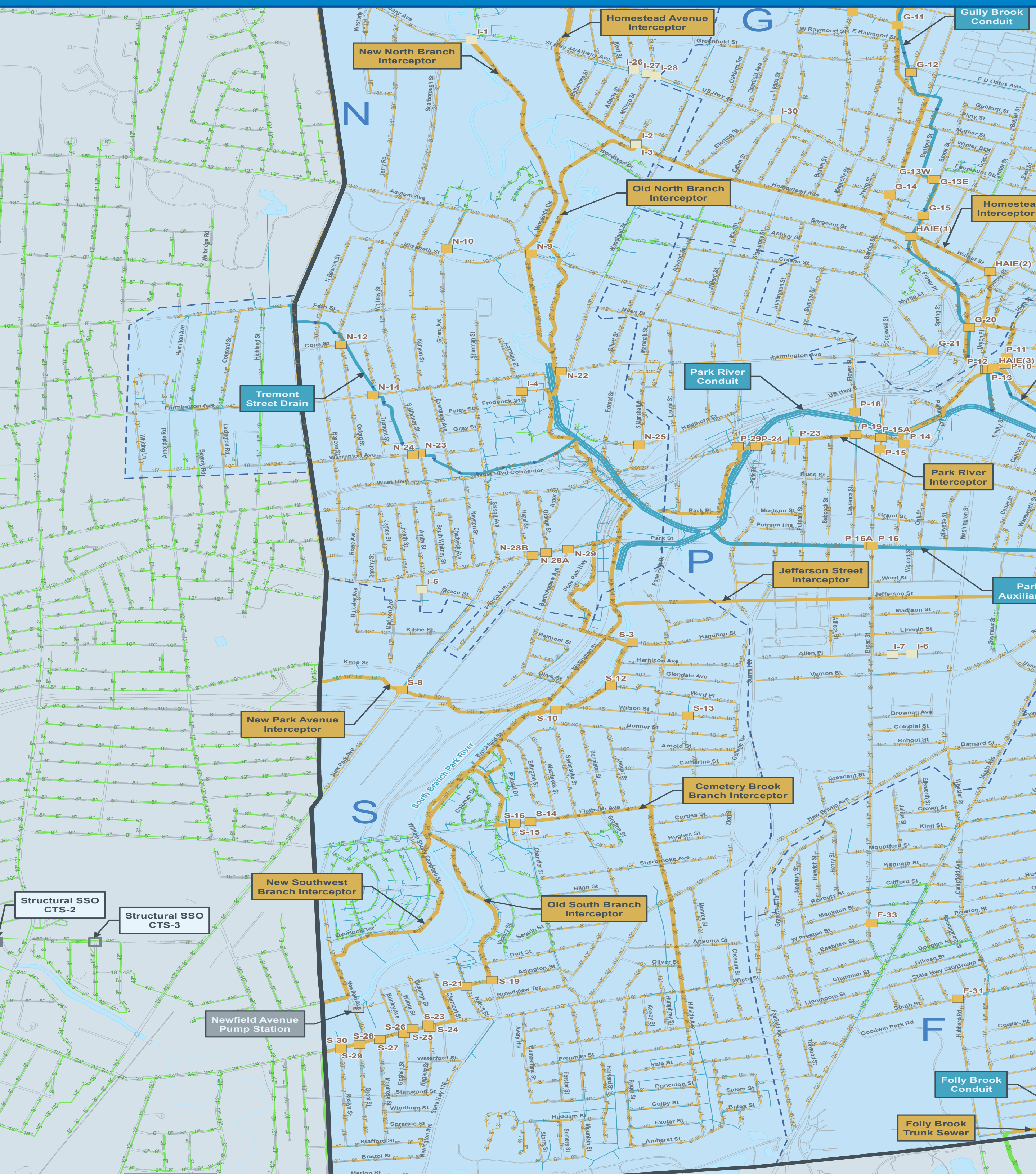
Long-Term Combined Sewer Overflow Control Plan

2012 Update



The Metropolitan District, Hartford, Connecticut

December 28, 2012

Revised August 28, 2014

Revised December 4, 2014

CDM Smith

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Introduction

The Metropolitan District of Hartford (District) operates a combined sewer system, located primarily in the city of Hartford. The combined sewer system dates back to the 19th century when it was common for communities to install a single pipe to convey sewer and stormwater flow to the receiving waters. During intense rain storms, these single pipe systems were designed to discharge excess flow as combined sewer overflows (CSOs) to adjacent waterways to relieve the sewer system.

