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

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SUPPORTING INFORMATION

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
13th Street and Rowan Street Storage Basin	Ohio River	CSO022, CSO023, CSO050, CSO051, CSO052, CSO053, CSO054, CSO055, CSO056, CSO150,CSO155, CSO156, CSO208, & Central Relief Drain	Off-Line Storage	30.8	31.08	20.52	26.46	14.44	34.56	10.06	31.82

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
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
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 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
- Dry wells
- 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

MSD identified 19 potential locations for green infrastructure demonstration projects that will begin implementation upon approval of the Integrated Overflow Abatement Plan (IOAP). To date, only a planning level evaluation has been performed for each of the proposed projects.

The proposed demonstration projects include a variety of green initiatives as follows:

Green Alleys (three projects)

- Seventeenth Street and West Hill
- Campbell Street and Main Street
- Seventh Street and Market Street

Dry Wells (five projects)

- Interstate (I)-264 On-Ramp
- I-264 Off-Ramp
- I-264 and Gibson Lane
- JFK Montessori Area
- Russell Lee Drive

Green Parking Lots (five projects)

- Sixth Street and Muhammad Ali Boulevard
- Seventh Street and Cedar Street
- Second Street and Broadway
- MSD Main Office Parking Lot, 700 West Liberty Street
- Third Street and Ormsby Avenue

Rain Gardens (five projects)

- Potential project sites at Sixth Street and Broadway
- Four additional locations, yet to be determined

Green Street (one project)

- Potential project site at Twelfth Street and Jefferson 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 $0.13 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.

While MSD is committed to implementing each of the demonstration projects, issues such as easements, land acquisition, permitting and other site specific constraints that have not been identified at this level of evaluation. Adjustments may be required to the list of proposed projects during later phases. MSD plans to work closely with strategic project partners, such as Louisville Metro Public Works and other departments, to identify appropriate site locations and design and performance standards for the proposed green demonstration projects. As previously mentioned, MSD plans to have all 19 demonstration projects completed by December 2011. However developing these relationships early will allow MSD to maximize the commitment to implementing and maintaining green infrastructure within the Louisville Metro area. MSD will use these developed partnerships to make recommendations regarding the maintenance and rehabilitation practices on public/private property as well as within the right-of-way (ROW) to ensure the use of green infrastructure in the future.

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 4.1.2 summarizes MSD's proposed Green Infrastructure Demonstration Projects List.

Table 4.1.3 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 and programs 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, 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 $0.09 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 develop and 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 4.1.2
FINAL RECOMMENDED GREEN DEMONSTRATION PROJECT LIST

Project Name	Location	CSO Controlled	Technology	Gallons Removed Annually (MG)	Capital Cost (2008 Dollars)	Cost per Gallon Removed	Completion Date
MSD Main Office Parking Lot Bioswale	Ohio River	CSO053	Biofiltration Technique	0.88 MG	$80,000	$0.09	12/31/2010
Seventh and Cedar Green Parking Lot	Ohio River	CSO053	Biofiltration Technique	1.1 MG	$96,000	$0.09	12/31/2010
Second and Broadway Green Parking Lot	Ohio River	CSO181, CSO118	Biofiltration Technique	1.1 MG	$96,000	$0.09	12/31/2010
Third and Ormsby Biofiltration Swales	Ohio River	CSO198	Biofiltration Technique	0.53 MG	$ 48,000	$0.09	12/31/2010
Sixth and Muhammad Ali Green Parking Lot	Ohio River	CSO022	Biofiltration Swale	1.1 MG	$96,000	$0.09	12/31/2010
Sixth and Broadway Rain Garden	Ohio River	CSO028	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2010
Seventeenth and W Hill Permeable Alley	Ohio River	CSO015	Permeable Alley	1.74 MG	$278,000	$0.16	12/31/2010
Seventh and Market Permeable Alley	Ohio River	CSO053	Permeable Alley	0.97 MG	$155,000	$0.16	12/31/2010
Campbell and Main Permeable Alley	South Fork	CSO121	Permeable Alley	0.41 MG	$65,000	$0.16	12/31/2010
Twelfth and Jefferson Green Street	Ohio River	CSO208	Green Street	0.53 MG	$48,000	$0.09	12/31/2010
I-264 Off-Ramp Dry Well	Middle Fork	CSO189	Dry Well	0.15 MG	$30,000	$0.20	12/31/2011
I-264 On-Ramp Dry Well	Ohio River	CSO019	Dry Well	0.15 MG	$30,000	$0.20	12/31/2011
I-264 and Gibson Dry Well	Ohio River	CSO191	Dry Well	0.6 MG	$120,000	$0.20	12/31/2011
Russell Lee Drive Dry Well	Ohio River	CSO191	Dry Well	0.15 MG	$30,000	$0.20	12/31/2011
JFK Montessori Area Dry Well	Ohio River	CSO191	Dry Well	0.3 MG	$60,000	$0.20	12/31/2011
Additional Rain Garden Site	TBD	TBD	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2010
Additional Rain Garden Site	TBD	TBD	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2010
Additional Rain Garden Site	TBD	TBD	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2011
Additional Rain Garden Site	TBD	TBD	Rain Garden	0.53 MG	$48,000	$0.09	12/31/2011
TOTAL				**12 MG**	**$1,500,000**	**$0.13**	

TABLE 4.1.3
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

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

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
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
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)

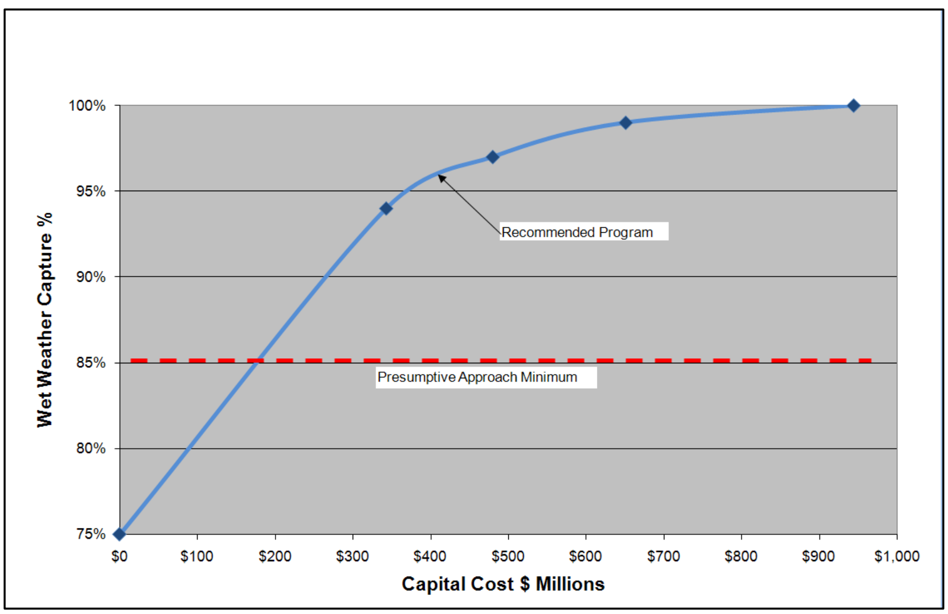


FIGURE 4.1.2 FECAL COLIFORM PEAK VS. PERCENT CAPTURE (OHIO RIVER)

