12. Recommended Plan

This section discusses the Recommended Plan for the BSA's LTCP implementation that addresses the requirements of the USEPA's CSO Control Policy and the BSA's Administrative Order with the USEPA. This section reflects the revisions developed by the BSA in response to Agencies' December 2012 comments and agreed to by the Agencies in October 2013. The BSA response included development of a Green Infrastructure Master Plan (summarized in Section 12.2) and updates to the No Feasible Alternatives Analysis (summarized in Section 8). The Recommended Plan is based on defining the most efficient solution for satisfying the receiving water body control objectives, consistent with the CSO Policy. Reference to the Recommended Plan refers only to the costs and benefits for projects related to the collection system, while the WWTP upgrades are referred to independently to reflect the scope of the entire 20-year program.

12.1 Recommended Plan Description

Sections 9 through 11 summarized the 2004 LTCP alternatives and provided an evaluation of additional alternative refinements. Four new system-wide CSO control alternatives were evaluated during this LTCP effort as presented in Section 11 of the report. Each alternative was evaluated for five levels of control (LOCs) in terms of estimated CSO activation frequency (0, 2, 4, 6 and 12 events per year) using the 1993 modified typical year. The system-wide percent capture, residual CSO volumes and remaining pollutant (bacteria) loadings were also estimated for informational purposes. The costs and benefits for each alternative at each LOC were evaluated not only on a system-wide basis, but also for each individual receiving water body.

Based on the economic evaluation of the alternatives, Alternative UA2 was shown to be the least expensive alternative at the knee of the curve for all receiving water bodies and, as such, was originally used as a basis for assembling a preferred system-wide alternative. However, a careful analysis of detailed receiving stream water quality modeling results revealed that a uniform level of CSO control for all BSA receiving water bodies is neither cost effective nor necessary to meet the applicable water quality standards (WQS) in each water body. The modeling revealed that each receiving water body has a unique combination of the current WQS attainment status, impacts from CSOs versus background sources, regulatory status (sensitive area), and CSO control costs. Furthermore, the evaluation results show that the knee of the curve points for Alternative UA2 for each receiving water body already provide 100% attainment of the New York State (NYS) recreational (bacteria) WQS. Therefore, the BSA's Recommended Plan was assembled with a primary focus on providing a cost-effective attainment of the current NYS bacteria WQS in each water body and the associated frequency of activation necessary to accomplish those WQS. As presented further in this section, the BSA has selected a water body-specific activation frequency as the compliance strategy and primary performance criterion, although percent capture and residual volumes are presented for informational purposes and can be used as a secondary demonstration of compliance with the CSO Policy.

The frequency of activation performance measure targets the USEPA CSO Control Policy presumption approach criterion of 4 to 6 overflow events per year. Following implementation of the Recommended Plan, all water bodies in the BSA system will meet the 4 to 6 events per typical year level of control, with the following clarifications:

- **Erie Basin -** The Erie Basin was identified as a sensitive area, and as such, has the highest selected cost-effective target LOC of 2 events per typical year. While water quality modeling reveals that the WQS are met under existing conditions in the Erie Basin, the BSA has elected to target the higher LOC as part of the Recommended Plan.

- **Buffalo River** - Based on the water quality modeling results, the Buffalo River would achieve 100% compliance with water quality standards at the lowest evaluated LOC of 12 events per typical year (provided that the USEPA and NYSDEC reasonably address upstream sources of pollutants by other parties); however, the BSA has targeted a higher level of control, 6 events per year, based on the activation frequency versus project present worth costs knee of the curve for this receiving water body.

- **Niagara River** - Water quality modeling results also reveal that the Niagara River already meets the current NYS bacteria WQS under the baseline conditions with 100% attainment. At the same time, the activation frequency versus project present worth costs knee of the curve for the Niagara River fell at approximately 8 to 10 events per year. Increased LOCs for the Niagara River provided marginal benefits in terms of CSO volume reduction and no additional benefits in terms of WQS attainment. Therefore, the BSA selected a cost-effective LOC of approximately 9 events per typical year for the Niagara River.

A summary of the basis for the selected target LOCs is presented in Table 12-1. The recommended plan features target activation frequencies of 4 to 6 events or less in the typical year, except as noted above for the Niagara River.

Table 12-1: Summary of Recommended Plan LOC Selection

Receiving Water Body	Basis for Selection of Level of Control	Target LOC Typical Year Activations
Black Rock Canal	WQS attainment KOC	4
Buffalo River	LOC and Remaining Volume KOC	6
Cazenovia Cr.-B	LOC and Remaining Volume KOC	4
Cazenovia Cr.-C	LOC and Remaining Volume KOC	6
Erie Basin	Designation as a Sensitive Area	2
Niagara River (incl. CSO 055)	LOC and Remaining Volume KOC	9
Scajaquada Creek	WQS attainment KOC	4

12.2 Green Infrastructure Master Plan Summary

In response to the Agencies' December 2012 comments on the April 2012 LTCP submission, the BSA provided additional detail on their green infrastructure (GI) program by developing a Green Infrastructure Master Plan (GI Master Plan), which was submitted to the Agencies in August 2013 and revised based on subsequent discussions and comments. The GI Master Plan, included in its entirety in Appendix 12-3, provided the following:

- Further refinement of the GI impervious surface control targets presented in the April 2012 LTCP document to determine, on the SPP level, where the system would most benefit from GI technologies.
- Background information on the environmental and land use conditions in Buffalo that will impact GI technology and site selection.
- An overview of GI technologies.
- A program level screening of GI for the BSA.
- Details on the Phase 1 GI projects to be implemented over the first five-year period.

- Details of the Phase 1 GI projects performance evaluation using a combination of modeling techniques implemented in the system-wide model, including a summary of the model results.

- An overview of a post-construction monitoring plan for the Phase 1 GI projects (a detailed plan will be developed as part of the overall LTCP PCM plan due to the Agencies within one year after the LTCP approval).

Relevant components from the GI Master Plan are presented in the following subsections.

12.2.1 Refinement of System-wide GI Impervious Surface Control Acreage

The GI control targets presented in Section 11 were further refined within the GI Master Plan to determine the SPP level where the system would most benefit from GI technologies. The SPP activation statistics for the revised Foundation Alternative were reviewed along with the recommended activation frequency (level of control) for each receiving water body (RWB). The target GI control level was then modified using the same general rationale that was applied at the CSO outfall level in Section 11. The following GI control of impervious acreage targets were applied at the SPP level:

- Applied 0 percent (no GI control) to any SPP with predicted activations less than or equal to the RWB target LOC.

- Applied 20 percent impervious surface control to SPPs with activations greater than the RWB target LOC.

- Applied 0 percent to stormwater only basins and any SPP basins that do not discharge directly to RWBs (e.g., Amherst Quarry SPPs).

The revised impervious surface control target percentages for GI are shown on Figure 12-1. Note Figure 12-1 presents an average percent impervious surface control for the CSOs, based upon the SPP-level evaluations described below. A summary of the revised impervious acreage to be controlled by GI for each receiving water body, as well as the original acreage recommended to be managed by GI from Section 11 is presented in Table 12-2. Overall, there is a decrease in the impervious acres to be controlled by GI due to the refinement at the SPP level. Refining the impervious control acreage to the SPP level allowed for better identification of SPPs (and by extension CSO outfalls) that would benefit most from implementing GI technologies, and also for determining which SPPs would not benefit because they were already at or below the recommended RWB LOC or do not discharge directly to a RWB. This result is consistent with the intentionally conservative estimates used in Section 11.

