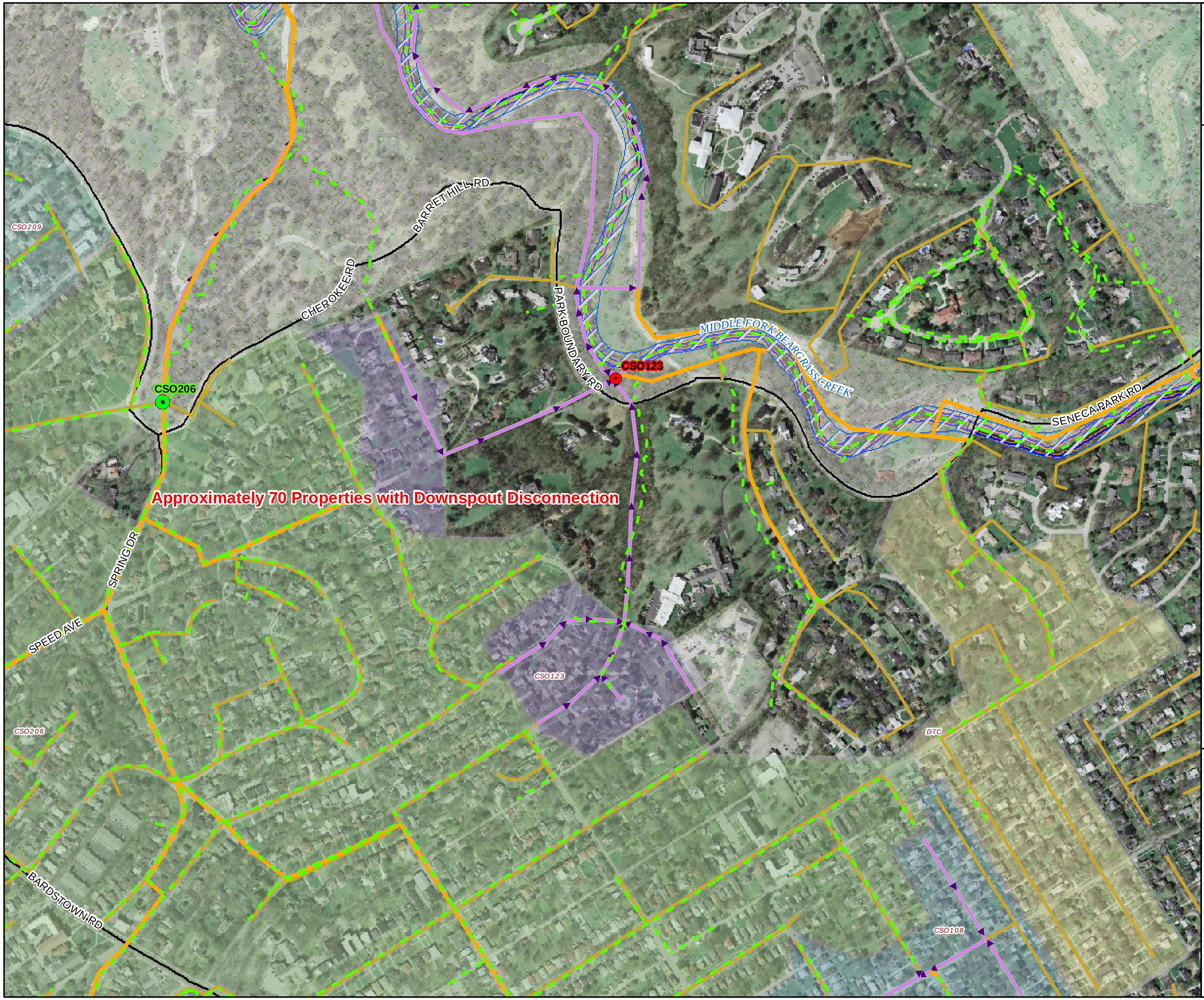
Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO123	REG NO 20 - RUTH-SULGRV				

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Middle Fork Beargrass Creek

Solution ID # L_MI_MF_123_S_08_A_A_0

CSO123 Downspout Disconnection

Preliminary - For Budget Development Only

Legend

- Proposed Storm Catch Basin
- Proposed Sanitary Manhole
- Proposed Storm Manhole
- Active CSO
- Eliminated CSO
- Pump Station
- Proposed Sanitary Pipe Solution
- Proposed Storm Pipe Solution
- Existing Drainage Line
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Streams
- Floodway
- Metro Parks
- County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 500 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
December 3, 2008

Aerial Date: 2006

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: I-64 and Grinstead Drive Storage Basin

Project Number: L_MI_MF_127_M_09B_B_A_8

Project Type: Off-Line Storage

Rec Stream: Middle Fork Beargrass Creek

Project Description: This project is to provide a 8.5 MG off-line storage facility consisting of a covered concrete basin for CSO125, 126, 127 & 166 to reduce overflows to 4 overflows per typical year. The facility will be a gravity in-pump out operation. A significant stormwater diversion away from the combined sewer system is also proposed.

Design Assumption: No backflow from Beargrass Creek is accounted for in model. Flapgates may need to be analyzed. Direct runoff from I-64 into outfall pipes is currently included in basin size. Separation may reduce basin size if cost effective. CSO 126 likely will be conveyed directly under I-64.

Capital Cost: $38,590,000

Capital Benefit/Cost: 17.73

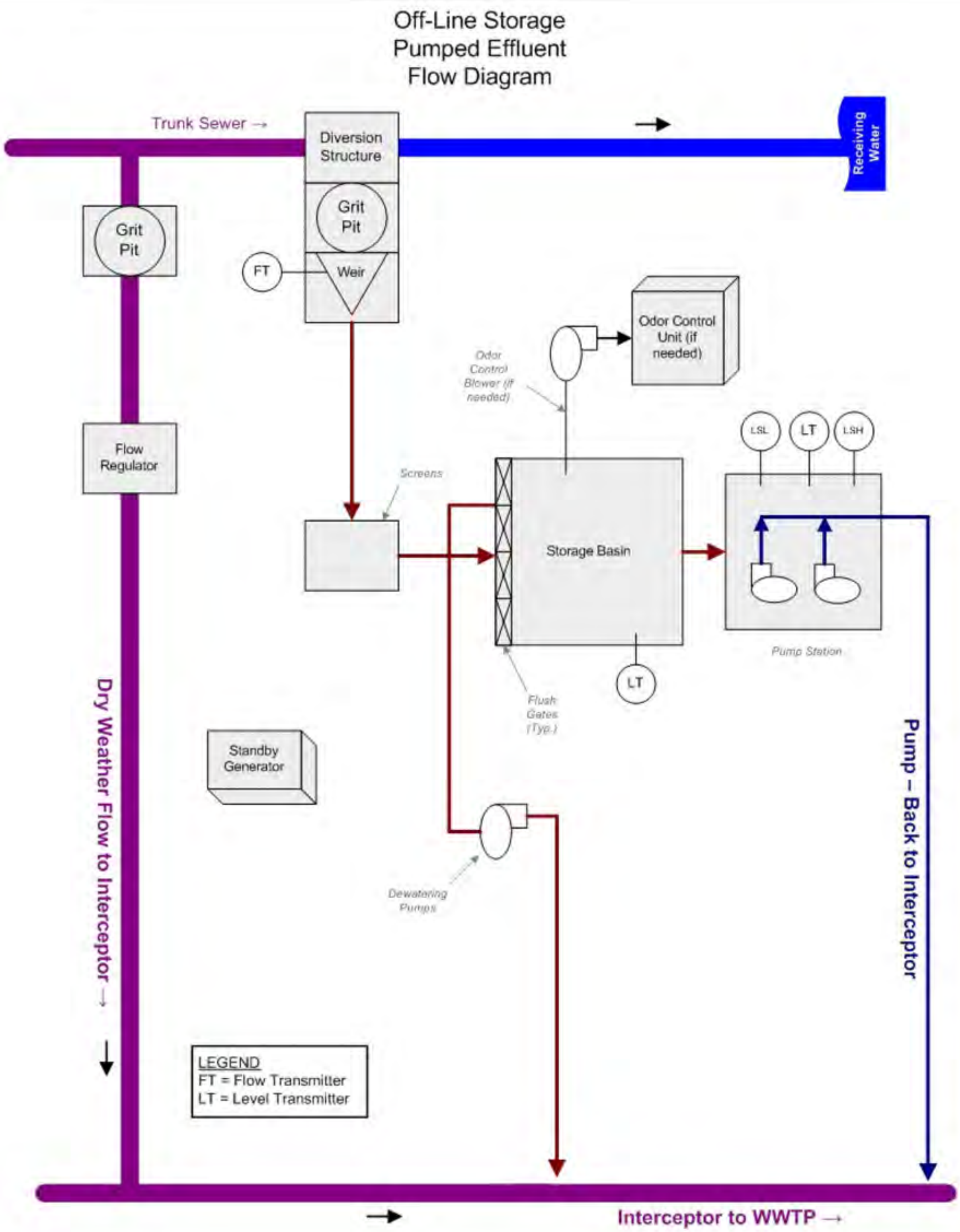
Present Worth Benefit Cost: 19.25

		Existing May 2012 [1]		Baseline May 2012 [2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO125	REG NO 24 - GRINSTEAD DR	201.71	57	200.36	57
CSO126	REG NO 26 - RAYMOND AVE	5.55	27	3.93	24
CSO127	ETLEY AVENUE	9.71	30	9.40	30
CSO166	BEALS BRANCH SAN DIV	64.66	36	62.36	36

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

CSO LTCP
Project Fact Sheet



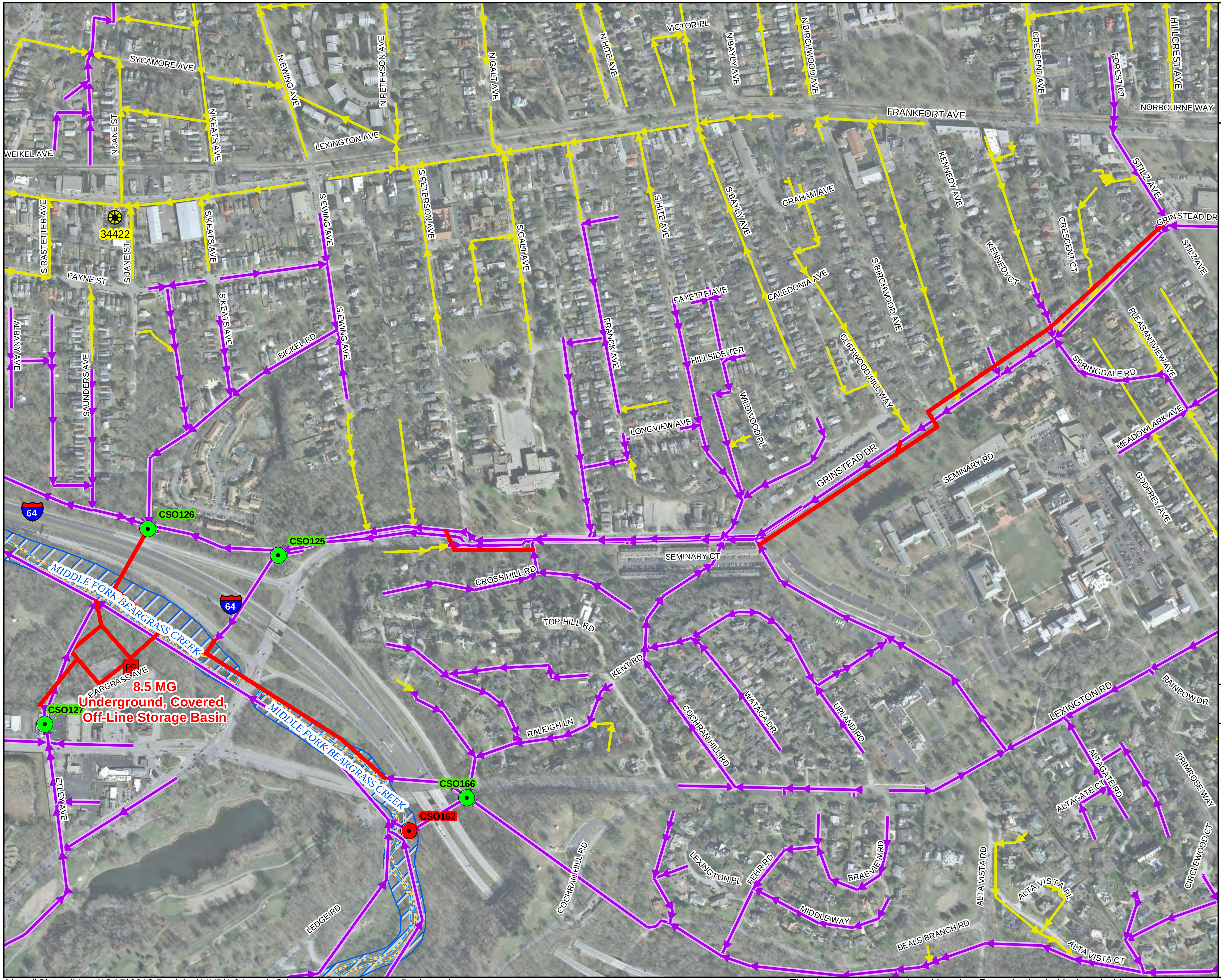
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Middle Fork Beargrass Creek

I-64 and Grinstead Drive Storage Basin

Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Proposed Storage Solution
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 500 feet	N	Aerial Date: 2009	Map Revision: April 14, 2014

MSD PROJECT WIN LOJIC

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\I-64_and_Grinstead_Drive_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: CSO140 In-Line Storage & Green Infrastructure Controls

Project Number: L_MI_MF_140_S_08_A_A_0

Project Type: Upsize Pipe Conveyance

Rec Stream: Middle Fork Beargrass Creek

Project Description: Upsize the downstream low flow line to 42-inch diameter, possibly with backflow prevention. Focused modeling and monitoring will be utilized to determine if the level of control is met. Green infrastructure within the drainage area will be constructed to reach the 0 overflow in a typical year of control to the extent that flow monitoring (conducted after the inline storage is constructed) indicate it is needed.

Design Assumption: Project will utilize the gray and green right-sizing process.