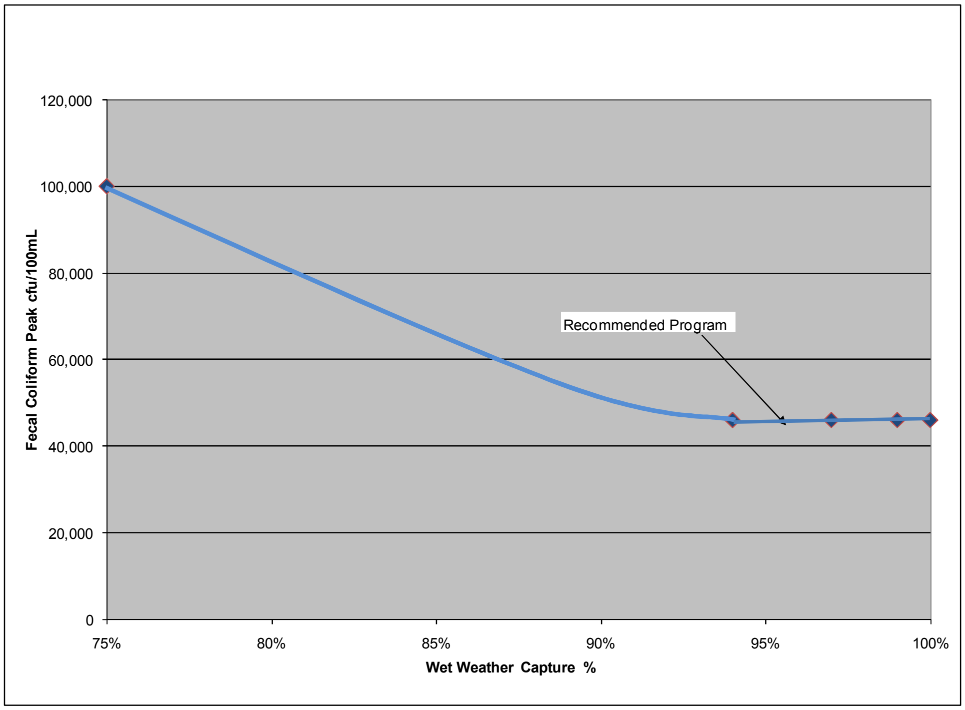


FIGURE.4.1.3 PEAK FECAL COLIFORM VS. CAPITAL COST (OHIO RIVER)

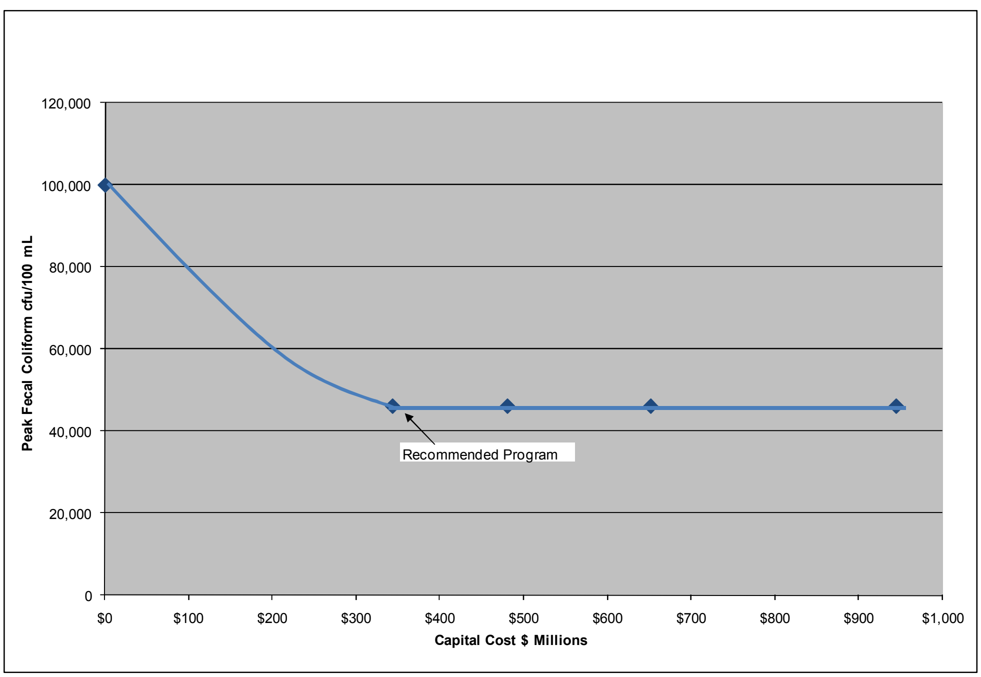


FIGURE 4.1.4 MONTHLY MAX. NON-COMPLIANCE-RECREATION SEASON VS. PERCENT CAPTURE (OHIO RIVER)

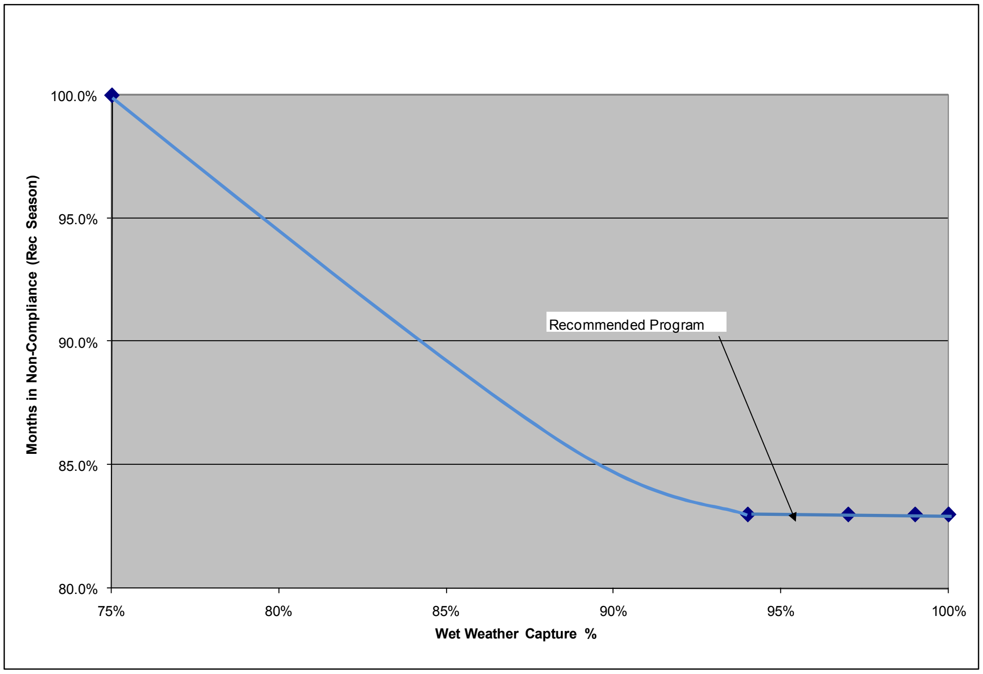


FIGURE 4.1.5 FECAL COLIFORM VS. PERCENT CAPTURE (BEARGRASS CREEK)