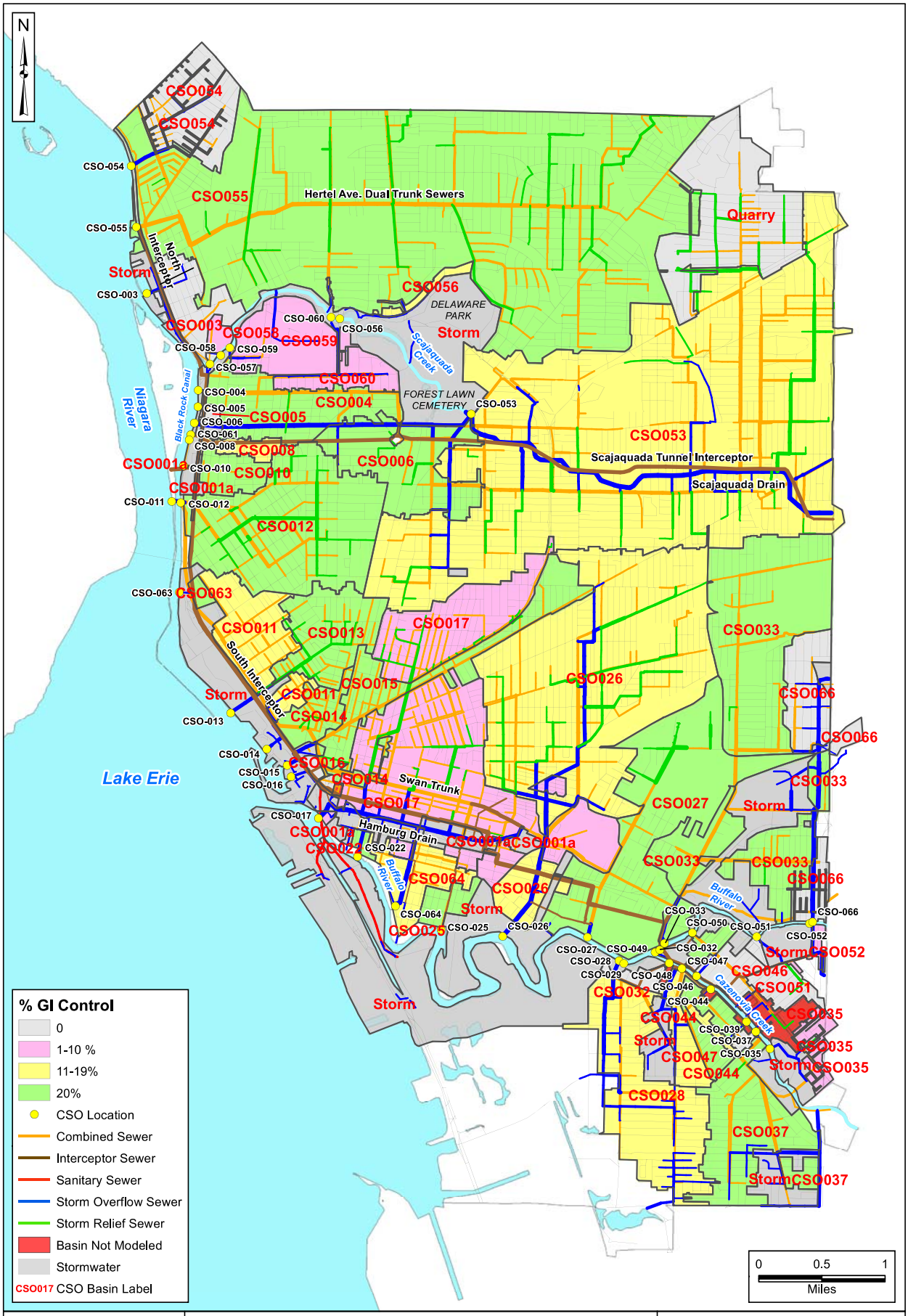

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FIGURE 12-1

Refined System-wide GI Control Levels (Based on SPP Refinement)

Table 12-2: Updated Impervious Area Target for Control by GI

Receiving Water	Area Managed (acres) by GI Based on CSO Level from Section 11	Updated Area Managed (acres) by GI Based on SPP Level
Black Rock Canal	168	198
Buffalo River	418	319
Cazenovia Creek - B	3	3
Cazenovia Creek - C	60	58
Erie Basin	49	53
Niagara River	412	378
Scajaquada Creek	510	305
Total	**1,620**	**1,315**

As shown in Table 12-2, this refinement resulted in minimal to moderate changes in controlled acreage on a receiving water body basis. Recommended acreages increased in the Black Rock Canal and Erie Basin, and decreased in the Cazenovia Creek –C, Buffalo River, Niagara River, and Scajaquada Creek. The most notable decrease occurred in the Scajaquada Creek basin, mainly due to the Amherst Quarry modifications. The Amherst Quarry is a storage basin that stores excess flows during wet weather events, and then drains combined wastewater and stormwater back to the collection system for subsequent conveyance and treatment after wet weather flows subside. Because of this, it was determined that there would be no CSO reduction benefit with application of GI technologies in areas tributary to the Quarry.

Because the SPP level GI allocation provides a more refined and cost-effective approach, the BSA will work towards a 1,315-acre total green infrastructure program effort. However, the BSA will utilize modeling and post-construction monitoring of the first three phases of GI projects to confirm that the 1,315 target acres will be sufficient to meet the level of control objectives. If needed, the acreage target for the fourth phase of GI projects will be adjusted to achieve the CSO outfall typical year frequency of activation requirements.

12.2.2 GI Refinement Model Results

The Recommended Plan with the refined impervious surface control acreages was evaluated for each receiving water body in terms of targeted reduction in CSO activations and volumes. Table 12-3 presents a comparison of model results for the SPP-refined GI control with the Recommended Plan. Projected residual volumes are presented for each CSO and receiving water body, as well as the remaining frequency of

activation. As shown in Table12-3, with the exception of CSOs 022, 047, and 050, the residual activations in any given receiving water body remained the same or decreased. For the CSOs that showed an increase in activations, the resulting activations remained within the targeted typical year LOCs for each receiving water body. The total system-wide CSO volume remaining increased slightly (approximately 4 percent); however, the projected increase in residual volume is within the uncertainty of the modeling tools and, accordingly, is insignificant, particularly in light of the conservative factors used elsewhere in the GI program and LTCP.

Table 12-3: Model Projected Frequency and CSO-Only Volume Results for SPP-based Refinement

		CSO-only Frequency			CSO-only Volume (Million Gallons)		
CSO Outfall	**Receiving Water**	**Revised Baseline[1]**	**Recommended Plan[2]**	**Recommended Plan + Updated GI Control[3]**	**Revised Baseline[1]**	**Recommended Plan[2]**	**Recommended Plan + Updated GI Control[3]**
003	Niagara River	6	5	5	0.1	0.7	0.8
004	Black Rock Canal	5	4	3	11.2	9.2	8.7
005	Black Rock Canal	4	4	4	0.1	0.1	0.1
006	Black Rock Canal	65	4	4	198.9	18.1	21.7
008	Black Rock Canal	39	0	0	6.1	0.0	0.0
010	Black Rock Canal	44	1	1	11.9	0.0	0.0
011	Niagara River	41	4	4	134.3	10.9	11.7
012	Black Rock Canal	42	2	2	52.5	0.9	0.9
013	Black Rock Canal	7	4	4	6.8	3.4	2.7
014	Erie Basin	4	2	2	4.2	2.8	3.1
015	Erie Basin	12	1	1	6.1	0.4	0.6
016	Erie Basin	0	0	0	0.0	0.0	0.0
017	Buffalo River	49	4	4	71.3	41.4	34.8
022	Buffalo River	49	4	5	29.8	1.7	2.0
025	Buffalo River	11	6	6	1.4	1.2	1.2
026	Buffalo River	63	3	3	124.2	27.0	29.6