Capital Cost: $574,000

Capital Benefit/Cost: 324.16

Present Worth Benefit Cost: 367.21

CSO	CSO Name	Existing May 2012 [1] Avg. Annual Overflow Volume	Existing May 2012 [1] Avg. Annual Frequency	Baseline May 2012 [2] Avg. Annual Overflow Volume	Baseline May 2012 [2] Avg. Annual Frequency
CSO140	LOCUST STREET	0.98	21	0.96	21

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

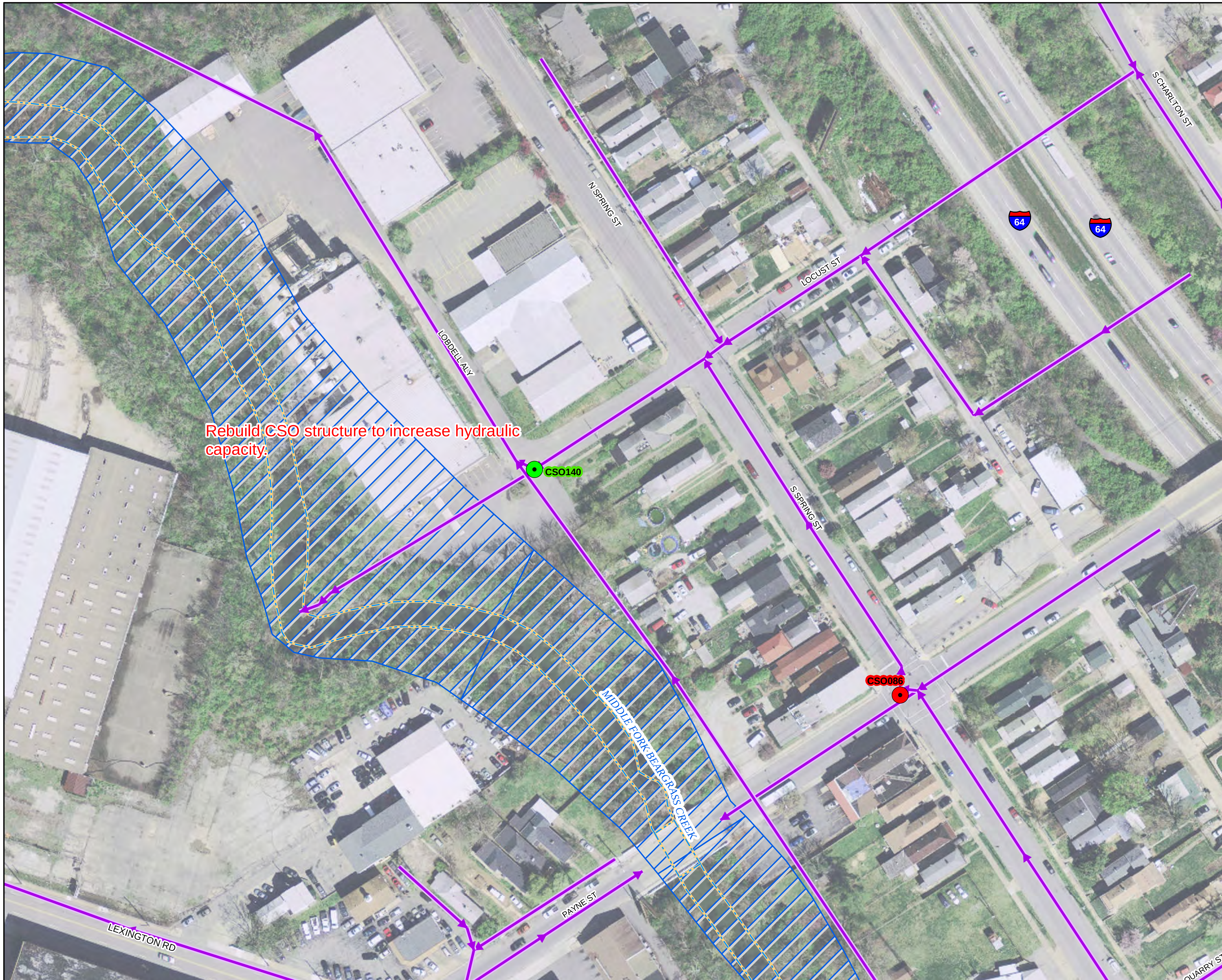
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

CSO140 Inline/Offline Storage

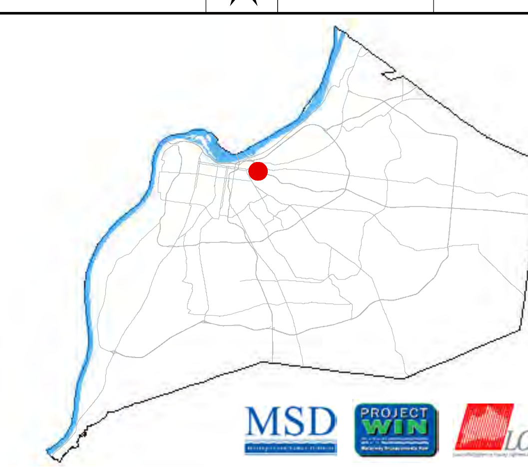
Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Haulop Locations
- Proposed Pump Station Solution
- Pump Stations
- MSD
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\CSO140_SewerSeparation.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

MSD

CSO Project Fact Sheet
2012 IOAP Project Modification

PROJECT WIN

Project Name: CSO206 Sewer Separation

Project Number: L_MI_MF_206_S_08_A_A_0

Project Type: Sewer Separation

Rec Stream: Middle Fork Beargrass Creek

Project Description: This project is to complete sewer separation by disconnecting downspouts from approximately 931 properties.

Design Assumption: Existing system consists of both storm and sanitary sewers with common manholes. CSO discharges in Cherokee Park.

Capital Cost: $3,842,000

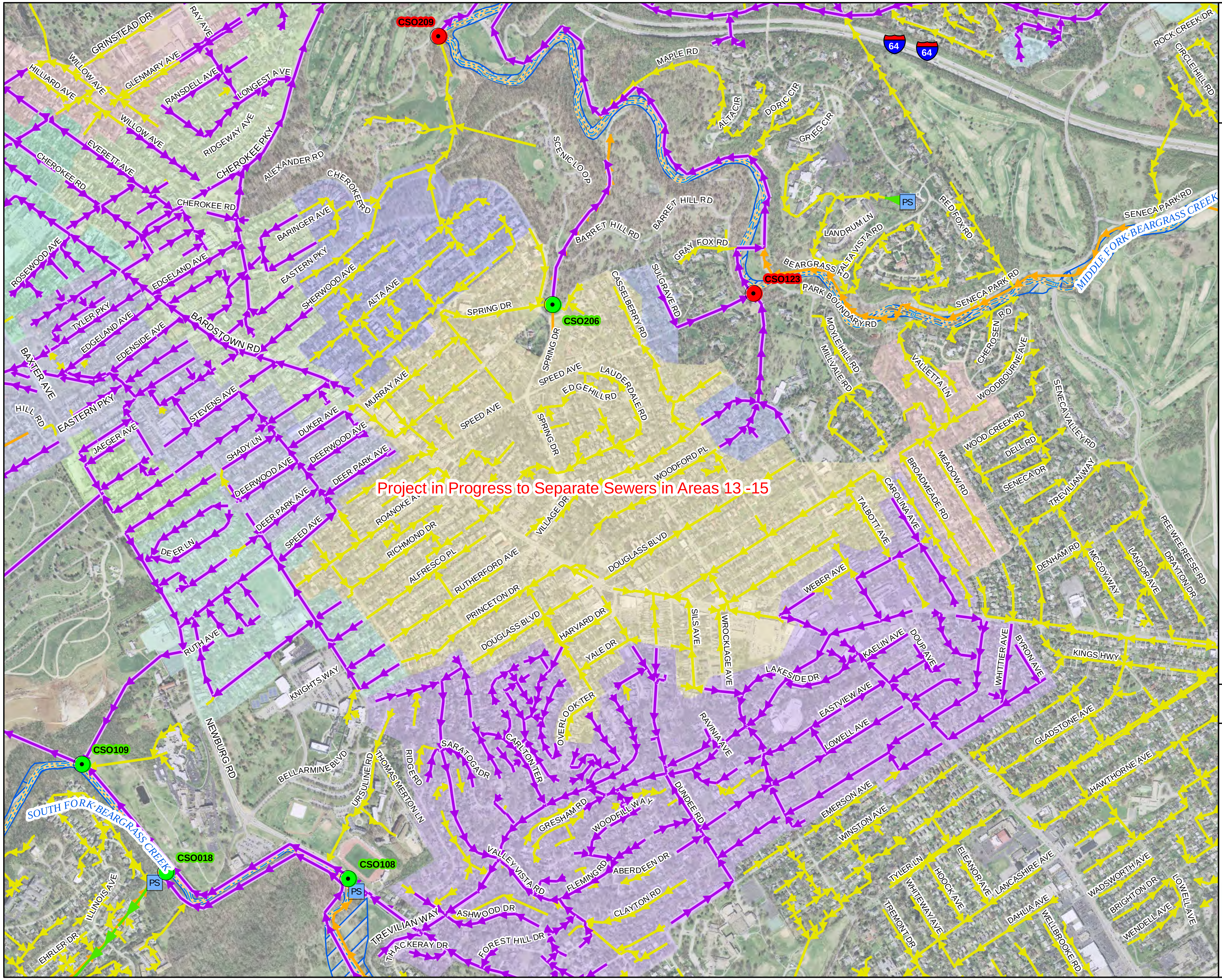
Capital Benefit/Cost: NA

Present Worth Benefit Cost: NA

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO206	CHEROKEE PARK @ SPRING DR	27.73	55	27.73	55

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Middle Fork Beargrass Creek

CSO206 Sewer Separation

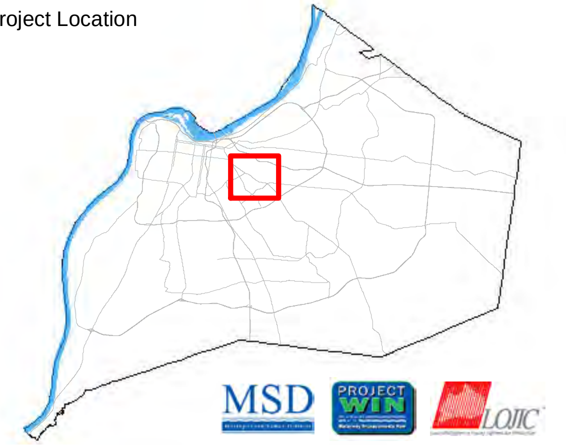
Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Haulop Locations
- Pump Stations
- MSD
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 1,101 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

Project Location



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\Middle_Fork_Beargrass_Creek.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

Ohio River

Project Name: Bells Lane Wet Weather Treatment Facility

Project Number: L_OR_MF_015_M_13_B_B_8

Project Type: High Rate Treatment & Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes a 50 MGD High Rate Treatment Facility and an Equalization Basin. The equalization basin is 25 MG. The project includes an upgrade to the Southwestern Pump Station to 160 MGD. The project includes modifications to RTC Setpoints at SWOR1 and SWOR2 to increase inline storage. The project also includes additional improvements to the existing SWOR2 facility and additional provisions to allow for air relief in the storage lines.

Design Assumption: The project assumes MFWQTC will be able to convey a minimum of 325 MGD. SWPS will pump towards MFWQTC the difference between the 325 MGD and the flow through the main diversion structure. A maximum of 100 MGD and a minimum of 0 MGD will be pumped towards MFWQTC during the LOC event. The remainder of the the 160 MGD SWPS will be used to pump into the HRT/EQ Basin.