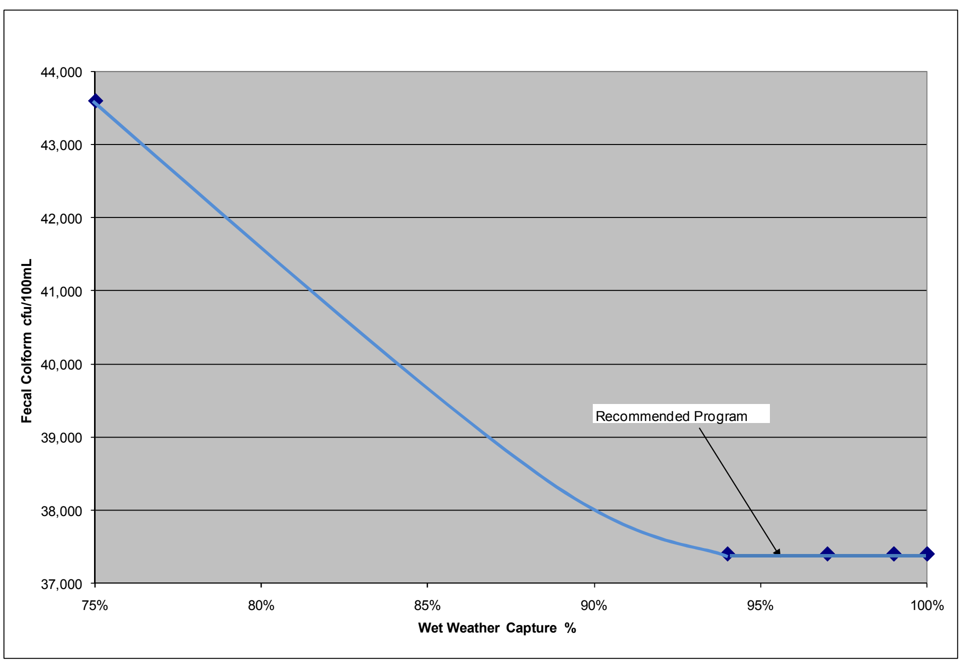


FIGURE 4.1.6 FECAL COLIFORM PEAK VS. CAPITAL COST (BEARGRASS CREEK)

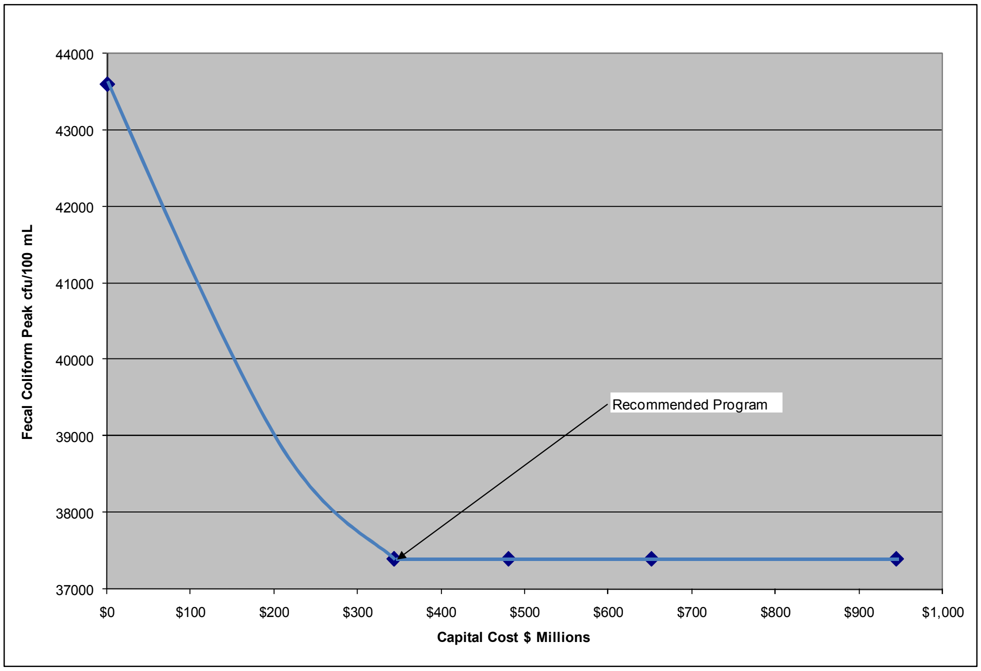
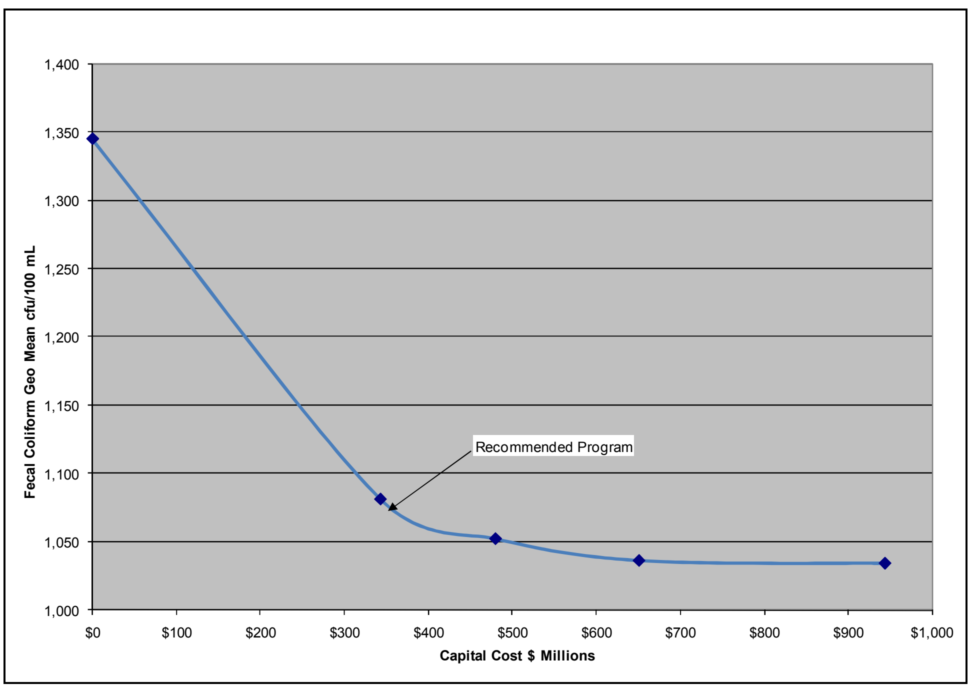


FIGURE 4.1.7 FECAL COLIFORM GEOMETRIC MEAN VS. CAPITAL COST (BEARGRASS CREEK)



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**	

Project ID	Construction Completion	CSO	Reach ID	Individual Reach Rating	Score	Composite Ranking	Comment
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**	
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 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 as an Appendix in Volume 1, Chapter 3. The Public Involvement component for the entire IOAP is 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.