		CSO-only Frequency			CSO-only Volume (Million Gallons)		
CSO Outfall	Receiving Water	Revised Baseline[1]	Recommended Plan[2]	Recommended Plan + Updated GI Control[3]	Revised Baseline[1]	Recommended Plan[2]	Recommended Plan + Updated GI Control[3]
027	Buffalo River	36	6	6	31.7	37.6	39.1
028	Buffalo River	69	6	6	45.5	20.6	22.7
029	Buffalo River	0	0	0	0.0	0.0	0.0
032	Buffalo River	0	0	0	0.0	0.0	0.0
033	Buffalo River	9	6	5	37.8	35.2	31.8
034	Buffalo River	0	0	0	0.0	0.0	0.0
035	Cazenovia Creek - B	0	0	0	0.0	0.0	0.0
037	Cazenovia Creek - C	13	6	6	23.3	11.8	11.9
039	Cazenovia Creek - C	0	0	0	0.0	0.0	0.0
044	Cazenovia Creek - C	7	2	2	2.3	0.7	0.7
046	Cazenovia Creek - C	1	1	0	1.3	1.2	1.3
047	Cazenovia Creek - C	44	2	3	8.7	1.3	1.5
048	Cazenovia Creek - C	0	0	0	0.0	0.0	0.0
049	Buffalo River	0	0	0	0.0	0.0	0.0
050	Buffalo River	14	4	5	3.2	2.5	2.8
051	Buffalo River	4	4	4	1.2	1.0	1.2
052	Buffalo River	10	3	3	10.9	6.2	6.3
053	Scajaquada Creek	65	4	4	268.0	44.5	52.1
054	Niagara River	0	0	0	0.0	0.0	0.0
055	Cornelius Creek	41	9	9	601.1	196.3	206.2
056	Scajaquada Creek	5	4	3	0.0	0.0	0.0
057	Scajaquada Creek	0	0	0	0.0	0.0	0.0

		CSO-only Frequency			CSO-only Volume (Million Gallons)		
CSO Outfall	**Receiving Water**	**Revised Baseline[1]**	**Recommended Plan[2]**	**Recommended Plan + Updated GI Control[3]**	**Revised Baseline[1]**	**Recommended Plan[2]**	**Recommended Plan + Updated GI Control[3]**
058	Scajaquada Creek	0	0	0	0.0	0.0	0.0
059	Scajaquada Creek	0	0	0	0.0	0.0	0.0
060	Scajaquada Creek	5	0	0	0.7	0.0	0.0
061	Black Rock Canal	10	2	2	31.2	1.1	1.2
063	Black Rock Canal	13	4	4	0.6	0.3	0.3
064	Buffalo River	56	2	3	21.1	6.1	6.9
066	Buffalo River	10	4	4	1.7	0.5	0.4
Total					**1,749.1**	**485.1**	**504.3**

Notes:

(1) Revised Baseline results from Table 11-3.

(2) Recommended Plan results from Appendix 12-2 of the BSA's April 2012 LTCP.

(3) Results for Recommended Plan with Updated GI Control (refined by SPP).

12.2.3 Phase 1 GI Projects

Several factors were evaluated to determine the Phase 1 GI projects for the first five-year implementation period, including:

- Capitalize upon the City's substantial investment in demolition of vacant properties from the time the CSS model was developed through the end of Phase 1;
- Support the City's green street agenda; and
- Capture the impacts of the Environmental Facilities Corporation investment in the PUSH Blue project.

As a result of these evaluations and the opportunities available within the City, the BSA Phase 1 GI projects, summarized in Table 12-4, rely upon demolition/vacant lot management, as well as runoff reduction from

seven green streets projects to achieve the impervious surface management goal. While the BSA is accounting for Phase 1 GI projects in all sub-catchments in the model, some of these projects may be located in a sub-catchment that is not targeted for impervious surface control. For the purpose of determining the green infrastructure implementation acreage towards target goals, the projects (primarily building demolitions) outside of the refined target areas were removed. Table 12-4 presents both the total impervious acreage controlled and the impervious acreage that would be applied to the proposed GI target acreage. The Phase 1 GI projects will control 448 acres of impervious area, of which 267 acres will be applied to the SPP-based GI acreage targets.

Table 12-4: BSA's Phase 1 Green Infrastructure Program Summary

Project Group	Sub Group	Impervious surface controlled (acres)	Impervious Acreage Applied to SPP-based Target CSO Control (acres)
Demolitions and Vacant Lot Management	2001 – 2013 Demolitions (excl. 2001-2009 demos in CSO 12)	354	210
	CSO 53 Pilot Project and 2014-2018 Demolitions	50	31
	Fillmore Ave green lots	0	0
	PUSH Blue Projects	1.0	1.0
Green Streets	Carlton Street porous asphalt	1.0	0
	Fillmore Ave porous parking lots	0.4	0.4
	Ohio Street	6.1	2.1
	Kenmore Ave(1)	4.1	4.1
	Kensington Ave(1)	5.5	2.5
	Allen Street(1)	2.5	2.5
	Niagara Street(1)	23	14.3
	TOTAL	448	267

Note: (1) Specific designs are not available for these projects at this time. The impervious acreage controlled was estimated based on the assumptions provided in Section 8 of the GI Master Plan.

12.2.4 GI Implementation Phases

Table 12-5 presents a comparison of the target control acres, by implementation phase, based on CSO-level targets presented in Section 11 and the SPP-refined targets. The more detailed, SPP-level modeling discussed above indicates that the same level of control may be achieved through 1,315 acres of impervious surface runoff control.

Table 12-5: Proposed GI Target Acres Based on Implementation Phase

Implementation Phase	Target (acres) Based on CSO Level	Target (acres) Based on SPP Refinement
Green 1	145	267
Green 2	320	410
Green 3	485	375
Green 4	670	263
Total	**1,620**	**1,315**

Because the SPP-level-based GI allocation provides a more refined and cost-effective approach, the BSA will work towards a 1,315-acre total green infrastructure program effort. However, the BSA will utilize modeling and post-construction monitoring during the first three phases to confirm that the 1,315 target acres will be sufficient to meet the performance criteria. If needed, the Phase 4 GI acreage target will be adjusted to achieve the level of control. Any necessary acreage adjustments will be proposed with the submission of the Green 4 plan in program year 13.

In response to public comment on the April 2012 submission, the BSA remains committed to evaluating opportunities to maximize the use of additional cost-effective green infrastructure approaches. The target acreage above is a minimum program commitment. Any additional green infrastructure acreage proposed in conjunction with the optimization of gray projects would be in addition to the acreage above. This approach allows the BSA to adaptively manage the green infrastructure program to incorporate lessons learned in each five year program and take advantage of land use and infrastructure investments projected for each period to deliver the maximum public benefits at the lowest cost.

12.3 Proposed Facilities and Operational Concepts

A summary of main component projects of the Recommended Plan is presented in Table 12-6. As described above, this alternative is based on Alternative UA2 concepts (optimized for cost effective levels of

control in each receiving stream) and, as such, includes all Revised Foundation Plan projects, refined GI projects to control up to 20% of the impervious area, and selected gray infrastructure projects. Additional optimization of the gray infrastructure facility sizes was done to meet the target performance criteria presented in Section 12.1. Note that all facility sizes presented are concept-level approximations and are subject to revision during facility planning and/or final design activities.