Capital Cost: $68,472,000

Capital Benefit/Cost: 3.93

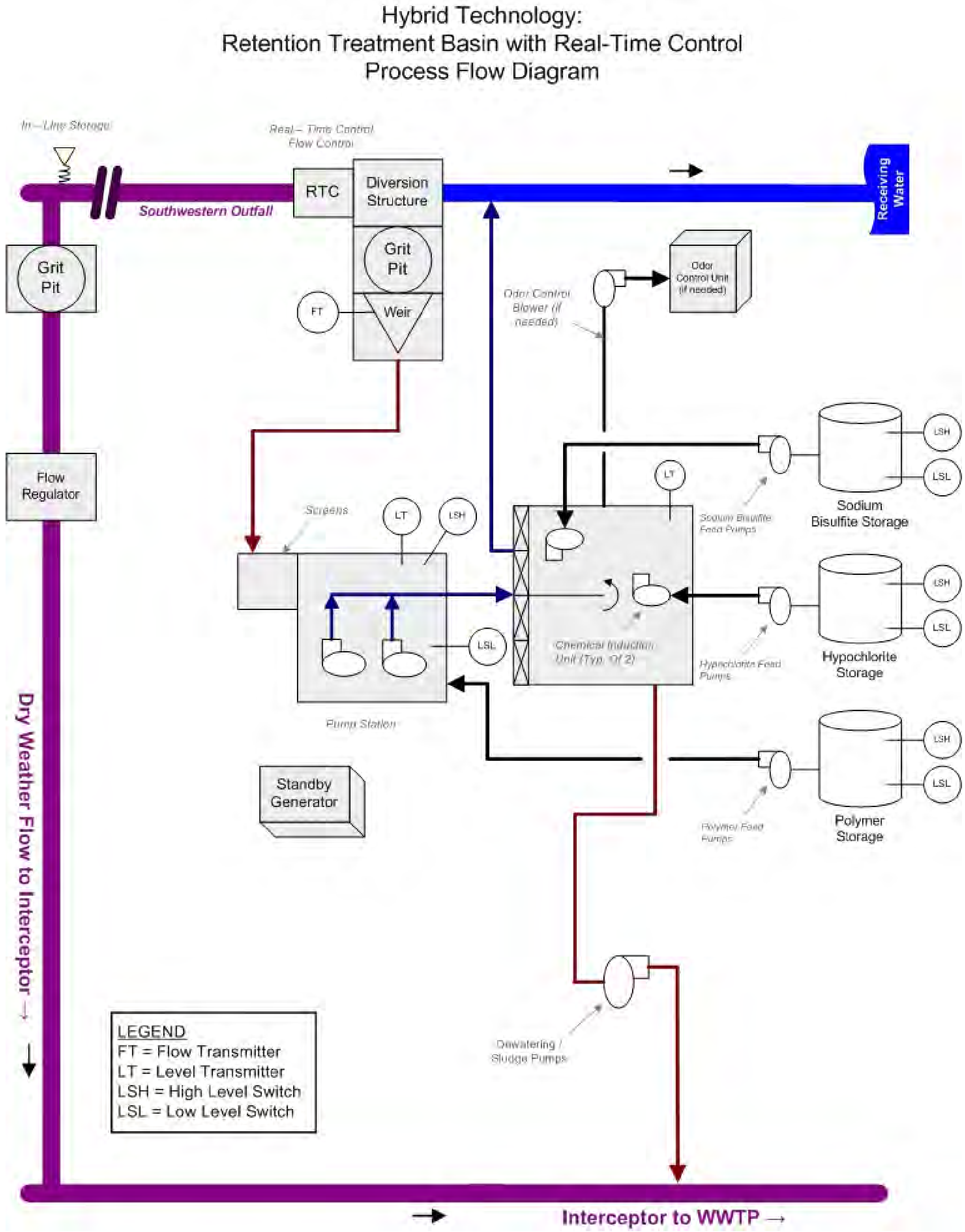
Present Worth Benefit Cost: 9.31

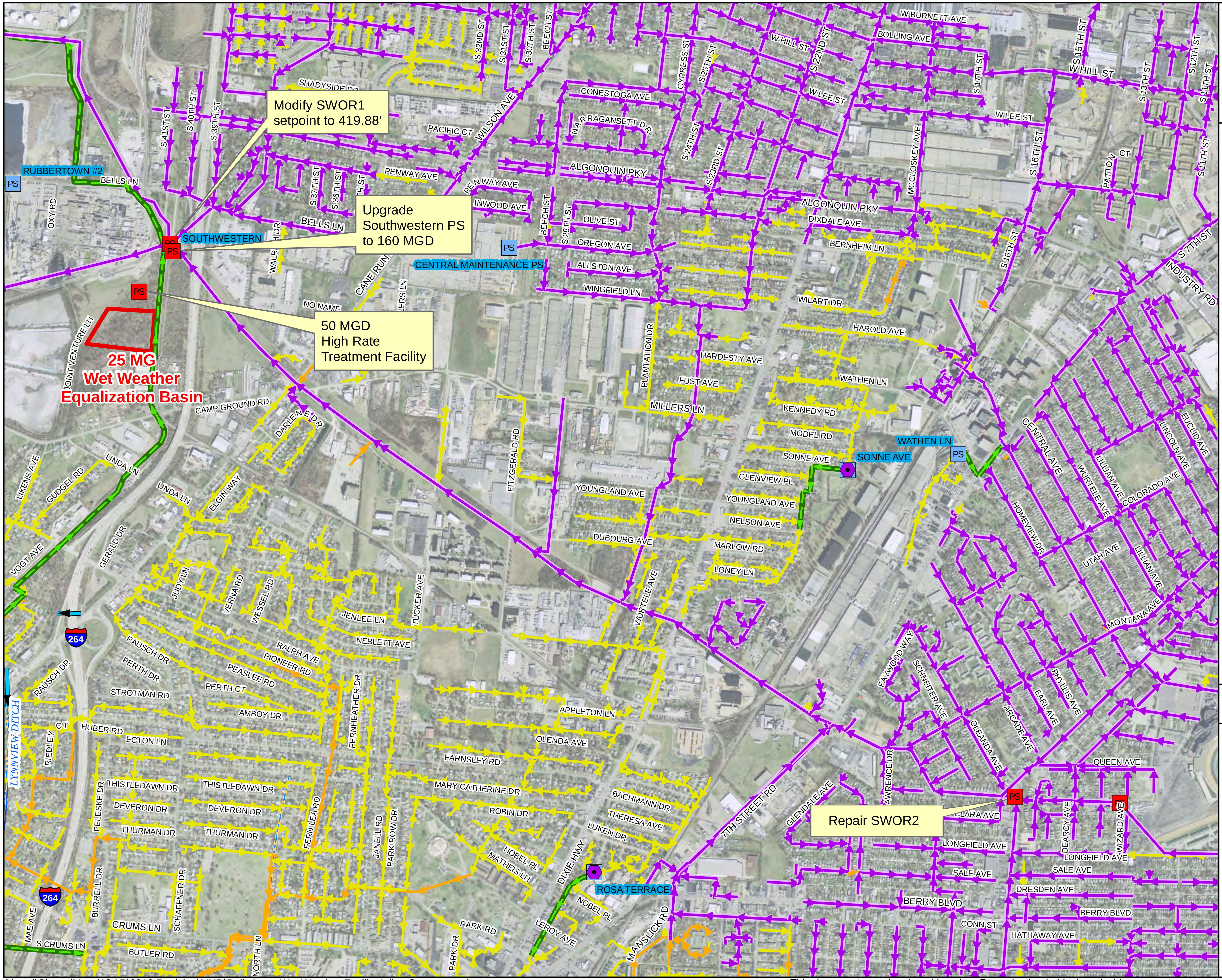
		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO015	SOUTHWESTERN PS	1233.00	33	710.00	26
CSO191	ALGONQUIN PKWY SAN DIV	32.00	32	20.00	23

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

CSO LTCP
Project Fact Sheet





Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

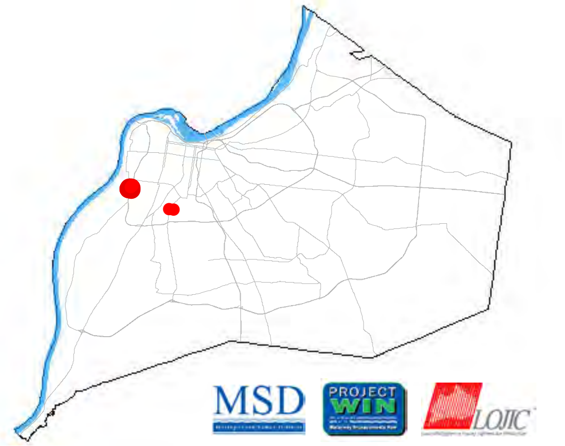
Bells Lane Wet Weather Facility & Inline Storage

Preliminary - For Budget Development Only

- PS Proposed Pump Station Solution
- PS Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 1,320 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\Bells Lane Wet Weather Facility Inline Storage.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Portland Wharf Storage Basin

Project Number: L_OR_MF_019_S_13_B_A_8

Project Type: In-Line & Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes a 6.37 MG underground covered concrete storage basin, with 1.8 MG of in-line storage from CSO019 to reduce overflows to 8 overflows per year in a typical year. The facility will require a 6.37 MGD pump station to return the stored flow back to the interceptor.

Design Assumption: Available CSS storage capacity is based on June, 2001 BPR RTC Study. Flow Control assumes inflatable dams are available. 34th Street Pump Station must continue to perform at current drawdown (approximately 11 MGD) rate.

Capital Cost: $20,000,000

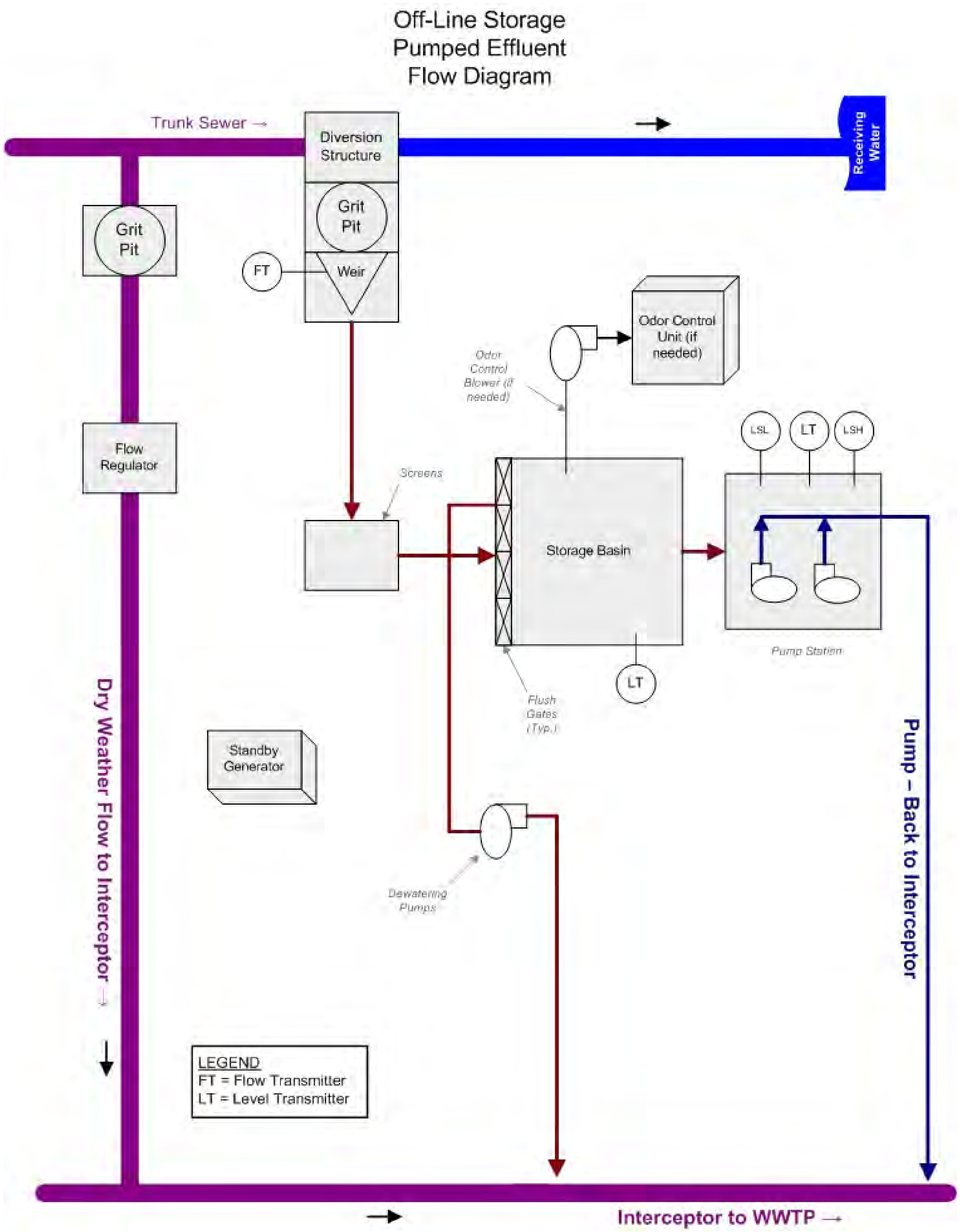
Capital Benefit/Cost: 9.87

Present Worth Benefit Cost:

		Existing May 2012 [1]		Baseline May 2012 [2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO019	34th STREET PS	57.73	42	57.76	43

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.


Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
Standby Generator
Dewatering Pumps
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

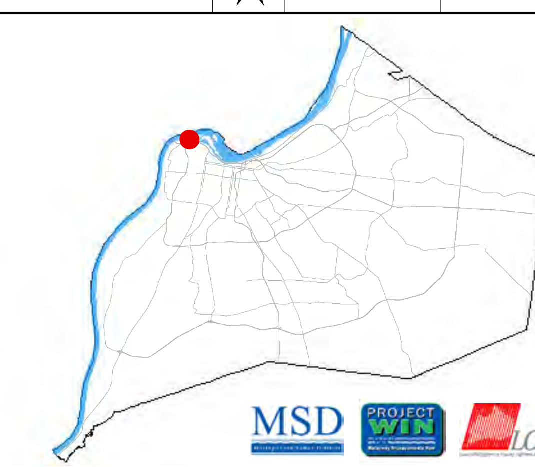
Portland Wharf Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Flow Control Solution
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 203 feet	N	Aerial Date: 2009	Map Revision: April 14, 2014



MSD

CSO Project Fact Sheet
2012 IOAP Project Modification

PROJECT WIN

Project Name: Story Avenue and Main Street Storage Basin

Project Number: L_OR_MF_020_S_09B_B_A_8

Project Type: Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes the construction of a 5.42 MG off-line underground covered storage basin for CSO020 to reduce overflows to 8 overflows per typical year. Project assumes that the Starkey Pump Station has a typical, minimum pumping rate of 108 MGD. Additional storage or a higher pump-out rate may be added if deemed advantageous to operational and maintenance flexibility as well as impacts to other downstream CSO control projects.

Design Assumption: Basins are designed to the 9th overflow event volume, resulting in 8 CSO overflows per typical year. Type of basin based on hydraulics and surroundings. Starkey PS must be able to maintain a minimum pumping rate of 108 MGD.

Capital Cost: $12,576,000

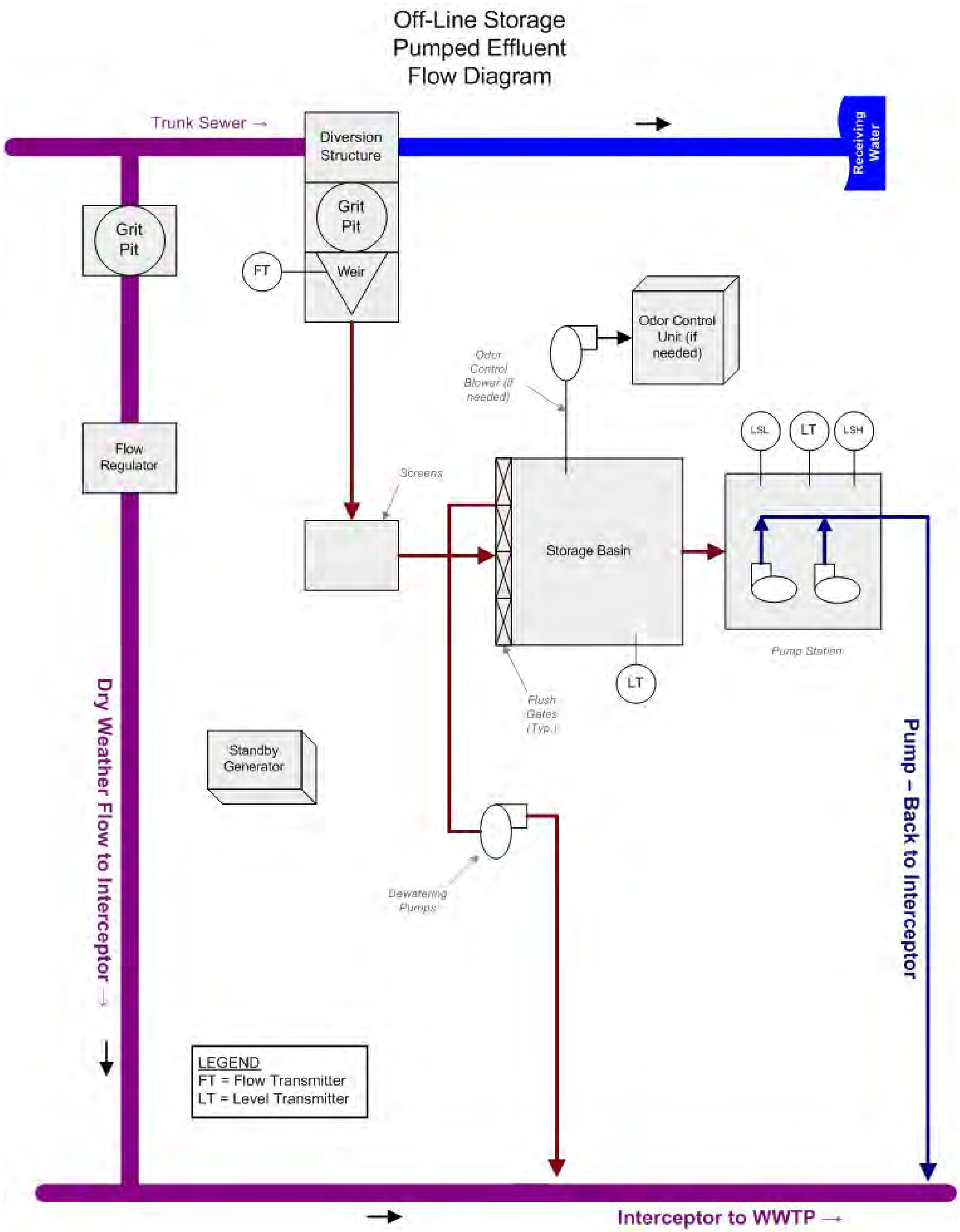
Capital Benefit/Cost: 18.78

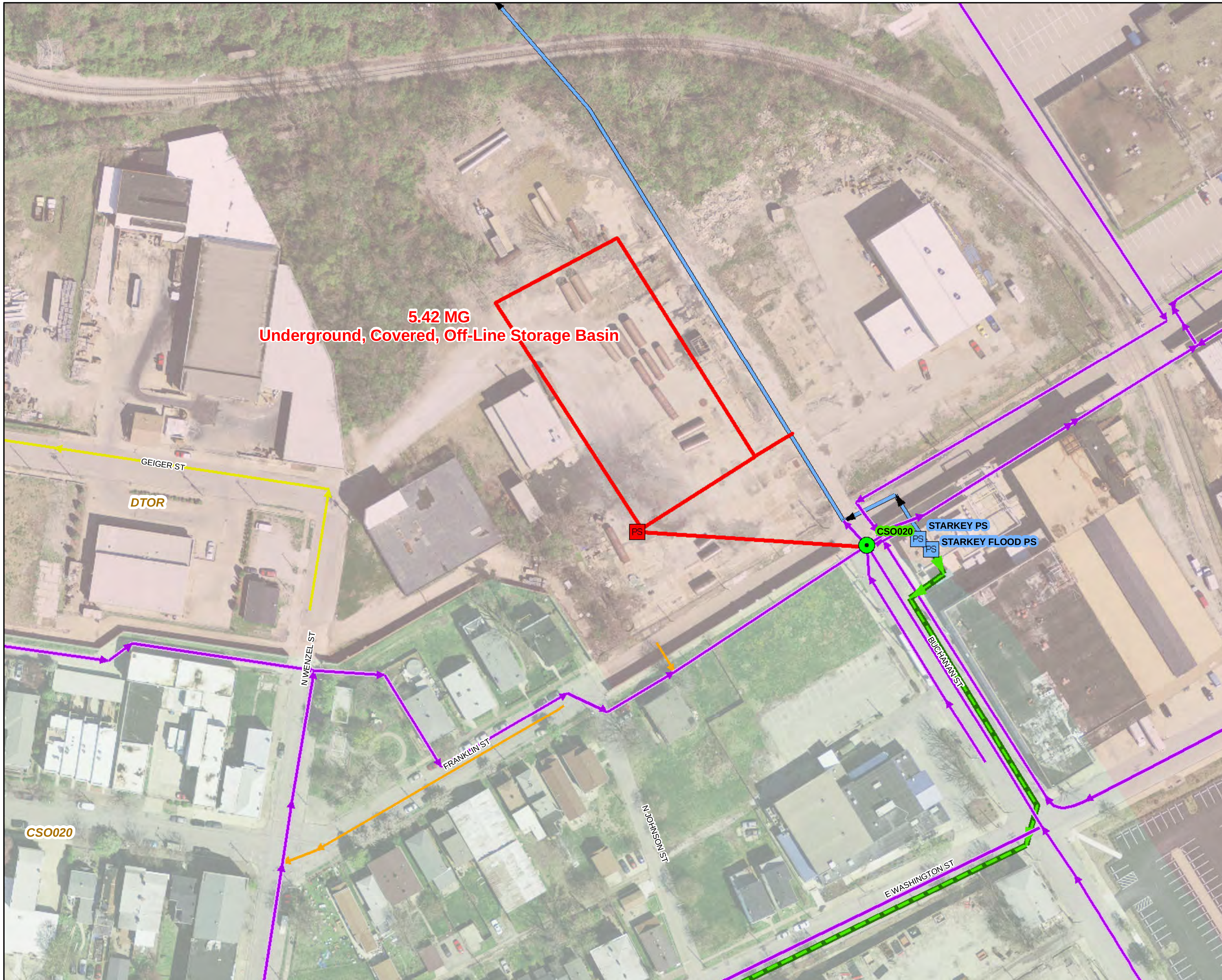
Present Worth Benefit Cost: 20.37

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO020	BUCHANAN PS	436.87	51	143.94	37

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.


Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
Flow Regulator
Screens
LSL
LT
LSH
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Standby Generator
Dewatering Pumps
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

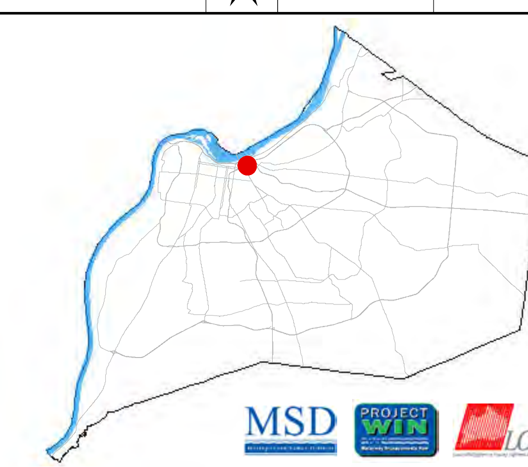
Story Ave & Main St Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



MSD PROJECT WIN LOJIC

CSO Project Fact Sheet
2012 IOAP Project Modification

Project Name: CSO058 In-Line Storage & Green Infrastructure

Project Number: L_OR_MF_058_S_08_A_A_0

Project Type: In-line Storage & Green Infrastructure

Rec Stream: Ohio River

Project Description: Mixed use of in-line storage (weir raise) for this CSO coupled with green stormwater control practices and distributed storage within the contributing drainage area. A bending weir may be used depending on the final flooding analysis. Included in 13th & Rowan Storage Basin Project. Weir modifications to be performed in 2014. Costs included in 13th and Rowan Storage Basin Project. The bending weir will be installed by 12/31/2014.

Design Assumption: Modeling indicates overflow is caused by surcharging, so solution must be part of 13th and Rowan Storage Basin Project. Some overflow reduction will be realized by increasing in-line storage with bending weir.

Capital Cost: $0

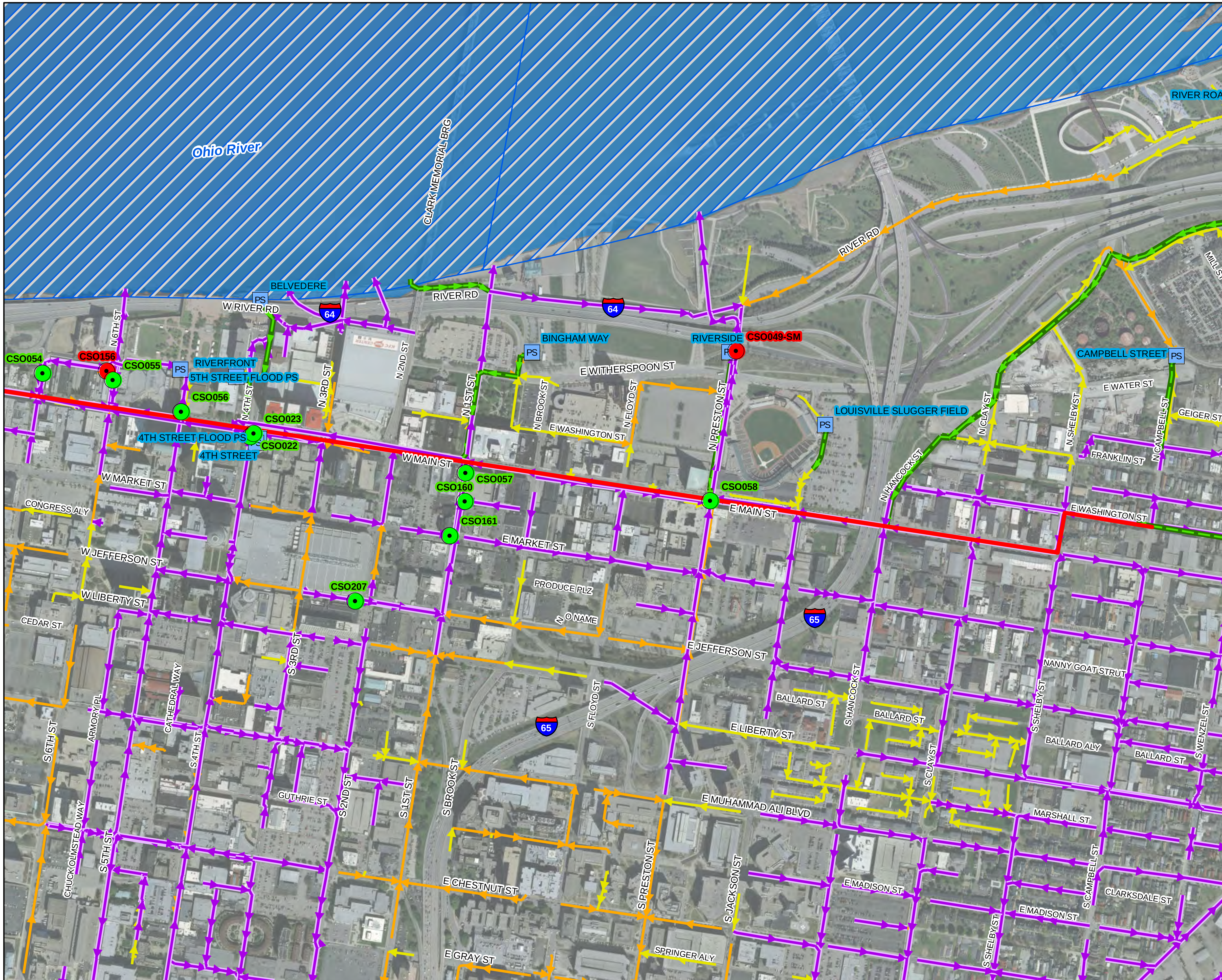
Capital Benefit/Cost: Included in 13th and Rowan Storage Basin Project

Present Worth Benefit Cost: Included in 13th and Rowan Storage Basin Project

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO058	PRESTON ST OVFL WEIR	1.29	13	69.55	51

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

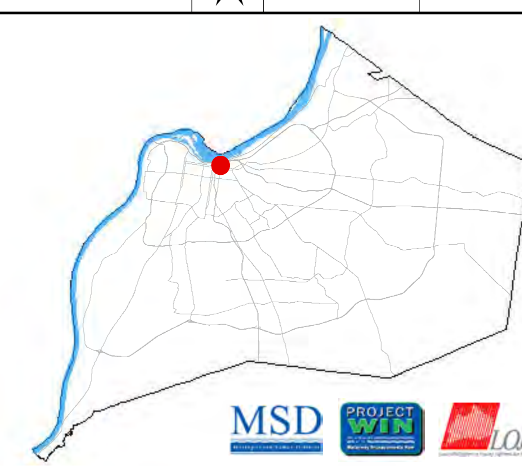
CSO058 Inline Storage & Green Infrastructure

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Haulop Locations
- Pump Stations
- MSD
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 646 feet	N	Aerial Date: 2012	Map Revision: April 14, 2014



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\CSO058_In Line Storage_ Green Infrastructure.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Southwestern Parkway Storage Basin

Project Number: L_OR_MF_105_M_13_B_A_0

Project Type: In-Line & Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes a 11.07 MG underground covered concrete basin for CSO104, 105, and 189 and in-line storage in the Western Outfall and the Northwest Interceptor for an an additional 8.8 MG using adjustable gates to reduced overflows to zero overflows per typical year.

Design Assumption: Available CSS storage capacity is based on June, 2001 BPR RTC Study. Model Run with RTC Coded in confirms available storage. Flow Control assumes inflatable dams are available at the time of construction.

Capital Cost: $30,937,000

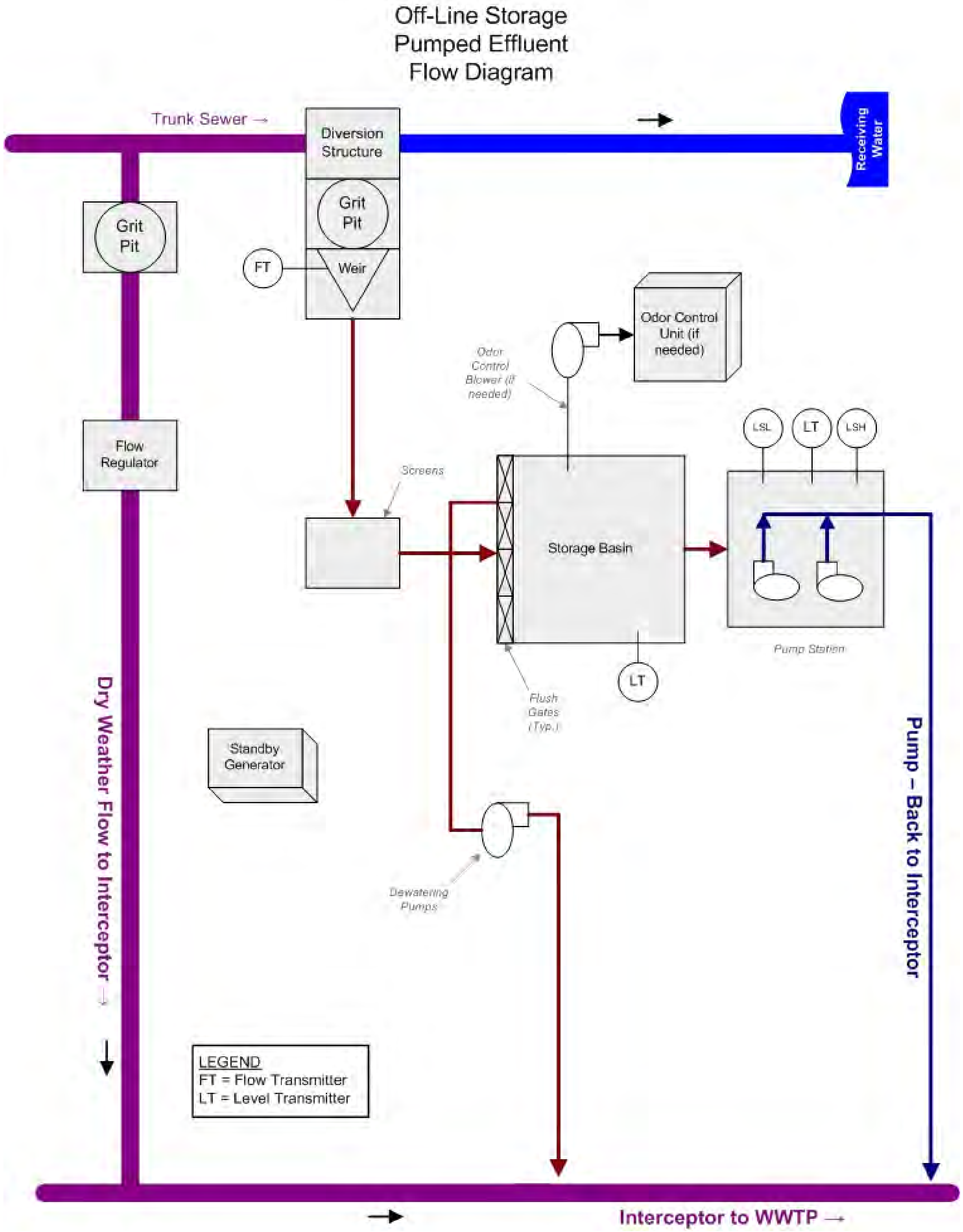
Capital Benefit/Cost: 22.14

Present Worth Benefit Cost: 24.06

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO104	SW PKWY SEWER @ BROADWAY	3.90	16	3.90	16
CSO105	WESTERN OUTFALL @ BROADWAY	59.69	30	59.67	30
CSO189	NORTHWESTERN SAN DIV	51.19	28	43.98	28

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.


Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Dry Weather Flow to Interceptor →
Standby Generator
Pump – Back to Interceptor
Dewatering Pumps
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

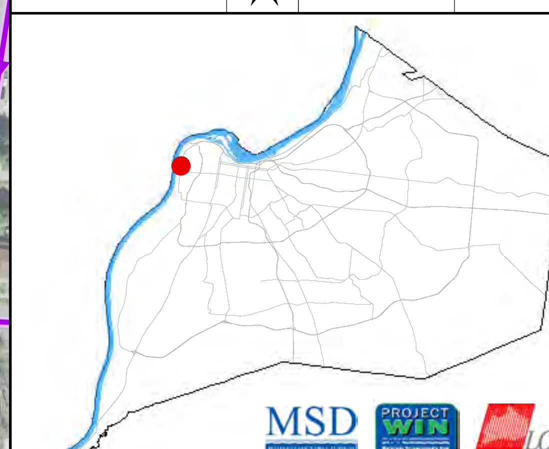
Southwestern Parkway Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Flow Control Solution
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 300 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\Southwestern_Parkway_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

Project Name: 13th Street and Rowan Street Storage Basin

Project Number: L_OR_MF_155_M_09B_B_B_4

Project Type: Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes a large conveyance line from multiple CSOs and 4.36 MG underground covered concrete basin to reduce overflows to 8 overflows per typical year. This project also includes weir modifications to CSO 023 and 058. Two routes and costs for the conveyance line have been identified. The first route involves micro-tunnelling along Main Street, and the alternate route involves traditional open cut sewer installation along River Road. A right-sizing analysis may be used to potentially reduce the size of the basins or eliminate some of the conveyance lines.

Design Assumption: Conveyance line along Main Street will be able to stay under existing utilities and over existing stormwater outfall lines. All CSOs are connected to the conveyance line near the weir, and no overflow pipes are used for conveyance due to the potential of additional direct stormwater runoff.