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.

FIVE VALUES

1. Asset Protection
2. Eco-friendly Solutions
3. Environmental Enhancement
4. Public Health
5. Regulatory Performance

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

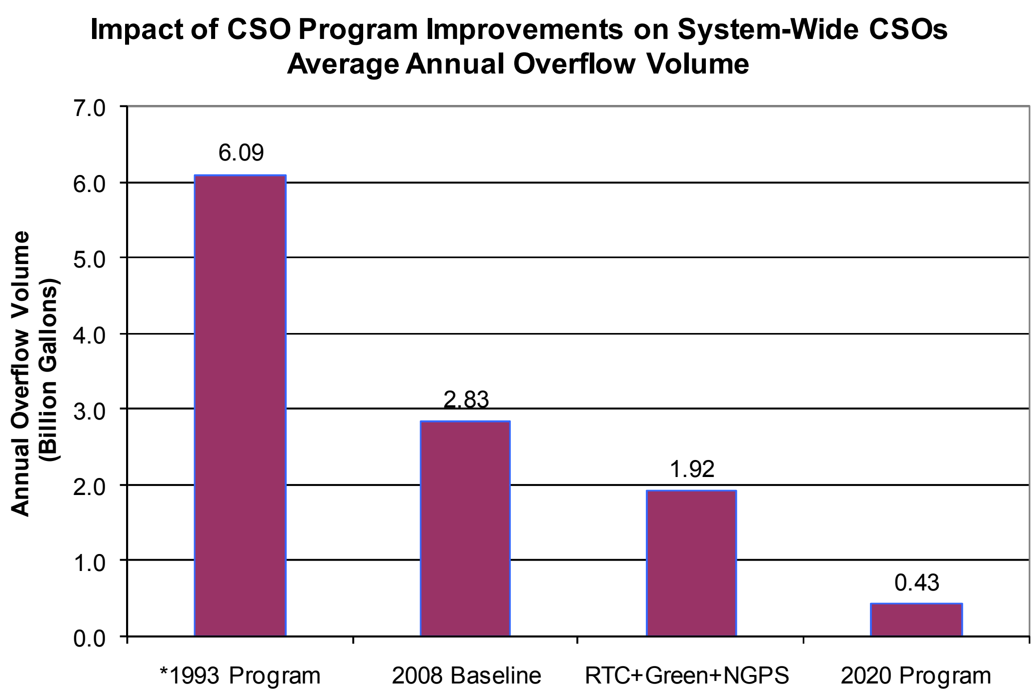
	No Additional Control (2008 Baseline)	Recommended Final CSO LTCP
Volume of combined sewage collected in the CSS during precipitation events (MG)	11,369	11,369
Volume of combined sewage captured or treated (MG)	8,536	10,944
% of volume captured or treated	**75%**	**96%**
Volume of remaining CSOs (MG)	2,833	425
% of CSO remaining	25%	4%

TABLE 4.4.2

CSS PERCENT CAPTURE BY WATERSHED

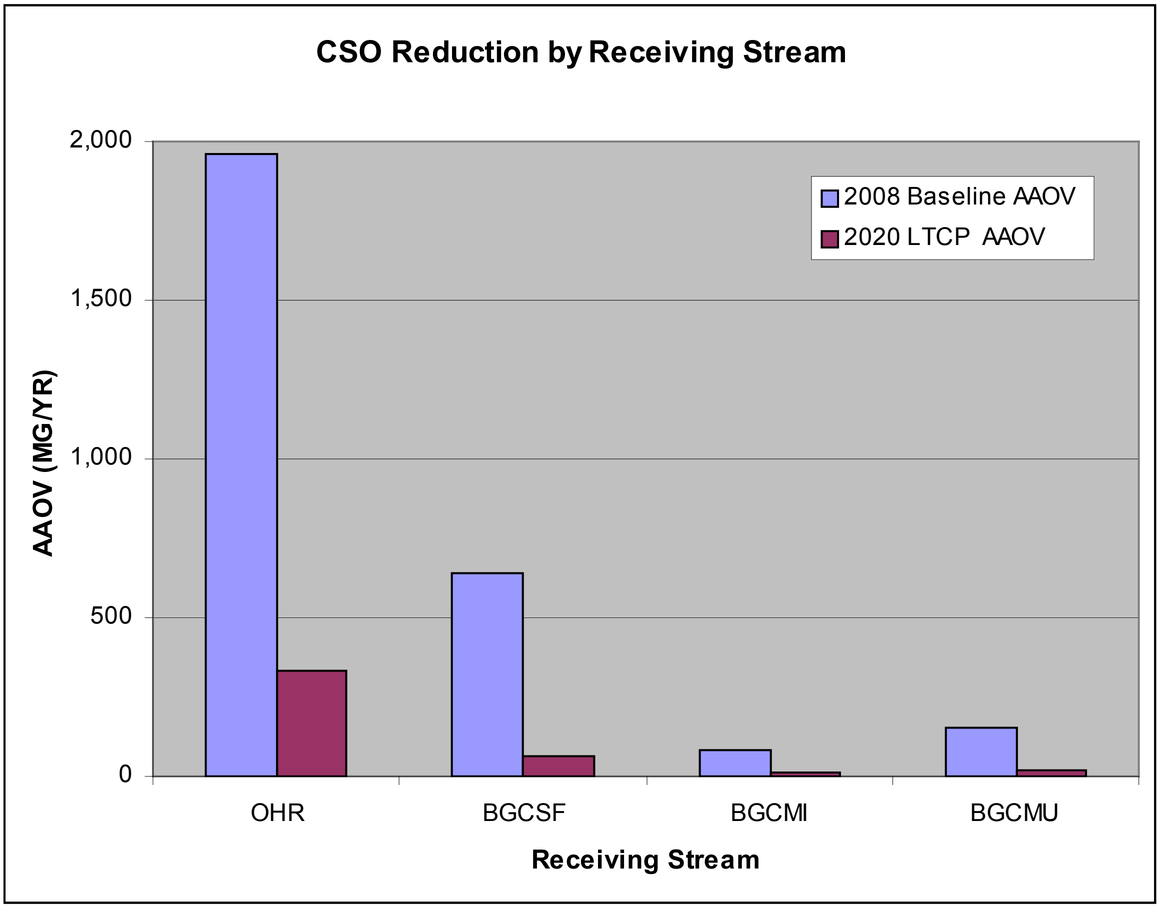
Watershed	2008 Baseline AAOV (MG/YR)	2008 Baseline Percent Capture	2020 LTCP AAOV (MG/YR)	2020 LTCP Percent Capture
Ohio River	1,941	77%	328	96%
BGCMI	81	80%	8	98%
BGCMU	153	54%	18	95%
BGCSO	658	65%	71	96%
Entire CSS	**2,833**	**75%**	**425**	**96%**

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.