Table 12-6: Summary of Recommended Plan Projects

Project Grouping	Specific Projects (Concept Level Approximate Sizing)

Revised Foundation Projects: Focus is on combination of low-cost system optimizations, pilot GI projects and cost-effective RTC projects	• Phase 1 Projects: Includes all Phase 1 projects described in Section 11.2.
	• Non-Phase 1 Projects: These projects are primarily sewer separation projects carried over from the original Foundation Plan and completed prior to the Phase 1 projects. These were also described in Section 11.2.
	• Real Time Control: 16 real-time control (RTC) projects that were selected after the evaluation described in Section 11.3
	• Green Infrastructure Pilot Projects
	  ○ CSO 060 – Combination of pervious pavements, rain gardens and downspout disconnections/rain barrel installations
	  ○ Downspout disconnect/rain barrel pilot projects in the Old First Ward and Hamlin Park neighborhoods
	• Additional SPP Optimizations: 20 additional optimization projects were identified as part of the alternatives evaluations conducted for this LTCP update. These modifications include optimizing weir elevations and orifice plate openings, increasing underflow pipe capacity, and flow redirection at a limited number of locations. Details on these SPP optimization projects are presented in Section 11.4
	• Additional Storage Projects: Three projects designed to increase capture of CSO flows have been identified and are currently in various stages of design by BSA.
	  ○ Hamburg Drain Storage - 5 MG offline storage facility
	  ○ Smith Street Storage - 0.5 MG offline storage facility
	  ○ CSO-016 Storage - 60,000 gallon inline storage

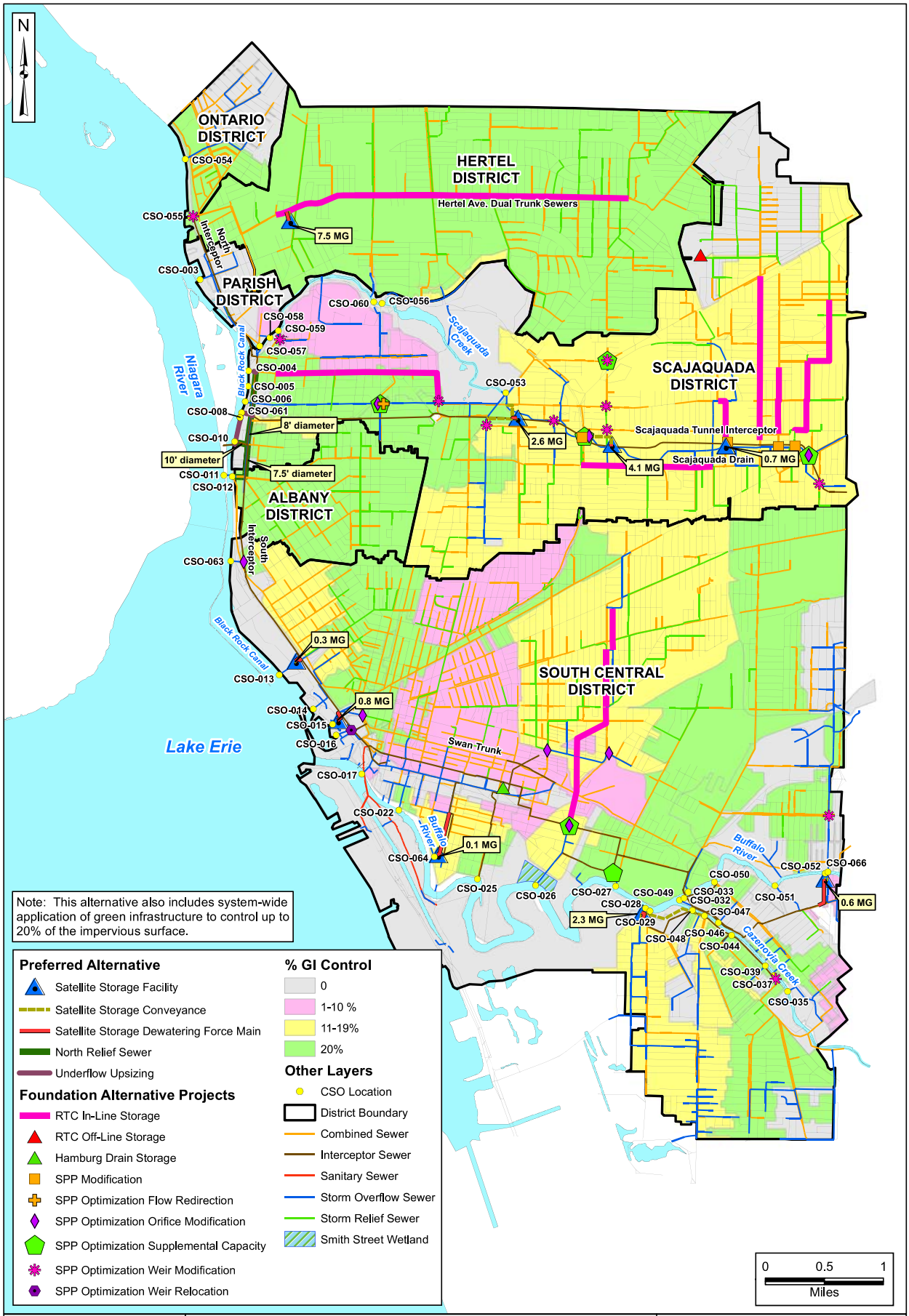
Gray Infrastructure Projects	• Black Rock Canal and Niagara River
	  ○ Underflow pipe upsizing (to maximize flow to the existing interceptors)
	  ○ New Northern Relief Sewer that runs parallel to the Black Rock Canal between CSO 004 and CSO 011/012 with an additional parallel relief sewer from CSO 004 to the existing siphon crossing at the WWTP influent. Northern Relief consists of the following components:
	  ▪ 5,310 feet of 96-inch pipe
	  ▪ 571 feet of 120-inch pipe
	  ○ CSO 055 – 7.5 MG offline storage facility
	  ○ CSO 013 – 0.3 MG offline storage facility
	• Scajaquada Creek
	  ○ SPP 337: 0.7 MG offline storage facility
	  ○ Jefferson Avenue & Florida Street: 2.6 MG offline storage facility
	  ○ SPP 336 a & b: 4.2 MG offline storage facility
	• Buffalo River and Cazenovia Creek:

Project Grouping	Specific Projects (Concept Level Approximate Sizing)
	○ CSOs 028, 044 and 047: 2.3 MG offline storage facility ○ CSO 052: 0.6 MG offline storage facility ○ CSO 064: 0.1 MG offline storage facility • Erie Basin ○ CSO 014 and 015 – 0.8 MG offline storage facility
Green Infrastructure Projects	Green Infrastructure projects will include a mixture of the following techniques based upon the results of pilot studies undertaken during the early years of the LTCP implementation schedule and will be focused primarily on publicly-owned properties. • Vacant property demolitions • Modifications to vacant lots to store and infiltrate street runoff • Pervious pavements (public streets and parking lots) • Rain gardens • Downspout disconnections/rain barrels Green Infrastructure technology implementation will be based upon the control of up to 20% of the impervious surfaces (publically owned) within selected sewersheds as follows based on the SPP-level refinement outlined in the GI Master Plan: • Black Rock Canal – 198 acres • Buffalo River – 319 acres • Cazenovia Creek (Class B section) – 3 acres • Cazenovia Creek (Class C section) – 58 acres • Erie Basin – 53 acres • Niagara River – 378 acres • Scajaquada Creek – 305 acres Total controlled acreage – 1,315 acres

Figure 12-2 shows the conceptual layout of the BSA's Recommended Plan throughout the City of Buffalo. The recommended percent of impervious surface for control using GI technologies, based on the SPP refinement, is also presented on Figure 12-2. As noted previously, the proposed facilities and operational concepts will vary among CSO receiving waters and LOCs for the Recommended Plan. The following sections present the proposed operational concepts (all approximate sizing) by receiving water.

12.3.1 Black Rock Canal and Niagara River

All of the CSOs that discharge along Black Rock Canal plus CSO 011, which discharges to the Niagara River, will be controlled using a combination of underflow pipe upsizing (to maximize flow to the interceptors) and a relief sewer that runs parallel to the Black Rock Canal between CSO 004 and CSO 011/012. CSO volumes (and associated activations) under larger (*i.e.*, larger than the proposed LOC) precipitation events will be regulated by modified regulators at the existing SPPs or by the new relief pipe. Any CSO discharges greater than the selected level of control will discharge through the existing outfalls.