Capital Cost: $27,863,000

Capital Benefit/Cost: 40.71

Present Worth Benefit Cost: 51.31

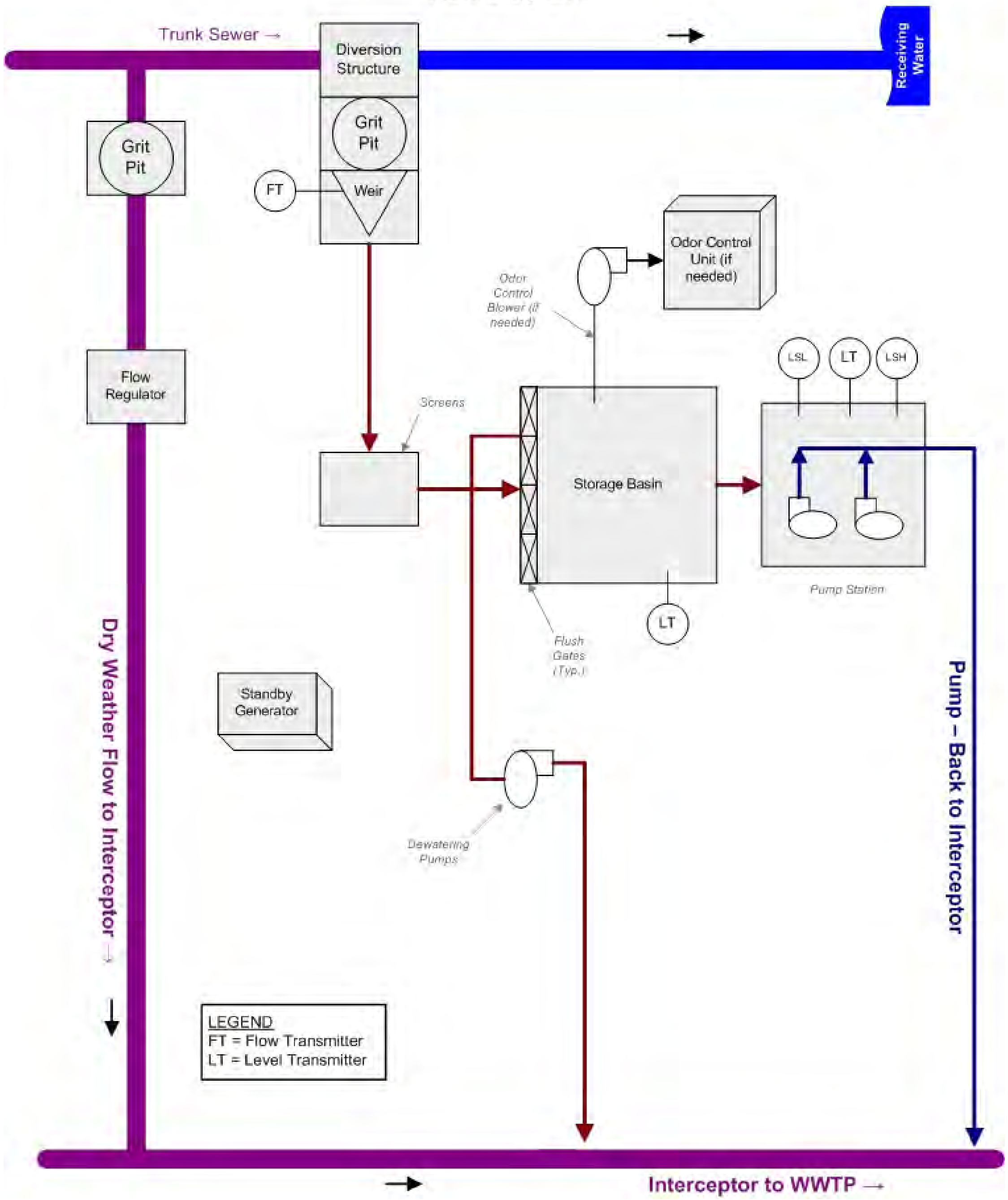
		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO022	FOURTH ST PS	3.13	7	3.13	7
CSO023	ORI @ 4th ST PS	3.95	6	16.15	15
CSO050	12th STREET	8.58	30	15.13	32
CSO051	11th STREET	1.18	13	1.89	15
CSO052	10th STREET	2.51	18	4.31	25
CSO053	8th STREET	4.62	38	4.62	38
CSO054	7th STREET	0.72	12	1.54	18
CSO055	6th STREET	2.66	14	6.53	21
CSO056	5th STREET	1.41	11	1.96	13
CSO058	PRESTON ST OVFL WEIR	1.29	13	69.55	51
CSO150	8th ST @ COMMON PLACE	0.86	14	1.88	21
CSO155	ROWAN ST @ 12th ST	2.36	38	2.36	38

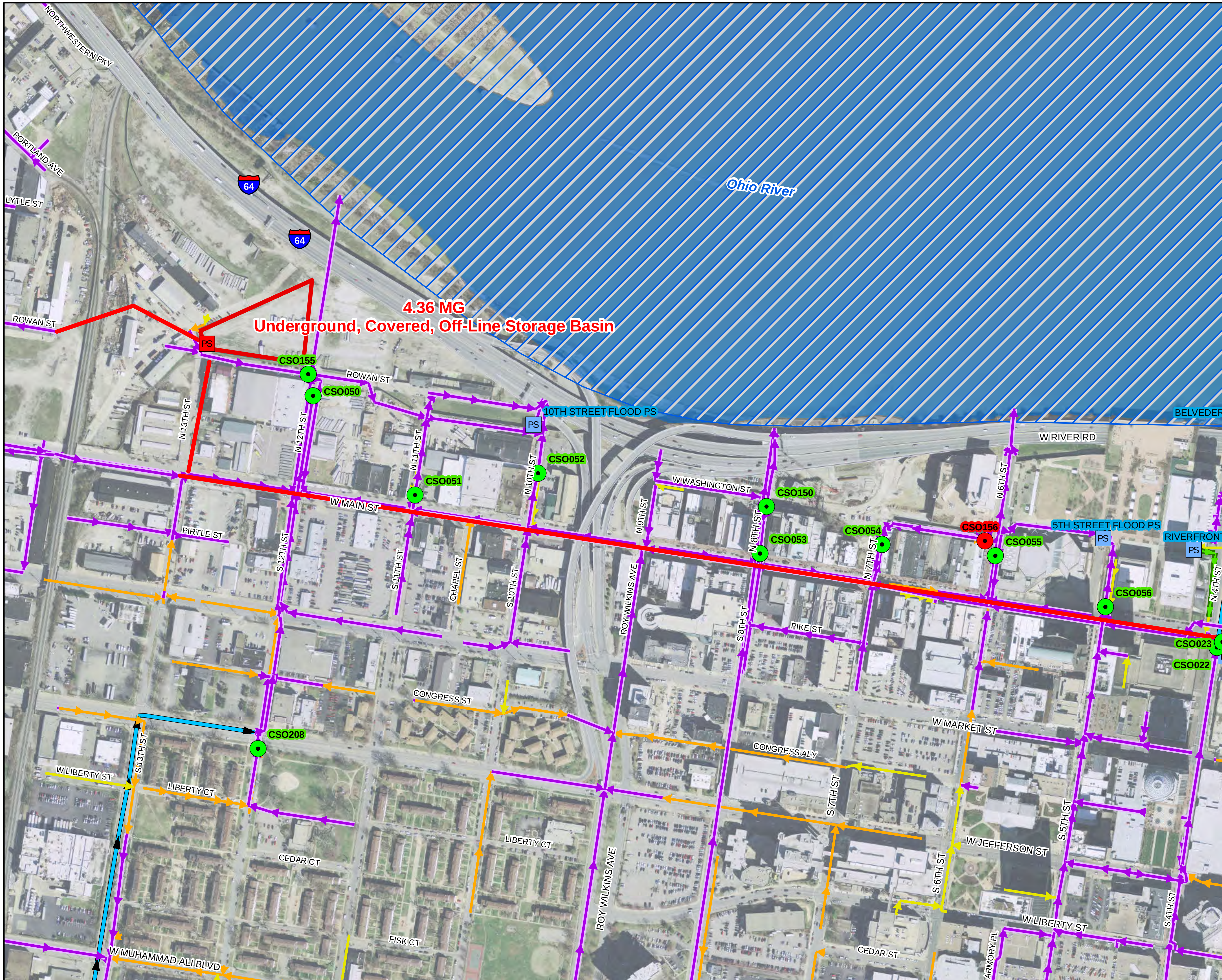
1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

CSO LTCP
Project Fact Sheet

Off-Line Storage
Pumped Effluent
Flow Diagram





Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

N 13th St and Rowan St Storage Basin

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 400 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

MSD PROJECT WIN LOJIC

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: CSO160 In-Line Storage & Green Infrastructure Controls

Project Number: L_OR_MF_160_S_08_A_A_0

Project Type: In-Line Storage

Rec Stream: Ohio River

Project Description: The CSO structure will be rebuilt to raise the overflow weir and create in-line storage in 88-feet of newly constructed 72-inch pipe. Focused modeling and monitoring will be utilized to determine if the level of control is met. Green infrastructure within the drainage area will be constructed to reach the 0 overflow in a typical year of control to the extent that flow monitoring (conducted after the inline storage is constructed) indicate it is needed.

Design Assumption:

Capital Cost: $231,000

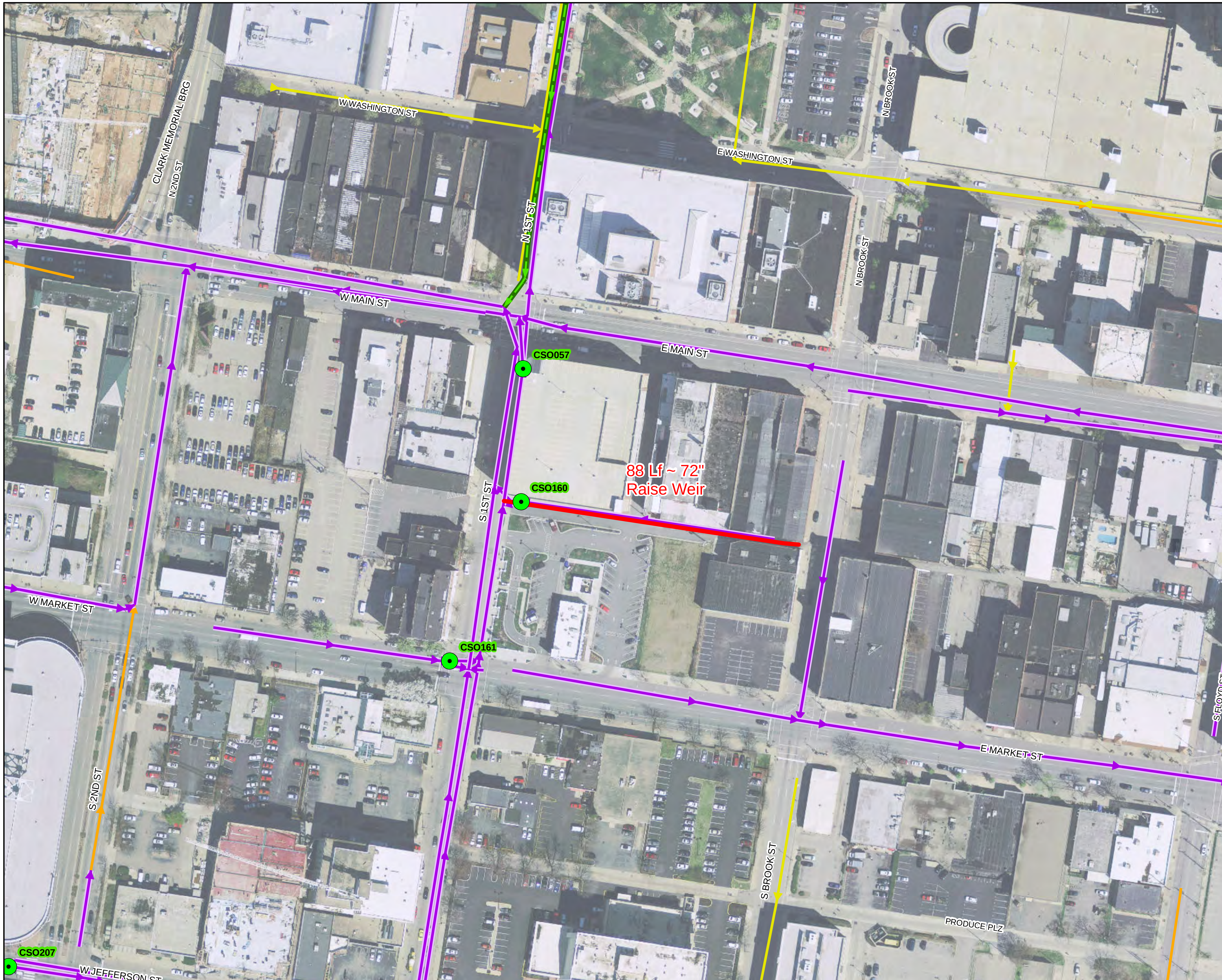
Capital Benefit/Cost: 554.11

Present Worth Benefit Cost: 684.49

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO160	SEWER IN ALLEY SAN DIV	0.07	2	0.09	4

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

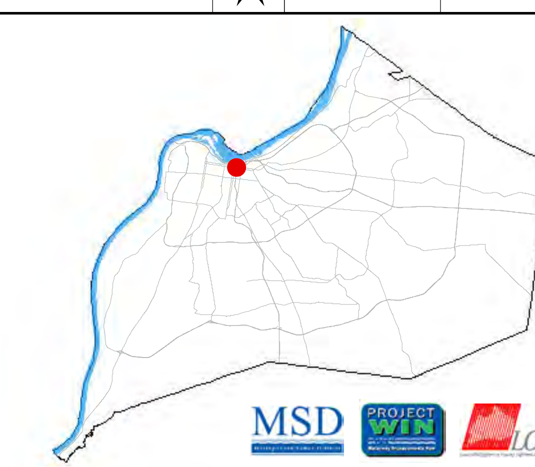
CSO160 Inline/Offline Storage

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Haulop Locations
- Proposed Pump Station Solution
- Pump Stations
- MSD
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 139 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\CSO160_SewerSeparation.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

Project Name: Adams Street Sewer Separation

Project Number: L_OR_MF_172_S_09B_B_A_0

Project Type: Sewer Separation

Rec Stream: Ohio River

Project Description: This project includes the separation of the final two stormwater catch basins from the CSO172 drainage area and closure of the CSO. Televised investigation of the upstream drainage area determined that the system had been mostly separated during the re-configuration of River Road. Project will reduce overflows to zero overflows in a typical year.

Design Assumption: Separating the final two catch basins eliminated this CSO. No other technical solution made sense, so no level of control analysis was performed and no benefit cost evaluation performed.