The District also provides sewer collection and treatment services to seven other member communities - Bloomfield, East Hartford, Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor. These communities predominately have separate sewer systems (with a second pipe for conveyance of stormwater); however, these sewer systems experience surcharging during intense rain storms. Excess flows that are discharged from these separated systems during storm events are referred to as sanitary sewer overflows (SSOs).

Both CSOs and SSOs must be managed under federal and state regulations that are administered by the U.S. Environmental Protection Agency (EPA) and the State of Connecticut Department of Energy and Environmental Protection (CTDEEP).

CSO Program Evolution

In 2005, the District completed a Long-Term CSO Control Plan (LTCP) in compliance with EPA CSO Control Policy (1991), State of Connecticut Combined Sewer Overflow Strategy (1990), and a CTDEEP-issued Consent Decree (WC 5365), dated October 2002. The 2005 LTCP incorporated the results of planning efforts and system improvements implemented by the District over the years in a continuous effort to manage their CSOs in compliance with state and federal regulations.

The 2005 LTCP was composed of five major components:

- ***Expansion of Hartford Water Pollution Control Facility (HWPCF) for wet weather treatment.*** The existing HWPCF facilities would be upgraded and expanded (up to a peak wet weather flow rate of 200 million gallons per day (mgd) to ensure reliable secondary treatment and increase and improve wet weather treatment capacity including a new influent pumping, preliminary treatment, wet weather treatment facility, improved disinfection facilities, and effluent pumping.

- ***Tunnel storage***. The District adopted a tunnel storage plan for CSOs in its system, whereby the excess wet weather flow would be stored in tunnels and pumped back to the HWPCF after the storm event for treatment. The existing Park River Auxiliary Conduit (PRAC), a city-owned 26 million gallon (MG) flood control tunnel and pumping station system, was going to be used to store CSO. In addition, the District was going to construct a new 23 MG deep rock tunnel in North Hartford, with its own pumping station, to store the CSOs in that portion of the system.

- ***Consolidation conduits***. The tunnel storage plan included nearly10 miles of large diameter consolidation pipe to connect the CSOs to the PRAC and North Tunnel.

- ***Sewer separation.*** The District included separation of nearly 2,300 acres of its combined sewer system to reduce CSOs and to abate sewer system surcharging , sewer back-ups, and street flooding in local neighborhood areas. The separation plan also included the Homestead Avenue Interceptor Extension (HAIE) and some new local sewers to enable the District to remove Gully Brook from the sewer system – this brook and stormwater flow contributed a significant amount of flow and created additional CSOs. In addition, sewer separation of the Franklin Avenue combined sewer system was proposed to eliminate CSO discharges into Wethersfield Cove.

- ***Reduction of I/I through sewer rehabilitation.*** Significant wet weather flow and infiltration and inflow is discharged into the District system by the member towns. This wet weather flow uses the capacity of the existing interceptor and treatment system within Hartford and causes additional CSO discharges. The 2005 LTCP included Sewer System Evaluation Studies (SSES) and proposed sewer system rehabilitation to reduce this extraneous flow by 25 percent.

Following submission of the October 2005 LTCP to address CSOs in Hartford, the District expanded its efforts to respond to CTDEEP's Water Pollution Control Facility (WPCF) nutrient removal initiative and an EPA Consent Decree for SSO elimination. Encompassing these three major focus areas, the District developed the Clean Water Project (CWP), which is the District's largest environmental program since the Commission was chartered over 75 years ago. Phase I of the CWP was approved by all eight District member towns in a referendum vote in November 2006 in which $800 million was authorized. A second referendum vote for Phase II of the Clean Water Project was sent to the voters in November 2012 for a second $800 million and was overwhelmingly approved. In 2009, the CWP was anticipated to cost approximately $2.1 billion to complete.