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.

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.

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						

FIGURE 4.4.3 GEOMETRIC MEAN STANDARD IN SOUTH FORK STATIONS

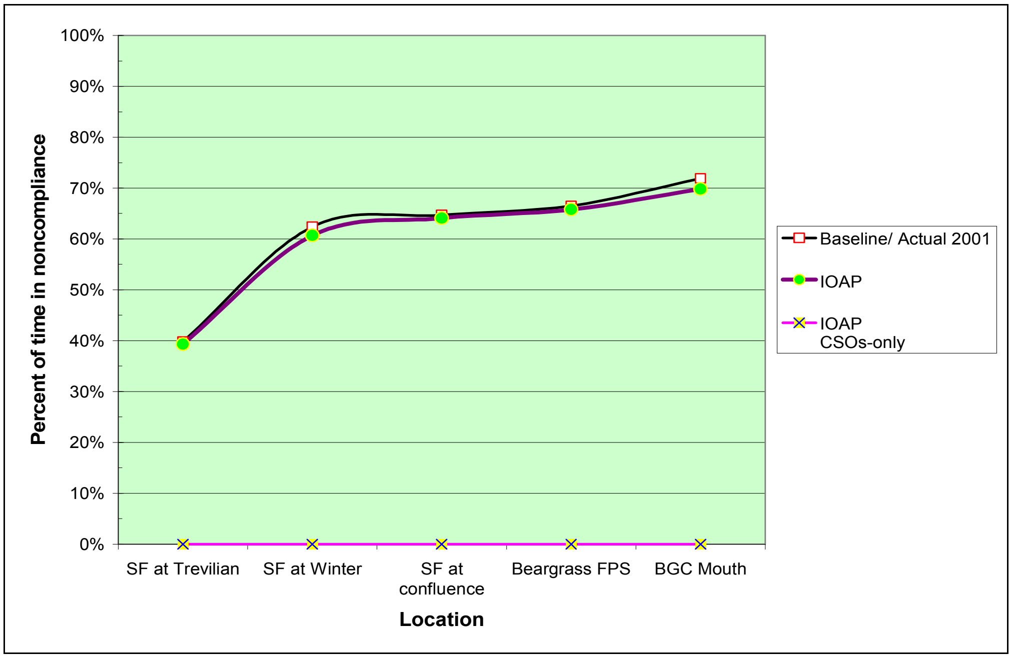


FIGURE 4.4.4 MAXIMUM STANDARD IN SOUTH FORK STATIONS

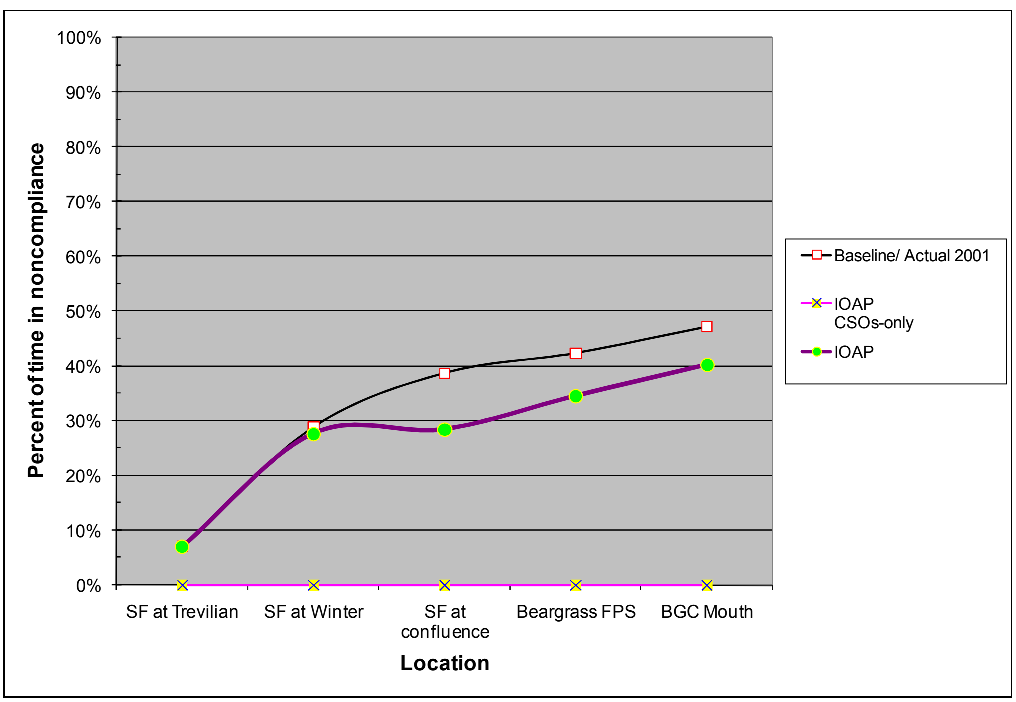


FIGURE 4.4.5 NONATTAINMENT OF GEOMETRIC MEAN STANDARD AT MOUTH OF BEARGRASS CREEK

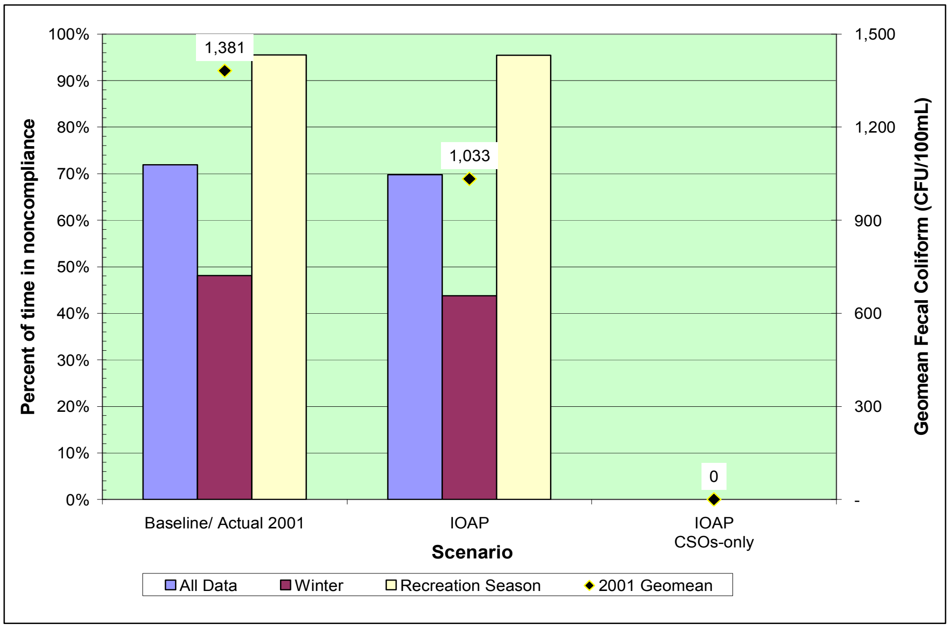
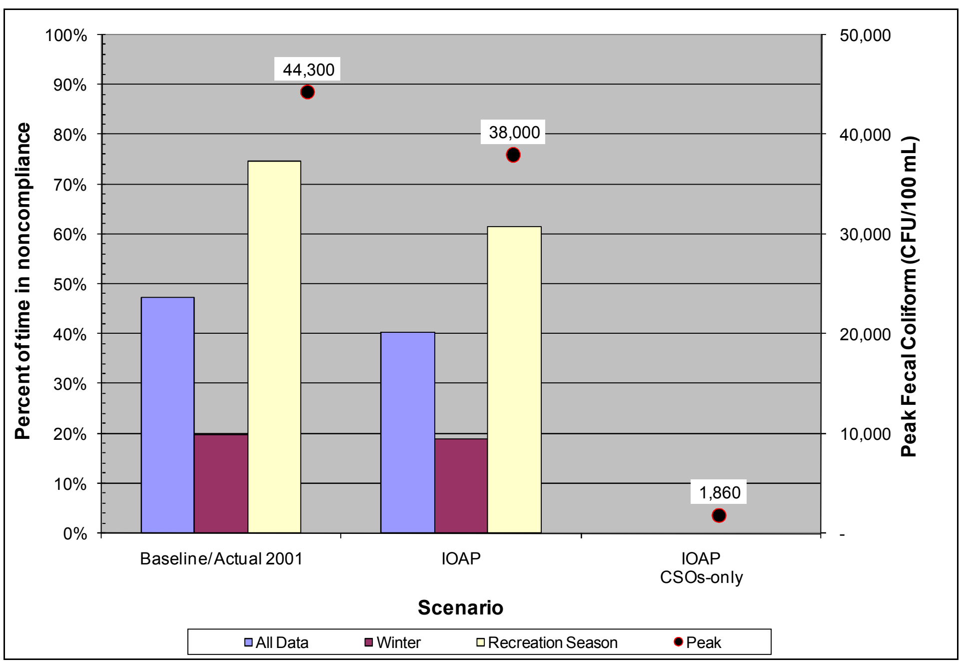