Capital Cost: $20,000

Capital Benefit/Cost:

Present Worth Benefit Cost:

CSO	CSO Name	Existing May 2012[1] Avg. Annual Overflow Volume	Existing May 2012[1] Avg. Annual Frequency	Baseline May 2012[2] Avg. Annual Overflow Volume	Baseline May 2012[2] Avg. Annual Frequency
CSO172	ADAMS STREET	1.13	25	1.11	25

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

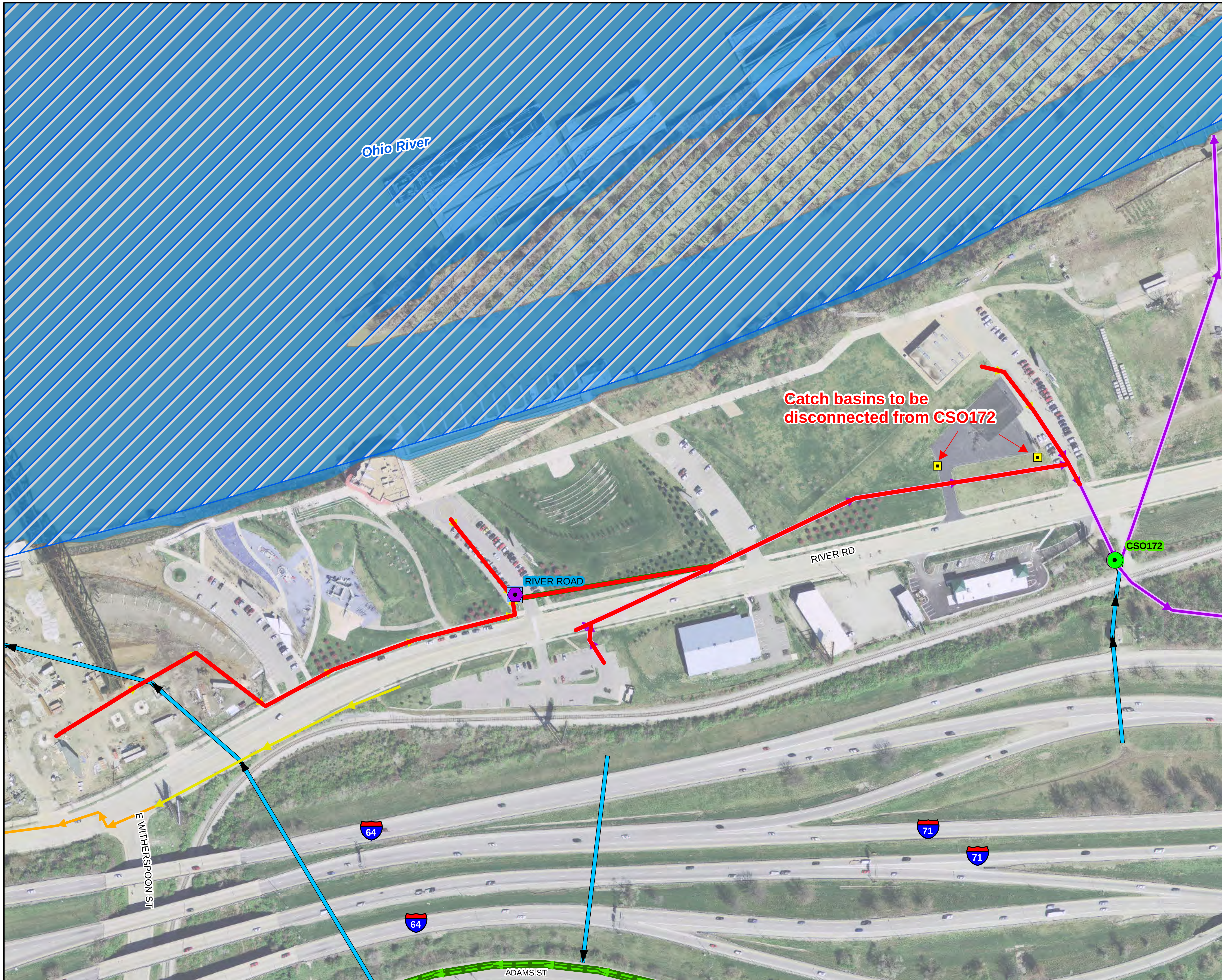
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

Adams St & CSO172 Sewer Seperation

Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 200 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\AdamsSt_CSO172_SewerSeparation.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: 18th and Northwestern Pky. Storage Basin

Project Number: L_OR_MF_190_S_09B_B_A_8

Project Type: Off-Line Storage

Rec Stream: Ohio River

Project Description: This project includes a 1.24 MG underground covered concrete basin for CSO190 to reduce overflows to 8 overflows per typical year. The basin is located in a vacant lot near I-64. The project includes a 1.86 MGD pump out facility. Green right-sizing will be performed at this basin and evaluated in-lieu of the proposed project.

Design Assumption: Basins are designed to the 9th overflow event volume, resulting in 8 CSO overflows per typical year.

Capital Cost: $4,486,000

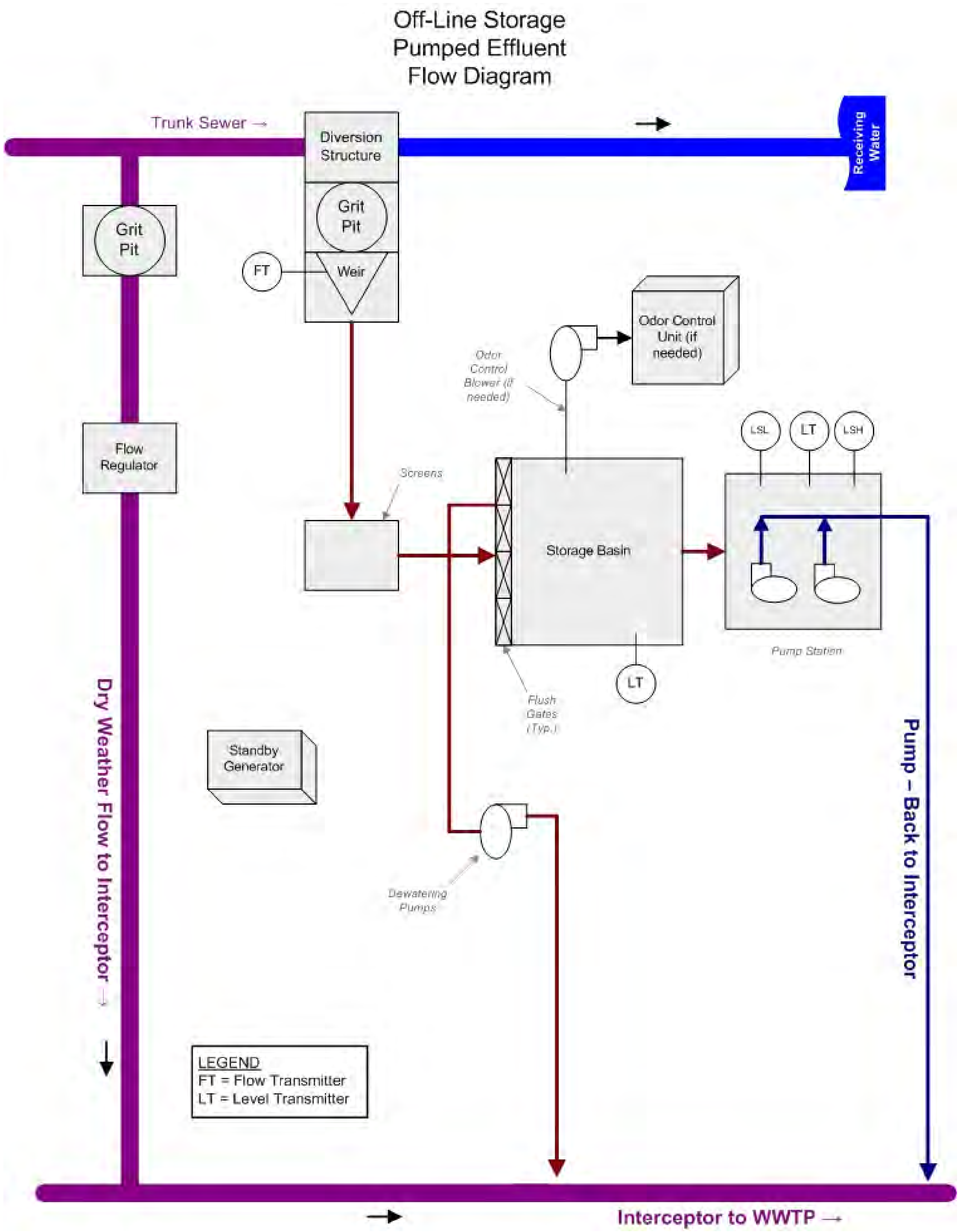
Capital Benefit/Cost: 52.79

Present Worth Benefit Cost: 54.33

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	**CSO Name**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**	**Avg. Annual Overflow Volume**	**Avg. Annual Frequency**
CSO190	SEVENTEENTH ST SAN DIV	35.40	54	35.40	54

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.


Off-Line Storage
Pumped Effluent
Flow Diagram
Trunk Sewer →
Diversion Structure
Receiving Water
Grit Pit
Grit Pit
FT
Weir
Odor Control Unit (if needed)
Odor Control Blower (if needed)
LSL
LT
LSH
Flow Regulator
Screens
Storage Basin
Pump Station
LT
Flush Gates (Typ.)
Standby Generator
Dry Weather Flow to Interceptor →
Pump – Back to Interceptor
Dewatering Pumps
LEGEND
FT = Flow Transmitter
LT = Level Transmitter
Interceptor to WWTP →

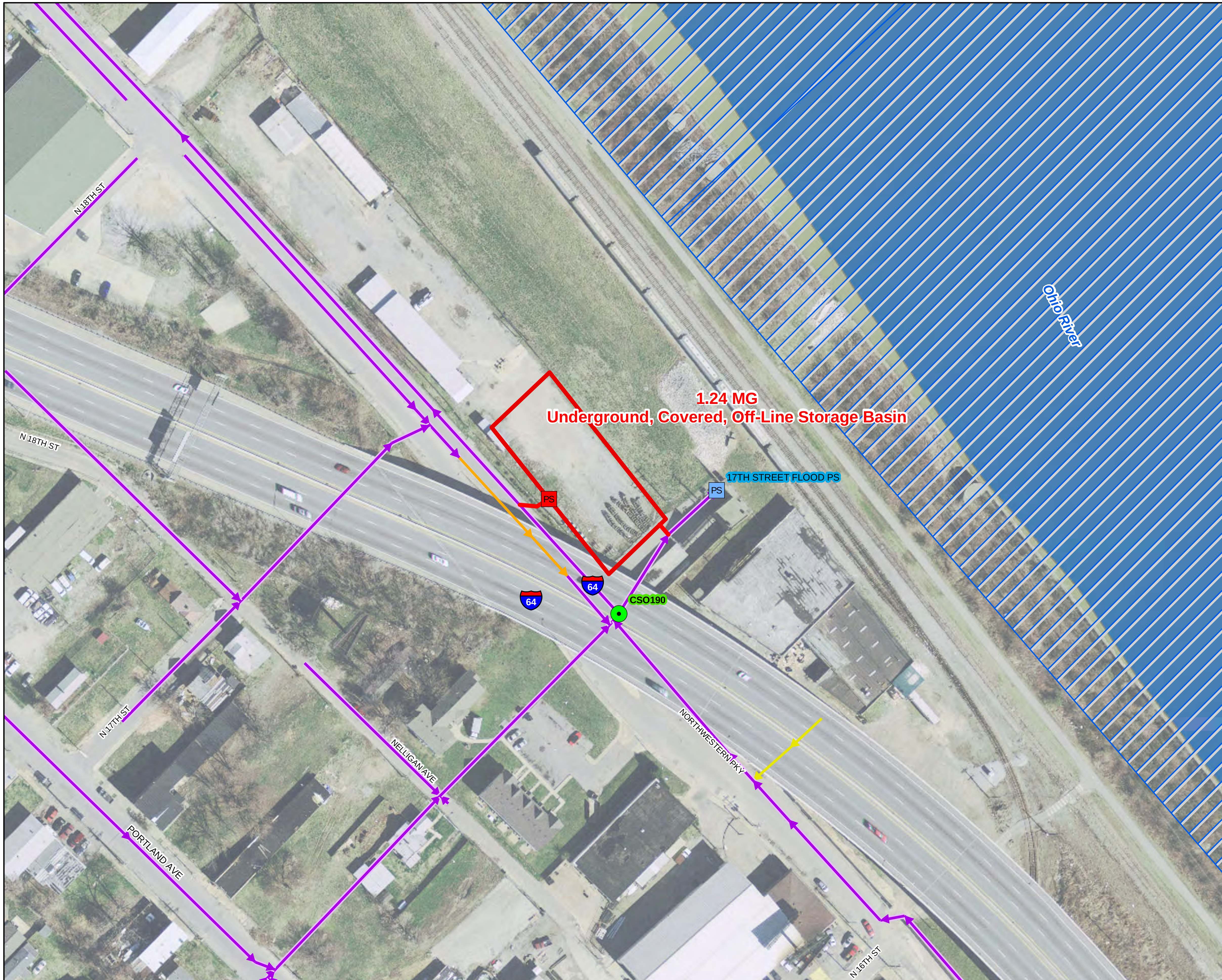
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

18th St & Northwstern Pky Storage Basin

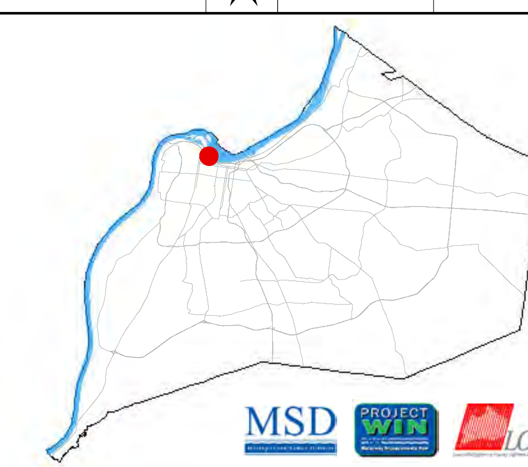
Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Proposed Pump Station Solution
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Proposed Storage Solution
- Streams
- Floodway
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 100 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012



J:\msd\SharedMaps\IOAP\2012 Revision\MXD\18thSt_and_NorthwesternPky_Storage_Basin.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

MSD

CSO Project Fact Sheet

2012 IOAP Project Modification

PROJECT WIN

Project Name: Central Relief Drain CSO In-line Storage, Green Infrastructure & Distributed Storage

Project Number: L_OR_MF_155_M_09B_B_B_4

Project Type: Diversion, Inline Storage and Green Infrastructure

Rec Stream: Ohio River

Project Description: Modify weir elevations to maximize in-line storage to the extent practicable. Focused modeling and monitoring will be utilized to determine if the level of control is met. Green infrastructure and distributed storage within the CSO drainage areas will be constructed to reach the 8 overflows in a typical year level of control to the extent that flow monitoring and modeling (conducted after weir raises are completed) indicate it is needed.

Design Assumption: Assumes weir raises will be acceptable. Additional evaluating of potential flooding at weir raise level will need to be evaluated based on the configuration of each CSO structure. Green Infrastructure or bending weirs may be used to mitigate potential increase of flooding risks.