Note: This alternative also includes system-wide application of green infrastructure to control up to 20% of the impervious surface.

Preferred Alternative

- Satellite Storage Facility
- Satellite Storage Conveyance
- Satellite Storage Dewatering Force Main
- North Relief Sewer
- Underflow Upsizing

Foundation Alternative Projects

- RTC In-Line Storage
- RTC Off-Line Storage
- Hamburg Drain Storage
- SPP Modification
- SPP Optimization Flow Redirection
- SPP Optimization Orifice Modification
- SPP Optimization Supplemental Capacity
- SPP Optimization Weir Modification
- SPP Optimization Weir Relocation

% GI Control

- 0
- 1-10 %
- 11-19%
- 20%

Other Layers

- CSO Location
- District Boundary
- Combined Sewer
- Interceptor Sewer
- Sanitary Sewer
- Storm Overflow Sewer
- Storm Relief Sewer
- Smith Street Wetland

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FIGURE 12-2

RECOMMENDED PLAN WITH APPROXIMATE GI 2 - 9 OF/yr

Additional control of discharges to the Niagara River would be provided through a large satellite storage facility at CSO 055. In addition, a small satellite storage facility would be required to control discharges from CSO 013 to the Black Rock Canal. At CSO 013, the satellite storage facility would operate between the current SPP and the receiving water (*i.e.*, would be constructed such that the facility would be filled from the overflow conduit). When the SPP activates, overflow would flow by gravity to the storage basin. When the basin fills, the inlet gate to the storage facility would close and subsequent overflow from the SPP during the event would bypass the storage basin and then be discharged to the receiving stream through the existing CSO outfall. This discharge would be considered a CSO event in the new system. After the storm when the interceptor and plant capacity become available, the basin would be dewatered to the interceptor via a pump station sized to empty the basin within 24 hours (based on the 1993 modified typical year precipitation storm patterns).

For CSO O55, the proposed storage facility would be located upstream of the regulator, near Military Road. At this location, an offline facility would be constructed and flows above 26 MGD (instantaneous peak) would be diverted from the South Hertel Trunk sewer into the 7.5 MG storage facility. Flows in excess of the storage capacity would be conveyed down to the existing CSO 055 regulator structure and discharged through the existing outfall. After the storm when the conveyance and plant capacity become available, the basin would be dewatered into the Hertel Avenue combined sewer via a pump station sized to empty the basin within 24 hours (based on the 1993 modified typical year precipitation storm patterns).

All off-line storage facilities proposed for the BSA's system are assumed to be covered concrete, underground tanks. The basins would include a bar screen in the influent channel to provide floatables control for the overflow. Odor control would also be included with each facility. Solids handling dewatering pumps would be used to return the contents of the basin to the interceptor after the storm event. The pumps would be sized to empty the basin volume based on the available conveyance system and treatment capacity, with dewatering times targeted for 24 to 48 hours based on the 1993 modified typical year precipitation storm patterns. However, actual dewatering time would depend upon the actual precipitation patterns as they may affect the available conveyance and WWTP capacity.

12.3.2 Scajaquada Creek

CSO control for Scajaquada Creek will be provided primarily through satellite storage facilities. Storage facilities are proposed at the following locations:

- SPP 337: 0.7 MG offline storage facility
- Jefferson Avenue & Florida Street: 2.6 MG offline storage facility
- SPP 336 a & b: 4.2 MG offline storage facility

The operation concepts for these storage facilities will mimic those described above for the Black Rock Canal and the Niagara River. In lower Scajaquada Creek, the remaining CSOs (056, 057, 058, 059, and 060) will discharger infrequently after implementation of the Phase I projects, the Revised Foundation Plan, and the proposed GI control of impervious surfaces. For CSOs 056, 057, 058, and 059, Phase I projects are currently providing a high level of CSO capture and the BSA is in a post-construction monitoring phase to document the frequency of activation for these CSOs. Accordingly, no additional controls are provided in the Recommended Plan for these remaining CSOs.

12.3.3 Buffalo River (including Cazenovia Creek Class B and C portions)

The Revised Foundation Plan, assuming the implementation of GI controls, provides a high LOC for most CSOs in the Buffalo River and Cazenovia Creek basins. SPP-optimizations, storage in the Hamburg Drain system to control CSOs 017, 022 and 064 and RTC/ storage facilities at Smith Street (CSO 026) are included within the Revised Foundation Plan. These facilities will be designed to reduce the CSO events to up to 6 overflows in a typical year. The remaining CSO volumes are addressed through satellite storage facilities as follows:

- CSOs 028: 044 and 047: 2.3 MG offline storage facility
- CSO 052: 0.6 MG offline storage facility
- CSO 064: 0.1 MG offline storage facility

CSO 035 in the Class B portion of Cazenovia Creek has been eliminated through previously completed projects. Therefore, the control plan for this receiving water is implementation of GI to provide additional treatment for stormwater discharges. The remaining CSOs along the Class C portion of Cazenovia Creek are consolidated down to storage facilities at CSO 028 with the consolidation piping sized for the largest storm in the 1993 modified typical year.

The operation concepts for these storage facilities will mimic those described above for the Black Rock Canal, Niagara River, and Scajaquada Creek.

12.3.4 Erie Basin

The Revised Foundation Plan, with GI implementation, provides a high level of control for the three CSOs discharging to the Erie Basin (014, 015 and 016). CSO 016 discharges will be eliminated for the 1993 modified typical year through a combination of the optimization of an upstream SPP that was part of a Phase I project, completed after the 2004 LTCP was submitted, and a small in-line storage project to be completed under the Revised Foundation Plan. Because the Erie Basin has been designated as a sensitive area, a

LOC of 2 events per typical year was considered. As discussed in Section 11 (Alternative UA2), satellite storage facilities are proposed to control the remaining overflows from CSOs 014 and 015 with a small consolidation sewer also required. These storage facilities would operate in the same manner as described in the previous subsections. Alternatively, during the subsequent facility planning efforts, the BSA may optimize the storage concept by considering a Bangor, Maine-type inline pre-cast underground storage facility with similar nominal storage capacity and receiving stream benefits. We understand that a similar pre-cast storage program is being implemented in Scranton, Pennsylvania.

12.4 **Additional LTCP Program Refinement**

Following submission of the April 2012 LTCP, the BSA continued to refine the LTCP to address actual conditions in the City of Buffalo as well as to improve upon the projected impacts of the entire program.

- **Green Infrastructure:** As outlined in the GI Master Plan, the City of Buffalo has undertaken an extensive program to demolish vacant properties citywide. These building demolitions resulted in a significant reduction in impervious surface from that originally modeled. Consequently, the BSA has and will continue to take advantage of this impervious surface reduction, a large portion of which was not accounted for in the hydraulic and water quality models used in this LTCP, making both even more conservative. As further detailed in the GI Master Plan, building demolitions, as they occur will be incorporated into the model and their performance verified during the post-construction monitoring program. This process will be used to further refine the overall LTCP.

- **Gray Infrastructure:** As the BSA moves forward with the implementation of major gray infrastructure projects, project-specific facility planning will be completed. The results of the facility planning processes, in conjunction with GI performance, will likely result in changes to the initial concepts based on post-construction monitoring results, more specific site condition information and/or through the development of optimized approaches for CSO control. For example, following submission of the April 2012 LTCP, the BSA commissioned preliminary design services for both the Hamburg Drain storage and Smith Street RTC/storage projects. Based on the results of facility planning efforts, the BSA identified opportunities to optimize both projects while still meeting the target LOCs for the Buffalo River. The following provides potential revised concepts for each project:

    - Hamburg Drain Storage (CSOs 017, 022 and 064): In lieu of constructing a single large storage facility, the BSA is evaluating a number of in-system optimizations that may ultimately reduce the overflow events at a number of upstream SPPs. Note, however, that should hydraulic modeling and/or post-construction modeling suggest that optimizations alone will not achieve target LOCs, the BSA may still consider the construction of off-line storage capacity.