Fully implemented, the CWP will prevent CSO discharges into the District waterways for storms up to and including the 1-year storm event, except for the Granby Avenue and Franklin Avenue combined sewer areas where the CWP will allow the District to completely eliminate (and permanently close via brick and mortar) structural CSO discharges to the North Branch Park River and Wethersfield Cove.

Purpose

This report was prepared to comply with the requirements of Paragraph B.9 of Consent Order WC0005434, dated November 2006. Paragraph B.9 requires the District to provide a 5-year update of the LTCP, due by December 31, 2012, to outline the combined system improvement work completed to-date, identify the effectiveness of the program to reduce or eliminate CSO discharges, and to recommend any CSO program modifications to meet the water quality goals.

There have been significant changes to the LTCP since 2005 including;

- Use of the PRAC as a CSO tunnel storage option was removed from the LTCP based on its existing conditions and the recommendation of a Value Planning Study, completed in October 2006 to update the CWP to integrate the goals of CSO and SSO control.

- The South Tunnel was added to the CWP as a recommendation of the 2006 Value Planning Study to replace the PRAC to provide additional tunnel storage along with the North Tunnel.

- District studies indicated that it was cost-effective to connect the South Tunnel and the North Tunnel together to operate them as a single tunnel storage system with one dewatering pumping station. This has the major benefit of eliminating one large pump station.

- The Stormwater Management Model (SWMM) of the combined sewer system was updated between 2009 and 2011 with new system-wide flow monitoring data.
- A consent order requirement to eliminate CSO discharges to the North Branch Park River CSOs (affecting N-2, N-4, N-9 and N-10) was added in 2006.
- Sewer system evaluation studies of the member community sewer systems, completed as part of the SSO program, concluded that a system-wide goal of infiltration/inflow (I/I) reduction of 10 percent was more reasonable than the original 25 percent I/I reduction identified in the 2005 LTCP.
- The District initiated an aggressive sewer cleaning program (more than 500 miles of pipe cleaned each year) that has increased the capacity of the sewer system, reduced the occurrences of blockages, and reduced sewer system surcharges and complaints.
- The costs, challenges, and disruptions associated with the ongoing sewer separation program and the recent reduction in the number of sewer surcharge complaints caused the District to reconsider its extensive separation program and investigate alternatives to use more tunnel storage of CSOs as appropriate.

Accordingly, this LTCP Update is intended to document the benefits achieved by the ongoing system improvements currently under construction and to examine alternatives to update the recommended plan based on a cost-effective approach that integrates the program changes since 2005.

Future Baseline CSO Control Status

Table ES-1 summarizes the average annual CSO reduction achieved by the LTCP improvements that will be completed with all ongoing projects (future baseline). At the completion of all ongoing projects, the District will have completed approximately 20 construction projects that will have separated about 700 acres of the combined sewer system with the installation of more than 25 miles of new sewer and drain pipes. In addition, since 2006, the District has rehabilitated (either by lining or direct replacement) more than 130 miles of existing sewer pipe in Hartford, Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor to reduce infiltration and inflow. LTCP improvements also include peak flow capacity improvements at the HWPCF that will provide 200 mgd of wet weather treatment capacity.

	Annual CSO Discharges (million gallons)	
Drainage Area	**2009**	**Future Baseline**
North Branch	56	43
Gully Brook	225	37
Park River	276	279
North Meadows	114	102
South Branch	86	85
Franklin Avenue	111	72
South Meadows	106	34
TOTAL	**974**	**652**

Table ES-1 Annual Average CSO Discharge Volumes

The District will have significantly reduced CSO discharges in the Gully Brook Drainage Area through the elimination of Gully Brook from the sewer system, the closure of the largest CSO in the system (G-20), and better controlled CSOs in this area with the completion of the HAIE, and the Garden Street Relief Sewer. The North Branch, North Meadows, and Franklin Avenue annual CSO discharges are partially reduced due to the District's upstream sewer separation projects. CSO reduction was also achieved within the South Meadows area as a result of the improved HWPCF operations. The CWP has not yet addressed the Park River area, as shown by the slight increase in CSO volume.