Capital Cost: $2,184,000

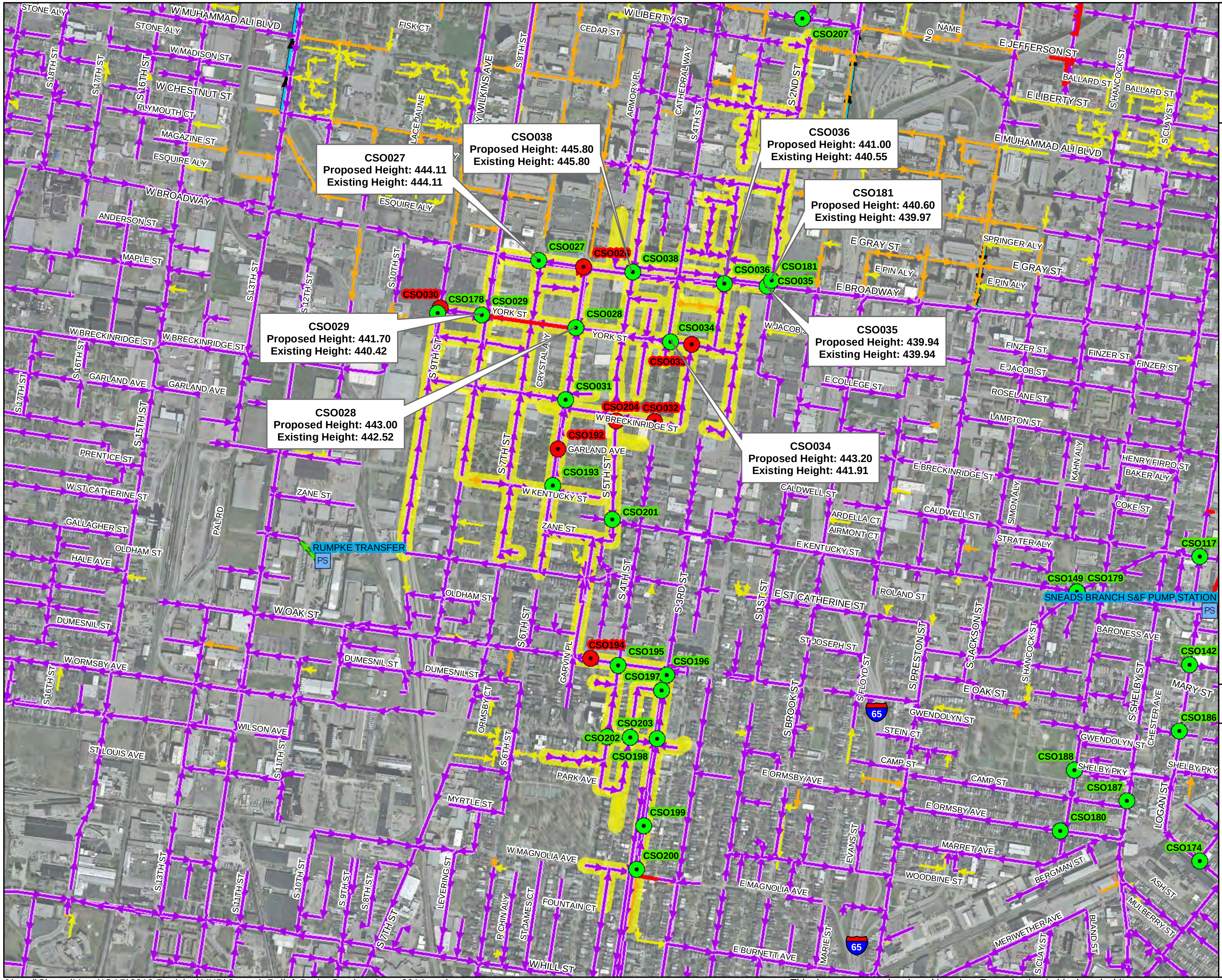
Capital Benefit/Cost: 543.96

Present Worth Benefit Cost: 581.21

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO028	CRD 6th & YORK	1.28	26	1.28	26
CSO029	CRD 8th & YORK	5.30	37	5.30	37
CSO034	CRD 4th & YORK	0.29	21	0.29	21
CSO036	CRD 3rd & BROADWAY	0.00	0	0.00	0
CSO178	CRD 9th & YORK "B"	18.58	48	18.58	48
CSO181	CRD 2nd & BROADWAY NO 2	15.70	61	15.70	61
CSO193	CRD S 6th & KENTUCKY	0.02	4	0.02	4
CSO195	CRD S 4th & OAK	1.55	42	1.55	42
CSO196	CRD S 3rd & OAK	0.00	1	0.00	1
CSO197	CRD S 3rd S OF OAK	1.87	45	1.87	45
CSO199	CRD S 3rd N OF MAGNOLIA	0.19	27	0.19	27
CSO200	CRD S 3rd & MAGNOLIA	2.54	57	2.54	57
CSO202	CRD S ORMSBY W OF 3rd	0.05	9	0.05	9

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

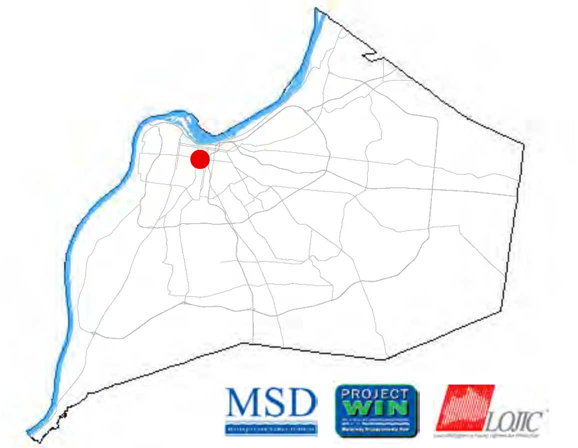
Central Relief Drain CSO Service Area

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Pump Stations
- Proposed Pipe Solution
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Drainage Mains
- Streams
- Floodway
- CRD CSO Service Area
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 1,000 feet	N	Aerial Date: 2009	Map Revision: April 14, 2014



This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Southern Outfall In-line Storage at 43rd St (SOR1)

Project Number: L_OR_MF_211_M_13_B_A_8

Project Type: In-Line Storage

Rec Stream: Ohio River

Project Description: In-line storage using an actuated gate or inflatable dam in the Southern Outfall (11.4 MG) linked to Real Time Control near the end of 43rd Street and the existing Whayne Supply property. Project will reduce overflows to 8 overflows in a typical year.

Design Assumption: Inflatable dam must be available for manufacture at the necessary size.

Capital Cost: $3,544,000

Capital Benefit/Cost: 109.27

Present Worth Benefit Cost: 113.96

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO016	MILES PARK BYPASS	47.90	28	13.86	29
CSO210	45th STREET-GREENWOOD	71.45	50	61.89	50

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

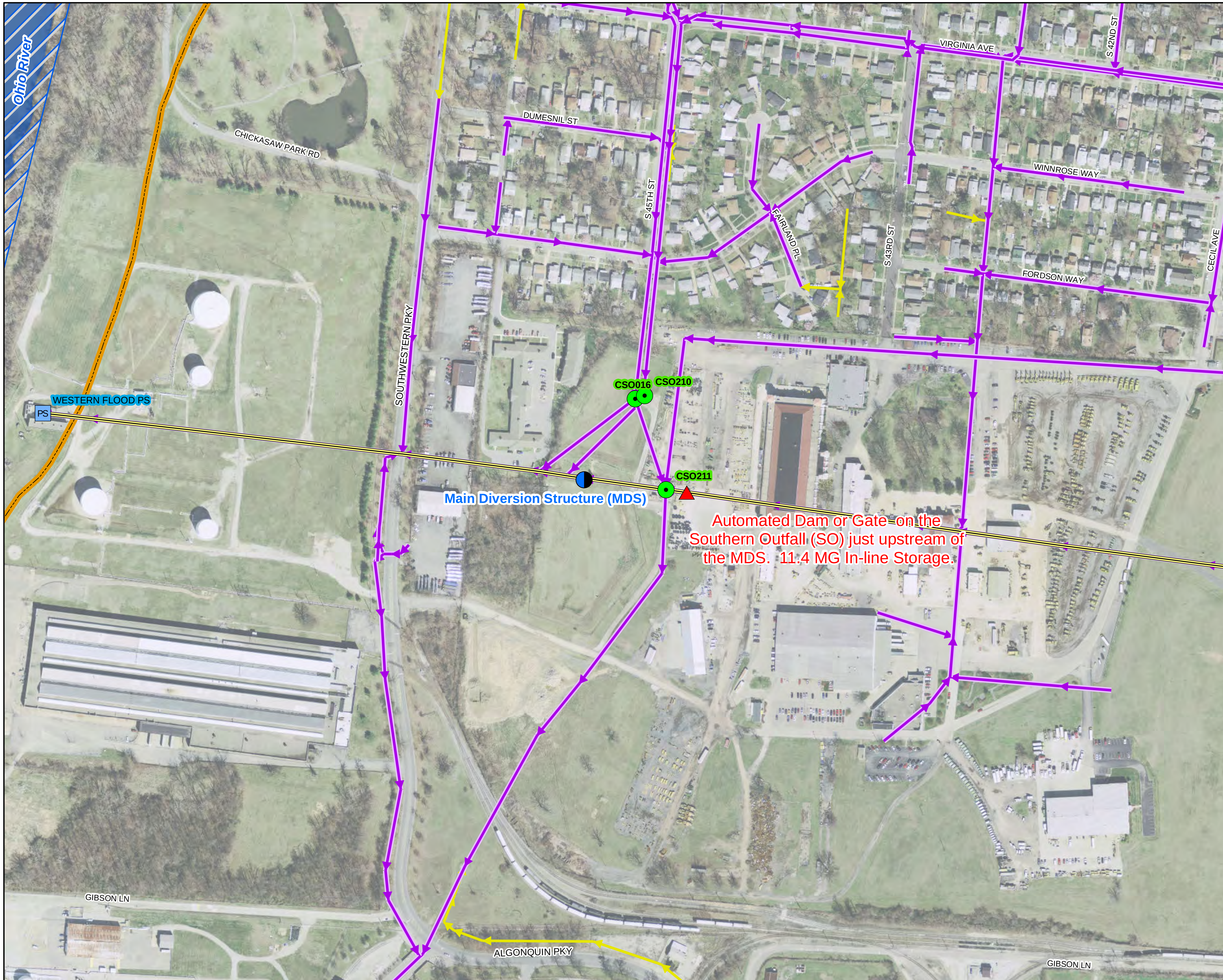
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

Southern Outfall In-line Storage - 43rd St (SOR1)

Preliminary - For Budget Development Only



- Active CSO
- Eliminated CSO
- Proposed Flow Control Solution
- Pump Stations
- MSD
- Proposed Pipe Solution
- Southern Outfall
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Proposed Off-line Storage
- Streams
- Floodway
- Flood Wall
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 300 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\SOR1.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Southern Outfall In-line Storage at 12th St & Wilson Ave (SOR2)

Project Number: L_OR_MF_211_M_13_B_A_8

Project Type: In-Line Storage

Rec Stream: Ohio River

Project Description: In-line storage using an actuated gate or inflatable dam in the Southern Outfall (4.7 MG) linked to Real Time Control near the intersection of 12th Street and Wilson Avenue. Project will reduce overflows to 8 overflows in a typical year.

Design Assumption: Inflatable dam must be available for manufacture at the necessary size.

Capital Cost: $3,544,000

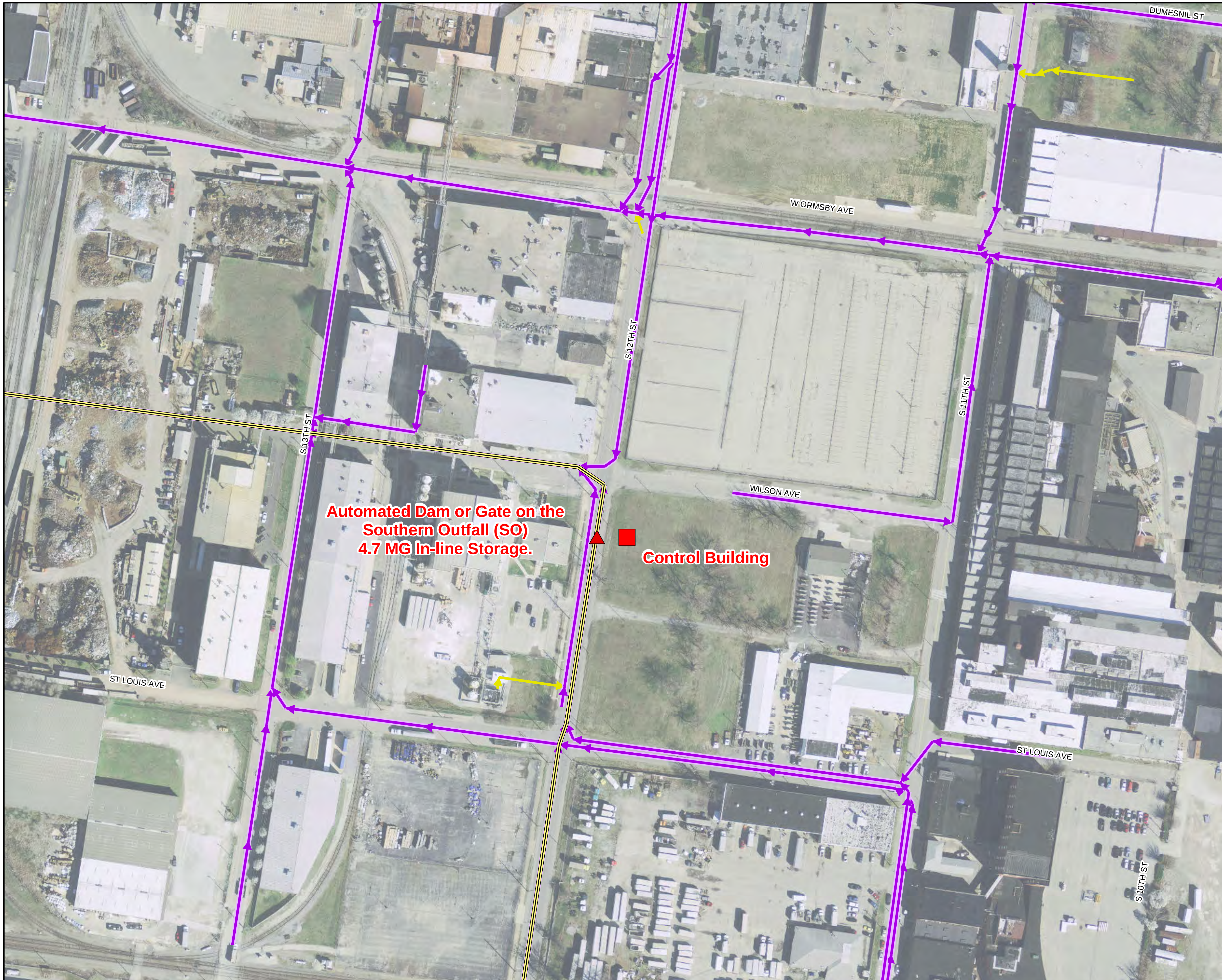
Capital Benefit/Cost: 109.27

Present Worth Benefit Cost: 113.96

		Existing May 2012 [1]		Baseline May 2012 [2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO016	MILES PARK BYPASS	47.90	28	13.86	29
CSO210	45th STREET-GREENWOOD	71.45	50	61.89	50
CSO211	MAIN DIVERSION STRUCTURE	348.50	24	283.12	22

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long Term Control Plan

Ohio River

Southern Outfall In-line Storage
12th St & Wilson Ave (SOR2)

Preliminary - For Budget Development Only

- Active CSO
- Eliminated CSO
- Proposed Flow Control Solution
- PS Pump Stations
- MSD
- Proposed Pipe Solution
- Southern outfall
- Combined Sewer Pipe
- Force Main
- Collector < 12"
- Interceptor >= 12"
- Proposed Off-line Storage
- Streams
- Floodway
- Flood Wall
- Jefferson County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch = 157 feet	N	Aerial Date: 2009	Map Revision: April 9, 2012

MSD PROJECT WIN LOJIC

J:\msd\SharedMaps\IOAP\2012 Revision\MXD\SOR2.mxd

This document was developed in color. Reproduction in black and white may not represent the data as intended. Scalable when printed on 11"x17" paper.

Flood Pumping Stations

MSD

CSO Project Fact Sheet

2012 IOAP Project Modification

PROJECT WIN

Project Name: 4th Street Flood Pump Station

Project Number: L_OR_MF_022_M_03_A_A

Project Type: Pump Station Modification

Rec Stream: Ohio River

Project Description: This project provides for the installation of hydraulic actuators on Gates 33 and P3. The gates will be operated by a local PLC and WLSs to ensure that DWOs do not occur. This modification will change the "Plant Idle" mode of operation at the FPS to a "Minor Flood" mode.