- Smith Street Storage (CSO 026): As presented in Table 12-6, the BSA initially considered off-line storage to control CSOs in the Smith Street basin. After completing additional evaluations and considering the use of upstream RTC and enhanced GI, storage capacity was identified within the Smith Street Drain that could potentially be used to eliminate or reduce the size of the off-line storage tank while meeting target LOCs for the Buffalo River. Preliminary facility planning is ongoing that will determine the feasibility of enhancing in-line storage for CSO 026.

While pursuing ongoing optimization and refinement of the Recommended Plan project concepts, the BSA remains committed to achieving the target LOC for each receiving water body as presented in Section 12.1. In the event that any recommended plan LTCP project is proposed to be modified, the BSA will inform the Agencies on an ongoing basis as warranted and via the semi-annual status reporting process.

12.5 Planning Level Costs

A two-step approach was used for developing planning level project costs for the Recommended Plan. The first step included assembling the costs using the technology cost curves described in Section 7 and used for evaluation of CSO control alternatives in Sections 9 and 11. The probable construction cost for the Recommended Plan under this methodology was estimated at $273.3 million including all future capital costs.

A summary of probable capital costs using the cost curve methodology is presented in Table 12-7 below. Please note that while the refinement of the GI control acreage at the SPP level reduced the target control acreage to 1,315 acres, the GI cost was conservatively held at the initial $92.6 million estimate (based on $57,000/acre using the initial 1,620 acres impervious surface control) to reflect the BSA's commitment to increasing GI if necessary in future and in response to the Agencies' view that GI costs were not conservative enough.

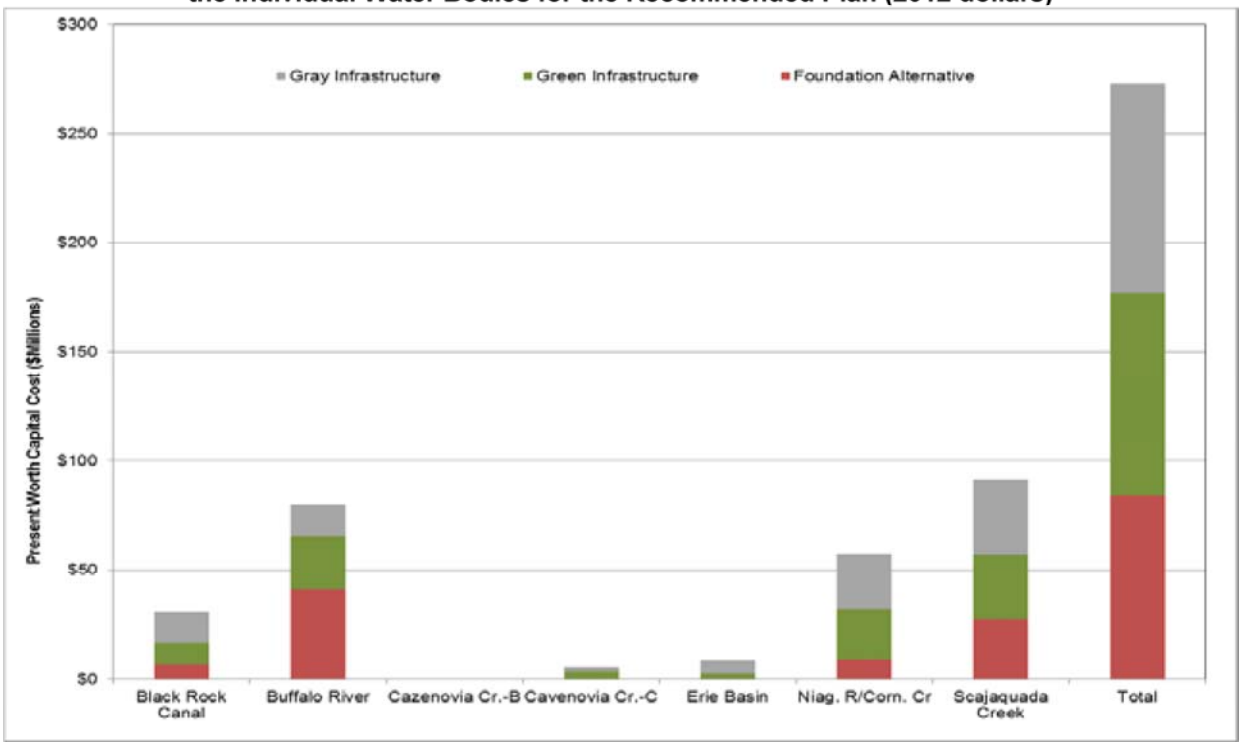
A cost breakdown (using present worth costs) by each receiving stream and general technology is shown on Figure 12-3. The estimated annual O&M cost associated with the Recommended Plan is approximately $350,000, resulting in a total 20-year Present Worth project cost (including O&M) of approximately $278 million.

Table 12-7: Summary of Recommended Plan Project Costs
(Cost Curve Methodology; not including O&M; 2012 dollars, Million dollars)

Receiving Water Body	Green Infrastructure[1]	Gray Infrastructure	Foundation	Total Construction Cost
Black Rock Canal	$9.51	$14.41	$6.89	$30.80
Buffalo River	$23.83	$15.15	$41.13	$80.11
Cazenovia Cr.-B	$0.17	$0.00	$0.00	$0.17
Cazenovia Cr.-C	$3.42	$1.85	$0.02	$5.28
Erie Basin	$2.87	$5.43	$0.01	$8.30
Niagara River (includes CSO-055 Cornelius Creek)	$23.50	$25.01	$8.70	$57.20
Scajaquada Creek	$29.32	$34.33	$27.75	$91.40
Total	**$92.61**	**$96.18**	**$84.49**	**$273.27**

NOTE: [1]GI cost based on initial target control of 1,620 acres as a conservative estimate.

Figure 12-3: Distribution of Gray, Green, and Foundation Alternative Present Worth Project Costs in the Individual Water Bodies for the Recommended Plan (2012 dollars)



NOTE: GI cost based on initial target control of 1,620 acres as a conservative estimate.

The next step was to develop a more detailed, yet still planning level, opinion of probable project costs. This cost was developed using more specific information such as conceptual facility layouts, local knowledge of construction costs, costs for similar projects constructed elsewhere, etc. The probable project cost for the Recommended Plan under this methodology was estimated at $340 million, including all future capital costs. In addition to the Recommended Plan cost, the costs for upgrades at the WWTP as outlined in Section 8 and the NFA Report (Alternative C2) have been added to reflect the overall expense for improvements across the BSA system ($380 million). For the purposes of this document, the O&M costs for all CSO-related construction projects are considered to be the same as presented above. However, the additional O&M cost for the NFA-related projects was estimated at $282,000 per year. A summary of the more detailed estimated project costs is provided in Table 12-8. It should be noted that while more detailed and refined, this cost estimate is still considered, at most, AACE Class 3 in that the costs are still based upon very limited design concepts. Backup estimating documentation is included in Appendix 12-1 (Recommended Plan) and Appendix 8-2 (WWTP upgrades). The refined system-wide project cost estimate of $380 million was used as a conservative value cost for the affordability evaluations and initial project budgeting and scheduling.