FIGURE 4.4.6 NONATTAINMENT OF MONTHLY MAXIMUM STANDARD AT MOUTH OF BEARGRASS CREEK



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

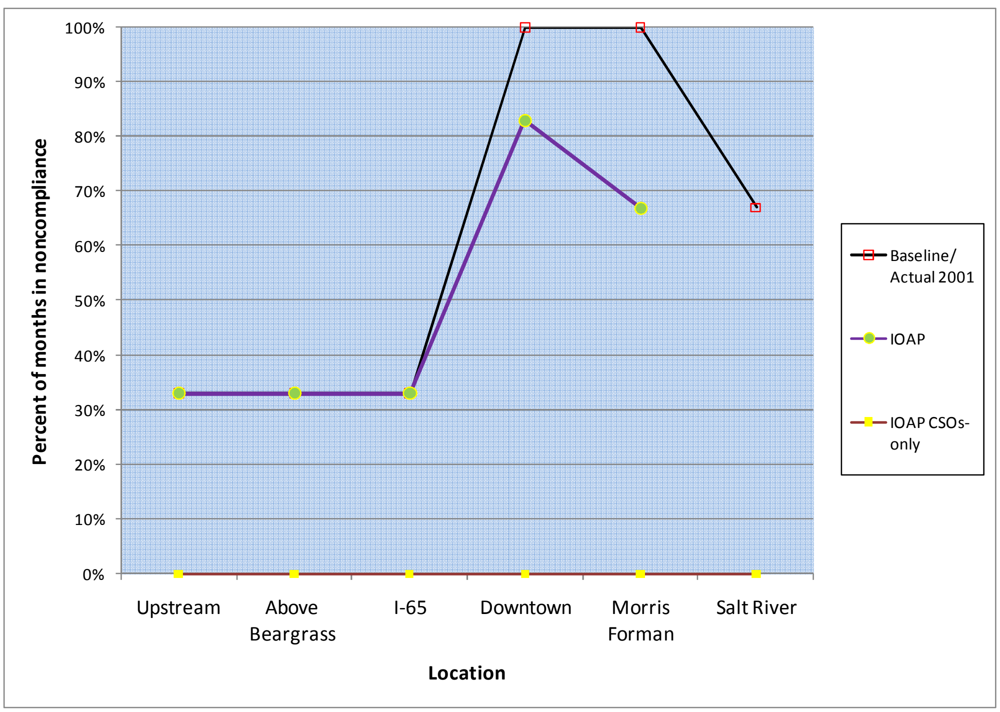
Average and maximum fecal coliform concentrations are also decreased by the IOAP when compared to baseline conditions. The largest benefit in geometric mean concentrations is observed in downtown Louisville Metro, where concentrations decrease from 74 to 34 cfu/ 100 ml. The largest benefit in maximum 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.