Design Assumption: Project design intended to eliminate dry-weather CSO caused by trapped water in the downstream conveyance line. No level of control analysis was necessary and no benefit cost evaluation performed, since the technical solution eliminated the dry weather overflow potential regardless of overflow event size or duration. The design will be developed in accordance with the MSD Design Manual.

Capital Cost: $944,000

Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012 [1]		Baseline May 2012 [2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO022	FOURTH ST PS	3.13	7	3.13	7
CSO023	ORI @ 4th ST PS	3.95	6	16.15	15

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long - Term Control Plan

Ohio River

Solution ID # L_OR_MF_022_M_03_A_A

4th Street FPS DWO Elimination

Preliminary - For Budget Development Only

Legend

- Active CSO
- Eliminated CSO
- Existing Catch Basin
- Existing Drainage Line
- Pump Station
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Floodway
- Metro Parks
- Streams
- County Boundary

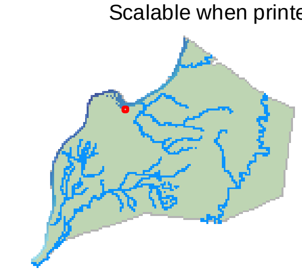
General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 100 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
December 9, 2008

Aerial Date: 2006



N

LOJIC MSD PROJECT WIN

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: 17th Street Flood Pump Station

Project Number: L_OR_MF_190_S_03_A_A

Project Type: Pump Station Modification

Rec Stream: Ohio River

Project Description: This project provides a new sluice gate with hydraulic actuator for Gate 53 with local control through a PLC and WLSs and will operate in conjunction with 34th Street FPS.

Design Assumption: Project design intended to eliminate dry-weather CSO caused by trapped water in the downstream conveyance line. No level of control analysis was necessary and no benefit cost evaluation performed, since the technical solution eliminated the dry weather overflow potential regardess of overflow event size or duration. The design will be developed in accordance with the MSD Design Manual.

Capital Cost: $625,000

Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO190	SEVENTEENTH ST SAN DIV	35.40	54	35.40	54

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

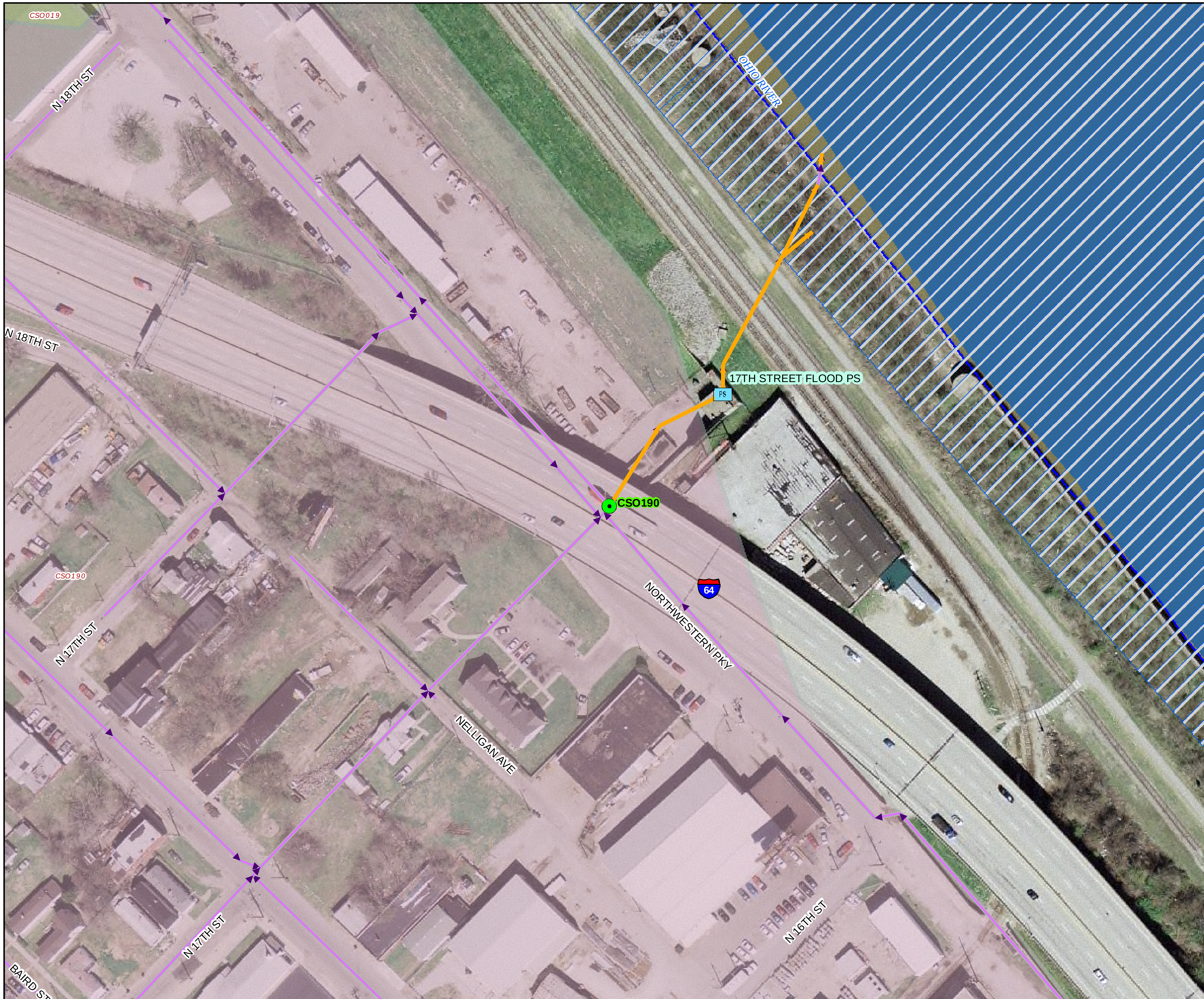
Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long - Term Control Plan

Ohio River

Solution ID # L_OR_MF_190_S_03_A_A

17th Street FPS DWO Elimination



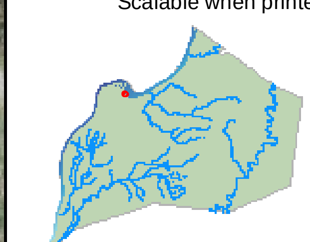
Preliminary - For Budget Development Only

Legend

- Active CSO
- Eliminated CSO
- Existing Catch Basin
- Existing Drainage Line
- Pump Station
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Floodway
- Metro Parks
- Streams
- County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 100 feet
Scalable when printed on 11" X 17" paper



Some boundaries are uniquely symbolized within the map.

Map Revision
December 9, 2008

Aerial Date: 2006

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.

CSO Project Fact Sheet
2012 IOAP Project Modification

Project Name: 27th Street Flood Pump Station

Project Number: L_OR_MF_019_S_03_A_A

Project Type: Pump Station Modification

Rec Stream: Ohio River

Project Description: This project provides a new electric actuator for Gate 65 and a replacement actuator for Gate 68 equipped with local control through a PLC and WLSs and will operate in conjunction with the 34th Street Pump Station.

Design Assumption: Project design intended to eliminate dry-weather CSO caused by trapped water in the downstream conveyance line. No level of control analysis was necessary and no benefit cost evaluation performed, since the technical solution eliminated the dry weather overflow potential regardess of overflow event size or duration. The design will be developed in accordance with the MSD Design Manual.

Capital Cost: $476,000

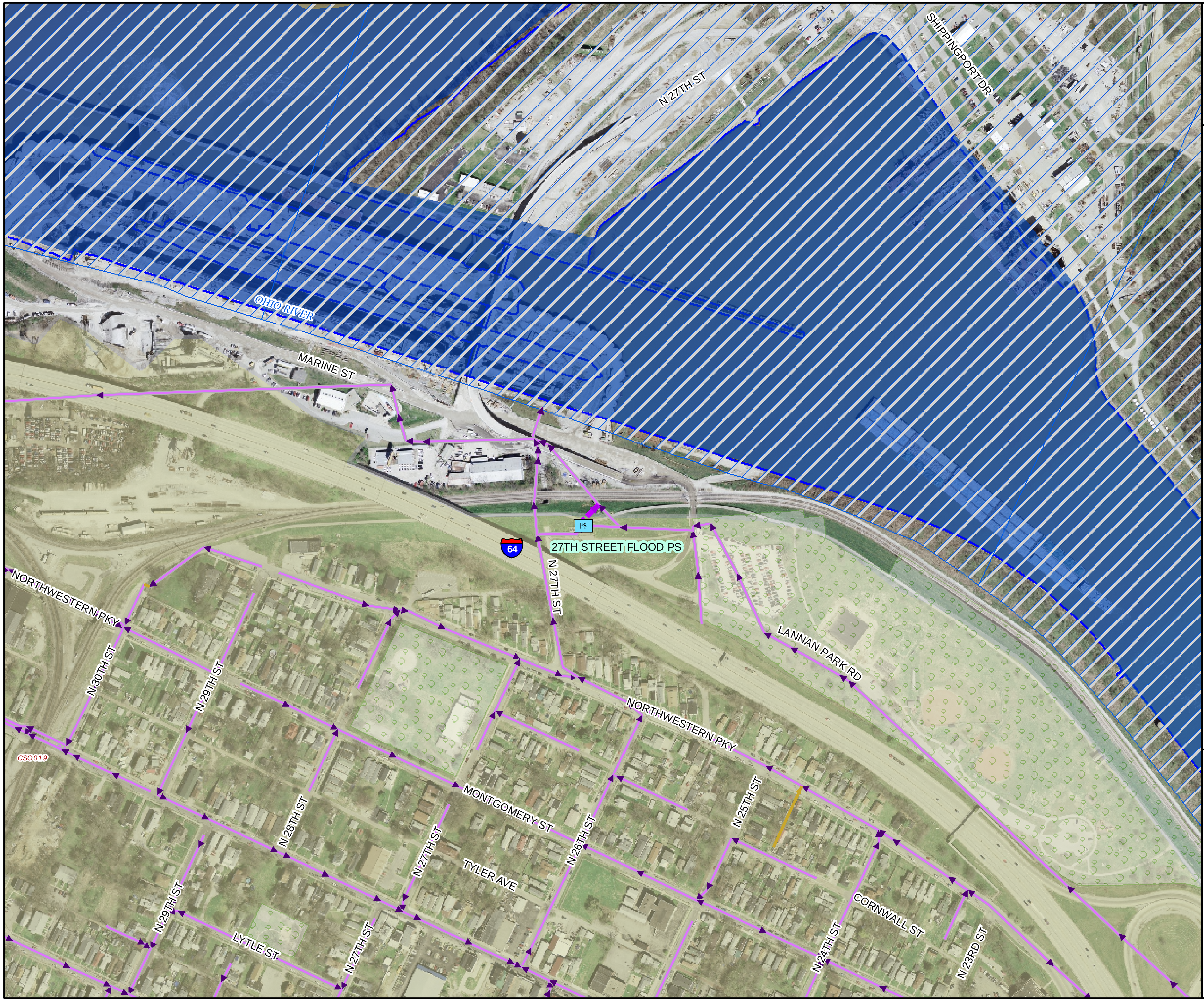
Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO019	34th STREET PS	57.73	42	57.76	43

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.



Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long - Term Control Plan

Ohio River

Solution ID # L_OR_MF_019_S_03_A_A

27th Street FPS DWO Elimination

Preliminary - For Budget Development Only

Legend

- Active CSO
- Eliminated CSO
- Existing Catch Basin
- Existing Drainage Line
- Pump Station
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Floodway
- Metro Parks
- Streams
- County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 350 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
December 9, 2008

Aerial Date: 2006

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: 34th Street Flood Pump Station

Project Number: L_OR_MF_019_S_03_A_B

Project Type: Pump Station Modification

Rec Stream: Ohio River

Project Description: This project provides a replacement actuator for Gate 71 equipped with local control through a PLC and WLSs and will operate in conjunction with the 27th and 17th Street FPSs.

Design Assumption: Project design intended to eliminate dry-weather CSO caused by trapped water in the downstream conveyance line. No level of control analysis was necessary and no benefit cost evaluation performed, since the technical solution eliminated the dry weather overflow potential regardess of overflow event size or duration. The design will be developed in accordance with the MSD Design Manual.

Capital Cost: $541,000

Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO019	34th STREET PS	57.73	42	57.76	43

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long - Term Control Plan

Ohio River

Solution ID # L_OR_MF_019_S_03_A_B

34th Street FPS DWO Elimination

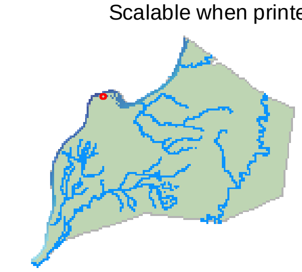
Preliminary - For Budget Development Only

Legend

- Active CSO
- Eliminated CSO
- Existing Catch Basin
- Existing Drainage Line
- Pump Station
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Floodway
- Metro Parks
- Streams
- County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 100 feet
Scalable when printed on 11" X 17" paper



Some boundaries are uniquely symbolized within the map.

Map Revision
December 9, 2008

Aerial Date: 2006

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.

CSO Project Fact Sheet

2012 IOAP Project Modification

Project Name: Shawnee Flood Pump Station

Project Number: L_OR_MF_189_M_03_A_A

Project Type: Pump Station Modification

Rec Stream: Ohio River

Project Description: This project provides a new electric actuator for Gate 88 equipped with local control through a PLC and WLSs.

Design Assumption: Project design intended to eliminate dry-weather CSO caused by trapped water in the downstream conveyance line. No level of control analysis was necessary and no benefit cost evaluation performed, since the technical solution eliminated the dry weather overflow potential regardess of overflow event size or duration. The design will be developed in accordance with the MSD Design Manual.

Capital Cost: $411,000

Capital Benefit/Cost:

Present Worth Benefit Cost:

		Existing May 2012[1]		Baseline May 2012[2]	
CSO	CSO Name	Avg. Annual Overflow Volume	Avg. Annual Frequency	Avg. Annual Overflow Volume	Avg. Annual Frequency
CSO104	SW PKWY SEWER @ BROADWAY	3.90	16	3.90	16
CSO105	WESTERN OUTFALL @ BROADWAY	59.69	30	59.67	30
CSO189	NORTHWESTERN SAN DIV	51.19	28	43.98	28

1. Existing May 2012 conditions reflect existing system operating conditions as of that date.

2. Baseline May 2012 assumes all SSDP projects are complete and critical combined sewer facilities (e.g. Morris Forman WQTC Southwestern Pump Station, Starkey Pump Station) are operating at optimal, sustainable levels.

Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long - Term Control Plan

Ohio River

Solution ID # L_OR_MF_189_M_03_A_A

Shawnee FPS DWO Elimination

Preliminary - For Budget Development Only

Legend

- Active CSO
- Eliminated CSO
- Existing Catch Basin
- Existing Drainage Line
- Pump Station
- Force Main
- Collector < 12"
- Interceptor => 12"
- Combined Sewer Pipe
- Floodway
- Metro Parks
- Streams
- County Boundary

General representation of overflow abatement solutions are for preliminary planning purposes. Alignments and locations may be altered during design.

1 inch equals 250 feet
Scalable when printed on 11" X 17" paper

Some boundaries are uniquely symbolized within the map.

Map Revision
December 9, 2008

Aerial Date: 2006

N

This document was developed in color. Reproduction in black and white may not represent the data as intended.