Table 12-8: Summary of System-Wide Estimated Project Costs

Receiving Water Body / Project	Project Cost [1,2,3]
Black Rock Canal	
CSO 013 (300,000 gallons)	$3,000,000
North Relief Sewer	$36,000,000
CSO 008/010, 061, 004 Underflow Upsizing	$500,000
Erie Basin Marina	
CSO 014/015 (800,000 gallons)	$6,700,000
Cazenovia Creek – C	
CSO 028/044/047 (2,300,000 gallons)	$12,200,000
Buffalo River	
CSO 052 (600,000 gallons)	$3,900,000
CSO 064 (100,000 gallons)	$2,000,000
Scajaquada Creek	
Jefferson Avenue & Florida Street (SPP 170B) (2,600,000 gallons)	$9,500,000
SPP 336 a/b (SPP165A, SPP165B, SPP 336A, SPP336B) (4,200,000 gallons)	$11,500,000
SPP 337 (700,000 gallons)	$4,000,000
Niagara River (Cornelius Creek)	
CSO 055 (7,500,000 gallons)	$18,500,000
Subtotal	*$107,800,000*
Contingency (20%)	$21,500,000
Probable Construction Cost	*$129,300,000*
Administrative and Legal (5%)	$6,500,000
Engineering (20%)	$26,000,000
Total Recommended Plan Cost	**$161,800,000**
Revised Foundation Plan Cost (for projects not already completed, see Table 11-11)	*$85,000,000*
Green Infrastructure (system wide)[5]	*$92,600,000*
Revised Foundation Plan + Recommended Plan	**$339,400,000**
NFA Alternative C2 at WWTP	*$41,000,000*
System-Wide Improvements	***$380,400,000***

NOTES:
[1] Year 2012 dollars.
[2] All Costs Rounded.
[3] Planning Level Estimate.
[4] Right-of-Way and/or land acquisition not included.
[5] GI cost based on initial target control of 1,620 acres.

12.6 Summary of Benefits

The Recommended Plan offers significant benefits by focusing efforts, and associated costs, to tailor CSO improvements to achieve receiving water in-stream improvements.

12.6.1 Description of Benefits (CSO Reductions and Water Quality Modeling Results)

The benefits of the Recommended Plan were evaluated for each receiving water body in terms of reduction in CSO volumes, system-wide percent capture and anticipated frequencies of activations in a typical year. The proposed performance measure at this time is the activation frequency criterion consistent with the presumption approach as provided in the CSO Policy. The following sections summarize these evaluations.

12.6.1.1 CSO Volume, Percent Capture, and Frequency of Activation

The Recommended Plan was evaluated for each receiving water body in terms of targeted reduction in CSO frequency of activation. CSO volumes and system-wide percent capture estimates are provided for informational purposes and not used in establishing the performance measures. Residual volumes are presented for each CSO receiving water, while percent capture is presented on a system-wide basis. Table 12-9 presents a summary of the predicted frequencies, residual CSO volumes and percent capture for the Recommended Plan. Moreover, estimated residual activations and volume results for each CSO are presented in Appendix 12-2.

Table 12-9: Summary of Recommended Plan Benefits

Receiving Water Body	CSO	Baseline Activations	Baseline CSO Volume (MG)	Projected Activations (LOC)	Residual CSO Volume (MG)	Remaining Fecal Coliform Annual Loadings (MPN)
Black Rock Canal	004	5	11.2	3	8.7	1.25E+14
	005	4	0.1	4	0.1	
	006	65	198.9	4	21.7	
	008	39	6.1	0	0.0	
	010	44	11.9	1	0.0	
	012	42	52.5	2	0.9	
	013	7	6.8	4	2.7	
	061	10	31.2	2	1.2	
	063	13	0.6	4	0.3	
	Total	**≤65**	**319.3**	**0 – 4**	**35.6**	

Receiving Water Body	CSO	Baseline Activations	Baseline CSO Volume (MG)	Projected Activations (LOC)	Residual CSO Volume (MG)	Remaining Fecal Coliform Annual Loadings (MPN)
Buffalo River	017	49	71.3	4	34.8	6.26E+14
	022	49	29.8	5	2.0	
	025	11	1.4	6	1.2	
	026	63	124.2	3	29.6	
	027	36	31.7	6	39.1	
	028	69	45.5	6	22.7	
	029	0	0.0	0	0.0	
	032	0	0.0	0	0.0	
	033	9	37.8	5	31.8	
	034	Closed	Closed	0	Closed	
	049	0	0.0	0	0.0	
	050	14	3.2	5	2.8	
	051	4	1.2	4	1.2	
	052	10	10.9	3	6.3	
	064	56	21.1	3	6.9	
	066	10	1.7	4	0.4	
	Total	**≤**69	**379.7**	**2 – 6**	**178.8**	
Cazenovia Cr.-B	035	0	0	0	0	0.00E+00
Cazenovia Cr.-C	037	13	23.3	6	11.9	5.38E+13
	039	0	0.0	0	0.0	
	044	7	2.3	2	0.7	
	046	1	1.3	0	1.3	
	047	44	8.7	3	1.5	
	048	0	0.0	0	0.0	
	Total	**≤**44	**35.6**	**0 – 6**	**15.4**	
Erie Basin	014	4	4.2	2	3.1	1.30E+13
	015	12	6.1	1	0.6	
	016	0	0.0	0	0.0	
	Total	**≤**12	**10.3**	**0 - 2**	**3.7**	
Niagara River (incl. CSO 055)	055	41	601.1	9	206.2	7.66E+14
	003	6	0.1	5	0.8	

Receiving Water Body	CSO	Baseline Activations	Baseline CSO Volume (MG)	Projected Activations (LOC)	Residual CSO Volume (MG)	Remaining Fecal Coliform Annual Loadings (MPN)
	011	41	134.3	4	11.7	
	054	0	0.0	0	0.0	
	Total	**≤41**	**735.5**	**4 - 9**	**218.7**	
Scajaquada Creek	053	65	268.0	4	52.1	1.82E+14
	056	5	0.0	3	0.0	
	057	0	0.0	0	0.0	
	058	0	0.0	0	0.0	
	059	0	0.0	0	0.0	
	060	5	0.7	0	0.0	
	Total	**≤65**	**268.7**	**0 - 4**	**52.1**	
Totals		**NA**	**1749.1**	**NA**	**504.3**	**1.77E+15**
Percent Capture		**NA**	**91.3%**	**NA**	**97.2%**	**NA**

12.6.1.2 Water Quality Compliance

The Recommended Plan was evaluated for each receiving water body in terms of remaining pollutant loads and water quality compliance (for the pollutant of concern, bacteria). The water quality compliance evaluations were performed consistent with the baseline scenario documented in the BSA's *Technical Memorandum: Water Quality Modeling For the Preferred CSO Control Alternative In Buffalo River, Scajaquada Creek, Niagara River, and Black Rock Canal* (LimnoTech, April 5, 2012) included as Appendix 12-2. Based on the SPP-level refinement of GI discussed in Section 12.2, the BSA re-ran the WQ models and the results are also included in Appendix 12-2. This baseline scenario incorporates upstream water quality conditions (i.e., bacteria) set at 75% of the WQS (cBOD has no WQS, so it was set to 75% of the existing conditions upstream concentration). These modified upstream boundary conditions were identical for both the Baseline scenario used in this report and for the Recommended Plan.

Attainment of the bacteria WQS for each water body under the Recommended Plan was calculated from model output and compared to the bacteria WQS attainment for the Baseline condition. Table 12-10 provides a summary of annual percent attainment of bacteria water quality standards for all modeled water bodies under these two scenarios. Attainment was first calculated for each model segment and then spatially averaged across each water body.