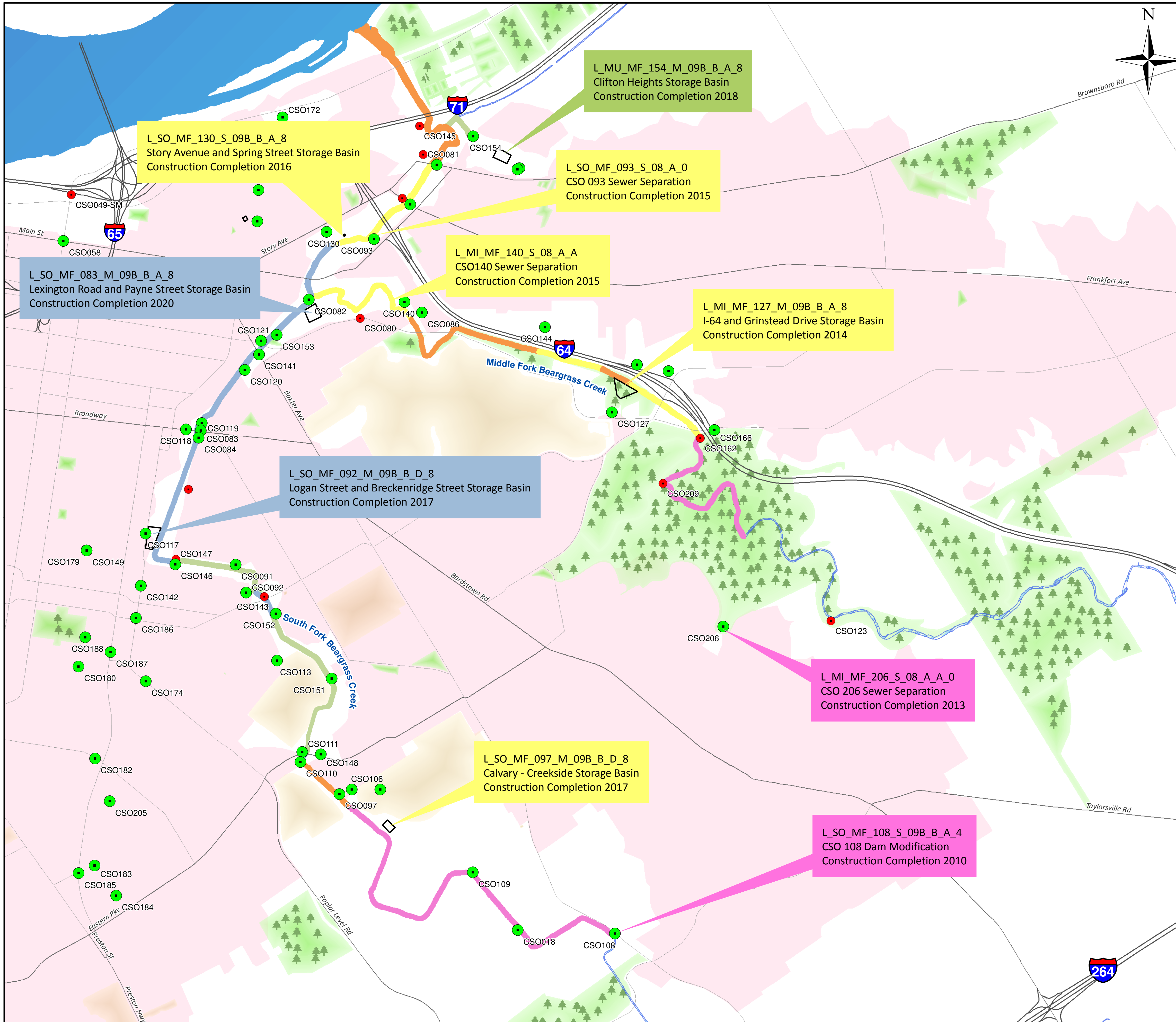
TABLE 4.4.6

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





Integrated Overflow Abatement Plan

Vol. 2 - Final CSO Long-Term Control Plan

FIGURE 4.1.8
STREAM REACH PRIORITY WITH ASSOCIATED PROJECTS ECOLOGICAL RANKING

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

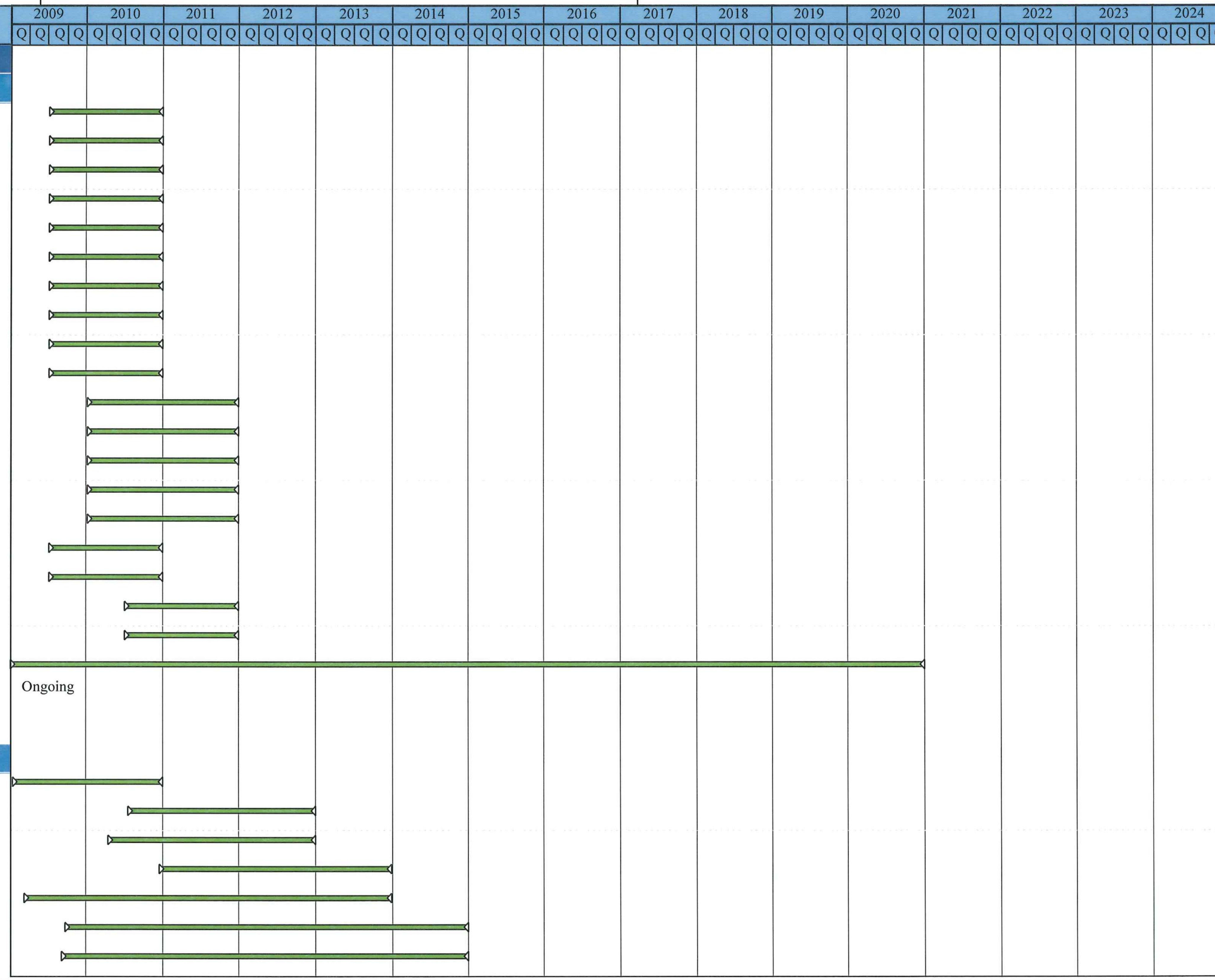
Map Date: August 7, 2009

LOJIC MSD PROJECT WIN

Figure 4.1.9

Final Long Term Control Plan Implementation Schedule

Project Name	Finish
Long Term Control Plan	**31-Dec-20**
Green Demonstration Projects	**31-Dec-20**
MSD Main Office Parking Lot Bioswale	31-Dec-10
Seventh and Cedar Green Parking Lot	31-Dec-10
Second and Broadway Green Parking Lot	31-Dec-10
Third and Ormsby Biofiltration Swales	31-Dec-10
Sixth and Muhammad Ali Green Parking Lot	31-Dec-10
Sixth and Broadway Rain Garden	31-Dec-10
Seventeenth and W Hill Permeable Alley	31-Dec-10
Seventh and Market Permeable Alley	31-Dec-10
Campbell and Main Permeable Alley	31-Dec-10
Twelfth and Jefferson Green Street	31-Dec-10
I-264 Off-Ramp Dry Well	31-Dec-11
I-264 On-Ramp Dry Well	31-Dec-11
I-264 and Gibson Dry Well	31-Dec-11
Russell Lee Drive Dry Well	31-Dec-11
JFK Montessori Area Dry Well	31-Dec-11
Additional Rain Garden Project	31-Dec-10
Additional Rain Garden Project	31-Dec-10
Additional Rain Garden Project	31-Dec-11
Additional Rain Garden Project	31-Dec-11
Green Infrastructure Program	31-Dec-20
Gray Infrastructure Projects	**31-Dec-20**
CSO108 Dam Modification	31-Dec-10