System-wide, the CSO volume in a typical year will have been reduced by 322 million gallons or a 33 percent reduction in average annual CSO overflow with the system improvements implemented (with the completion of all ongoing projects) so far as part of the District's LTCP.

Complete Elimination of Wethersfield Cove and the North Branch Park River CSOs

The Consent Order requires the complete elimination of CSO discharges to Wethersfield Cove and to the North Branch Park River. The draft December 2012 LTCP Update considered system alternatives to achieve complete elimination of the CSO discharges to these receiving waters using a historic storm from May 1989 with an estimated average return interval (ARI) of 18-years. This approach for control was based on the 2004 Wethersfield Cove study that interpreted complete elimination as the 18-year storm control objective. Based on review of the draft 2012 LTCP Update, CT DEEP has stated that this approach is an unacceptable option for their approval of the LTCP Update as it did not completely eliminate (i.e., brick and mortar) the structural CSO discharges to Wethersfield Cove and North Branch Park River.

Per CTDEEP's request, the draft LTCP Update required further evaluation of alternatives that would provide for complete elimination of the structural CSO outfalls to Wethersfield Cove and the North Branch Park River. In response, the District has conducted and submitted to DEEP multiple system analyses/alternatives (which are summarized in Sections 9 and 10) in the preparation of this revised LTCP Update report. If these CSOs to Wethersfield Cove and North Branch Park River were sealed, the requirements of the Consent Order would be met by controlling all remaining CSO discharges during the 1-year design storm. This would result in a less expensive solution than was submitted in the December 2012 LTCP Update (i.e., a smaller tunnel could be proposed). However, the District is proposing a larger tunnel than is necessary to meet the minimum requirements of the Consent Order, which will provide the District a greater level of service to its customers and more operational flexibility.

Hartford WPCF Upgrades

The District is implementing the design and construction of major improvements to the HWPCF to reliably treat dry-weather flow, improve treatment for wet weather flow, and meet the CTDEEP requirements for Biological Nutrient Removal (BNR). This work is being implemented through a number of planning, design and construction packages to upgrade the plant to a treatment capacity of 90 mgd for secondary treatment and 200 mgd for peak flow wet weather treatment. Improvements to the facility include new influent pumping, preliminary treatment (screening and grit removal), chemically-enhanced primary treatment (CEPT), wet weather disinfection chemical feed and storage facilities, and effluent pumping. To improve the secondary treatment process and meet the BNR requirements, the District upgraded its secondary process by constructing two additional aeration tanks and two additional final settling tanks. Other improvements completed include the installation of ultraviolet light (UV) for disinfection of dry weather flow, new odor control facilities, and construction of incinerator improvements for sludge processing and energy recovery. The estimated cost of completed and proposed HWPCF improvements is approximately $530 million. It is anticipated that the HWPCF projects will be completed by late 2018.

South Tunnel

Storage of wet weather overflows in tunnels below ground has become one of the standard approaches for the control of CSO discharges in the last 30 years. Some communities are taking advantage of existing conduits, and many are constructing new storage tunnels for the sole purpose of reducing CSO discharges.

The District's South Tunnel is proposed to collect CSOs from the South Branch Park River and Franklin Avenue drainage areas, as well as SSOs from West Hartford and Newington. CSO flow from the Franklin Avenue area will be collected in the South Tunnel to completely eliminate structural CSO discharges to Wethersfield Cove. South Branch Park River CSOs will be controlled to the 1-year design level. This project has been developed through various studies and is currently at a 30 percent design stage. The proposed South Tunnel will be excavated using a tunnel boring machine (TBM). As the design of the South Tunnel has progressed, the exact location, length, diameter, and volume of the tunnel has been refined based on the geologic conditions encountered, the location of the surface facilities that will serve the tunnel, and to integrate the tunnel with the other future system improvements (including a north CSO storage tunnel).