Table 12-10: Water Quality Standards Attainment for Bacteria Comparison of Baseline Scenario (Background 75% of WQS)

Scenario	Bacteria: Annual Percent Attainment (%) of WQS					
	Upper Scajaquada Creek	Lower Scajaquada Creek	Buffalo River	Black Rock Canal	Erie Basin	Niagara River (incl. CSO 055)
Baseline (Background 75% of WQS)	99	77	93	86	100	100
Recommended Plan	100	100	100	100	100	100

All water bodies demonstrated 100% attainment of the bacteria WQS under the Recommended Plan for the targeted levels of control described in Section 12.1 above (note that Black Rock Canal was rounded from 99.9% to 100%). The greatest improvement was seen for Lower Scajaquada Creek, where attainment increased from 77% in the Baseline (Background 75% of WQS) scenario to 100%. Additionally, bacteria WQS attainment increased from 86% to 100% in the Black Rock Canal, 93% to 100% for the Buffalo River, and from 99% to 100% for the Upper Scajaquada Creek. Bacteria WQS attainment in the Erie Basin and the Niagara River remained unchanged at 100% attainment for baseline conditions. Additional results for each water body can be found in Appendix 12-2. In addition to evaluating bacteria water quality compliance, residual bacteria loadings were also calculated and are presented in Table 12-9 above.

12.7 GI Sensitivity Evaluations

As described above, the Recommended Plan has an important and reasonable GI component with a number of the sewersheds within the BSA CSS targeted for up to 20% of impervious area control by GI projects. Figure 12-1 presented the conceptual level GI coverage for the CSS sewersheds City-wide.

GI has gained strong public and regulatory support over the past decade; while many GI technologies are still maturing communities nationwide and documenting their long term performance. That said, GI performance in colder climates, such as the City of Buffalo, may require additional time to validate. Finally, the ultimate effectiveness of a GI program in the longer term is heavily dependent upon community acceptance. These factors are why the BSA plans on conducting GI pilot projects prior to being able to define a system-wide GI implementation program. The BSA has constructed a demonstration project tributary to CSO 060, which is currently in the post-construction monitoring phase. This project includes a number of different GI techniques to provide a database of community-specific performance metrics. Additional GI pilot projects are considered for the early years of the LTCP implementation as discussed in the GI Master Plan (Appendix 12-3) and further presented in Section 14.

In order to evaluate the sensitivity of the program to GI effectiveness, the typical year precipitation simulation model was run incorporating only the gray components of the Recommended Plan. This run was intended to determine how the system would react in the event that in the worst case, GI proved to be ineffective. The sensitivity evaluation results are presented in Table 12-11 below. The SPP-level GI scenario represents the impervious surface area control associated with the SPP-level refinement discussed in Section 12.2. As can be seen from Table 12-11, with no GI assumed, the effect on projected activations is relatively minor; however, the implementation of GI results in an annual CSO volume reduction of approximately 210 MG. This evaluation demonstrates that even if the GI program falls significantly short of the established goals, the resulting reduction in system performance will be negligible given the significant progress and high LOC achieved to date.

Table 12-11: Green Infrastructure Sensitivity Analysis Results

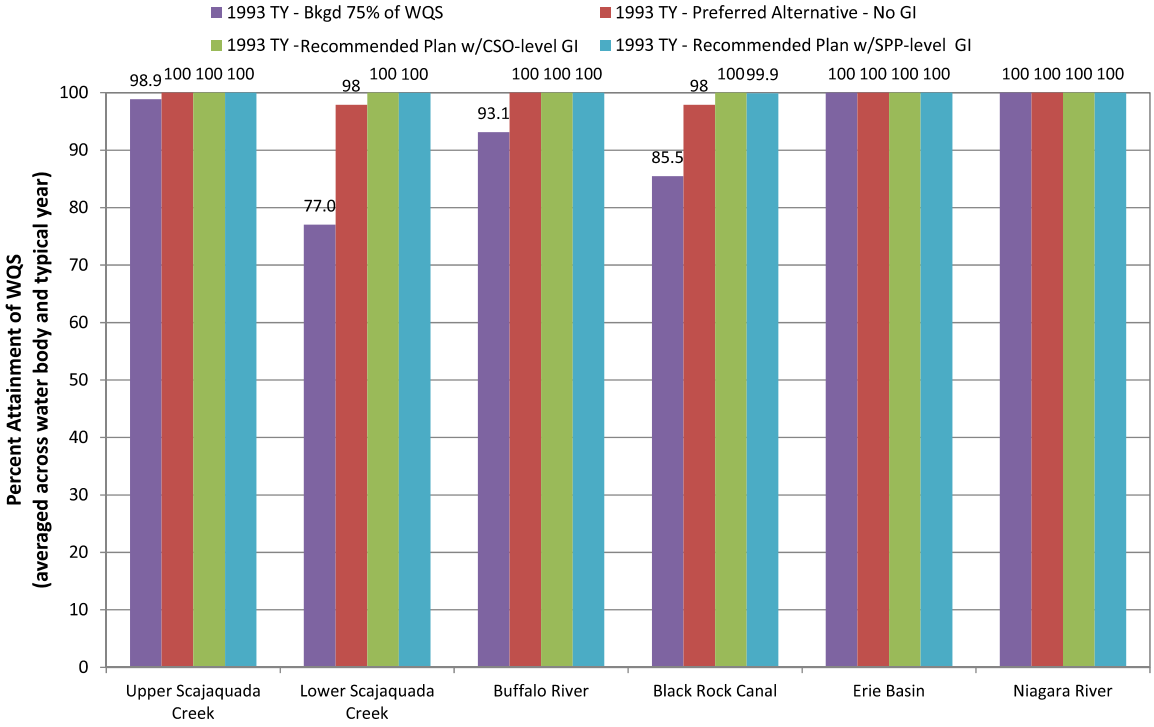
	Projected Activations (LOC)		Residual CSO Volume (MG)	
Receiving Water Body	**GI (SPP-level)**	**No GI**	**GI (SPP-level)**	**No GI**
Black Rock Canal	0 – 4	0 - 7	35.6	57.3
Buffalo River	2 – 6	3 - 10	178.8	233.9
Cazenovia Cr.-B	0	0	0.0	0.0
Cazenovia Cr.-C	0 - 6	0 - 8	15.4	20.6
Erie Basin	0 - 2	0 - 2	3.7	6.8
Niagara River (incl. CSO 055)	4 - 9	6 - 12	218.7	321.2
Scajaquada Creek	0 - 4	0 - 7	52.1	74.2
Totals	**NA**	**NA**	**504.3**	**713.9**
Percent Capture	**NA**	**NA**	**97.2%**	**96.5%**

In addition to the hydraulic modeling comparison discussed above, the BSA also evaluated the water quality impact of no GI. Figure 12-4 shows a graphical comparison of the resulting water quality impacts.

Figure 12-4

Summary of Percent Attainment for 1993 TY - Baseline - Background 75% of WQS vs. Recommended Plan Variations (Fecal Coliform)

TYPICAL YEAR (Jan 1 - Dec 31)



NOTE: The 99.9 percent capture in Black Rock Canal for the "Recommended Plan – Updated GI" scenario was rounded to 100 percent.

The WQ modeling results indicate that the Recommended Plan components with no GI will result in 100% attainment of the current NYS bacteria WQS in in all receiving water bodies, except for the Lower Scajaquada Creek and Black Rock Canal (both at approximately 98%). Further, as the figure shows, and as discussed previously, the Erie Basin and Niagara River already reflect a 100% attainment of the current NYS bacteria WQS under the baseline conditions and are thus not impacted by reductions in GI. This suggests that much of the system will not be affected appreciably by reductions in GI.

12.8 Performance Criteria and Designated Uses

The BSA reserves the right to petition the NYSDEC to perform a use attainability analysis (UAA) should the NYSDEC (or USEPA) conclude in the future that the applicable WQS are not attained after achieving the LTCP performance criteria recommended in this plan for each RWB. In addition, after achieving an extraordinarily high level of CSO control, the BSA expects that the NYSDEC would prepare a Total Maximum Daily Load (TMDL) to allocate loadings among all sources, particularly upstream sources that will not have achieved anywhere near the reductions that the BSA has achieved. The CSO Policy expressly calls for a TMDL and/or use attainability analysis where other sources than CSOs cause or contribute to water quality standards excursions.