CSO123 Downspout Disconnection	31-Dec-12
Adams Street Storage Basin	31-Dec-12
Story Avenue and Main Street Storage Basin	31-Dec-13
CSO206 Sewer Separation	30-Dec-13
Paddy's Run Wet Weather Treatment Facility	31-Dec-14
I-64 and Grinstead Drive Storage Basin	31-Dec-14



All Projects

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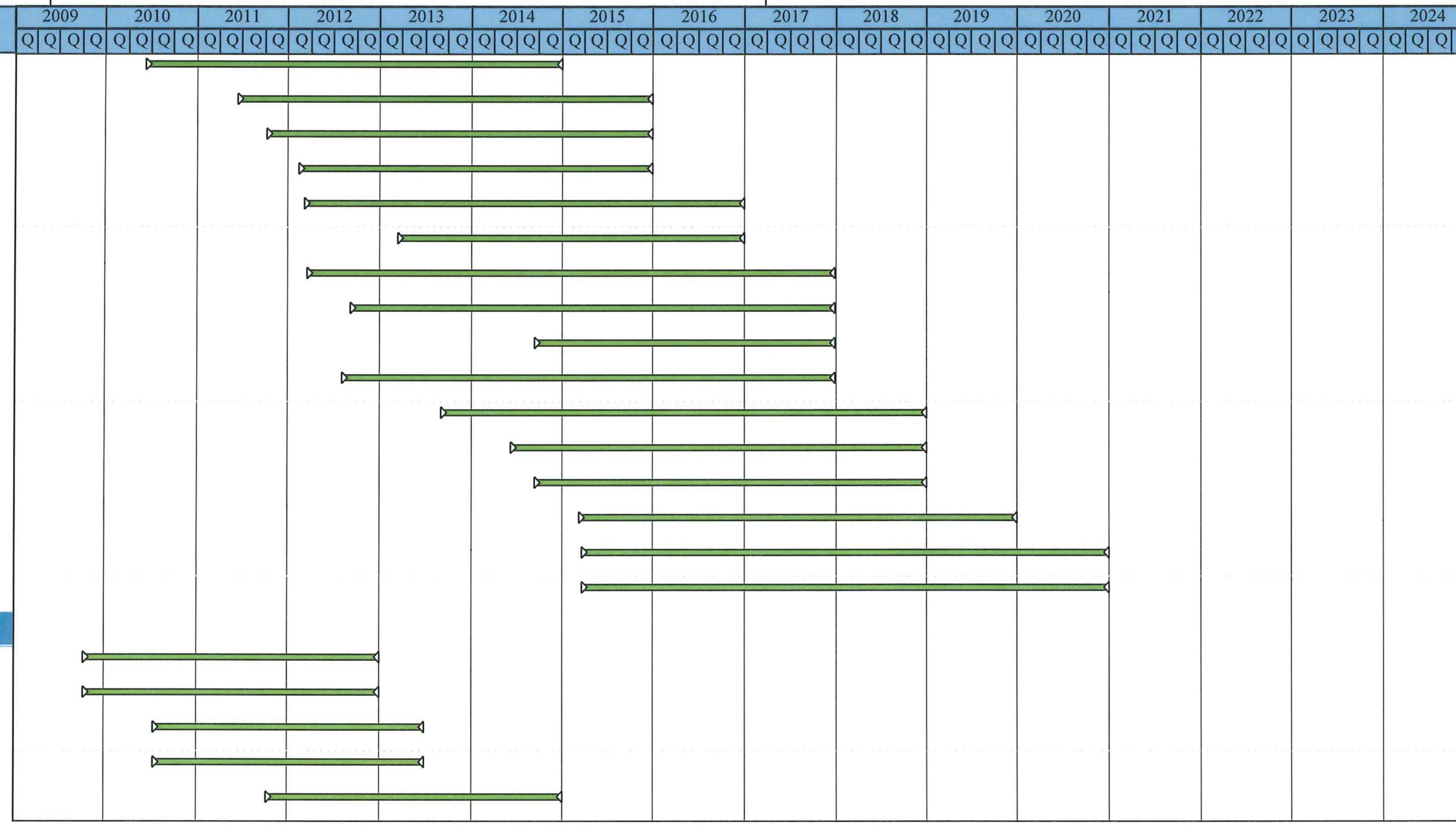
Final Long Term Control Plan Implementation Schedule

Figure 4.1.9

Project Name	Finish
CSO058 Sewer Separation	31-Dec-14
CSO140 Sewer Separation	31-Dec-15
CSO093 Sewer Separation	31-Dec-15
CSO160 Sewer Separation	31-Dec-15
Nightingale Pump Station Replacement	31-Dec-16
Story Avenue and Spring Street Storage Basin	31-Dec-16
Logan Street and Breckinridge St Storage Basin	31-Dec-17
Calvary - Creekside Storage Basin	31-Dec-17
18th and Northwestern Pky. Storage Basin	31-Dec-17
Beargrass Creek Parallel Interceptor	31-Dec-17
Clifton Heights Storage Basin	31-Dec-18
Algonquin Parkway Storage Basin	31-Dec-18
Southwestern Parkway Storage Basin	31-Dec-18
Portland Wharf Storage Basin	31-Dec-19
13th Street and Rowan Street Storage Basin	31-Dec-20
Lexington Road and Payne Street Storage Basin	31-Dec-20
Flood Pump Station Projects	31-Dec-14
34th Street Flood Pump Station	31-Dec-12
4th Street Flood Pump Station	31-Dec-12
27th Street Flood Pump Station	30-Jun-13
Shawnee Flood Pump Station	30-Jun-13
17th Street Flood Pump Station	31-Dec-14



All Projects

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