Proposed South Tunnel Alignment

The layout of the tunnel was originally evaluated in an extensive analysis summarized in the "South Hartford Storage and Conveyance Tunnel Basis of Design Report (BODR)", which was submitted by the District's final design engineer (FDE), AECOM, on September 12, 2013. Based on discussions with the District, the FDE aligned the tunnel in a circuitous route (partially under Franklin Avenue and past the larger CSOs near Broad Street and West Preston Street) to optimize the collection of the Franklin Avenue area and South Branch Park River area CSOs. These CSOs will be collected and discharged into the tunnel by large diameter consolidation conduits and new vortex drop shafts. As recommended in the BODR, the proposed South Tunnel is approximately 21,800 linear feet long (starting at the HWPCF and ending in West Hartford near the existing CTS-3 SSO Regulator) and approximately 175 feet deep. The tunnel project also includes a tunnel dewatering pump station that will discharge flow into the HWPCF, odor control systems, and other air release, venting, and energy dissipation devices.

Proposed South Tunnel Diameter/Volume

The South Tunnel has been evaluated independently of the North Tunnel and as a complete tunnel system including the North Tunnel. The tunnel size assumes that the dewatering pump station at the HWPCF is pumping at 40 mgd during a storm to maximize the full use of the future wet weather treatment capacity (up to 200 mgd). The dewatering pumping station will balance treatment of gravity flow from the interceptor system while optimizing the tunnel system volume.

If the size of the South Tunnel were considered independently of the other system improvements, a volume of 28 MG is needed to capture: 1) flow from the South Branch structural CSO regulators S-19 through S-30 up to the 1-year storm, 2) all flow from the Franklin Avenue structural CSO regulators F-26 through F-33 to completely eliminate these CSO discharges to Wethersfield Cove, and 3) flow from the SSO structural regulators CTS-2, CTS-3 and NTS at Hillcrest for all storms up to and including a 25-year storm. The minimum required South Tunnel volume under this scenario is driven by the peak flow from the structural CSOs in Hartford. If SSO flow was completely disconnected from the South Tunnel, there would be a 1.5 MG reduction in the tunnel; however, because of tunnel construction techniques, the tunnel diameter and length would remain unchanged. Based on the 21,800 linear foot length discussed above, this minimum volume would require a tunnel diameter of about 15-feet.

As part of the South Tunnel design, the District's FDE evaluated various combinations of North and South tunnel diameter combinations, as well as completed a hydraulic assessment to evaluate anticipated surge in the future tunnel system. This evaluation is summarized in the "South Tunnel Diameter Recommendation" technical memorandum by AECOM, dated February 17, 2014. The analysis concluded that a 17-foot diameter (approximately 37 MG volume) to 18-foot diameter (approximately 41 MG volume) South Tunnel would be required to address anticipated surge in the tunnel system. Ultimately, an 18-foot South Tunnel was recommended as it provides the District with better flexibility to optimize the North Tunnel during future BODR and design phases without significant additional cost. The proposed 18-foot diameter South Tunnel has a reserve storage capacity of about 13 MG (above the minimum tunnel volume required for the South Hartford CSOs). This reserve capacity will minimize the issues with surge in the South Tunnel and could supplement the storage volume required for the North Tunnel, which is proposed to discharge into the South Tunnel.

Conclusion

The recommended South Tunnel is approximately 21,800 linear feet long (starting at the HWPCF and ending in West Hartford), approximately 175 feet deep, and will have an internal finished diameter of 18 feet, with a total storage volume of about 41 million gallons. The current estimated cost of the South Tunnel project is approximately $500 million. It is anticipated that the tunnel project will be completed by the end of 2022.

LTCP Update on Five Major Components

The South Tunnel provides a CSO control approach for 21 of the District's 85 CSO regulators and results in complete elimination of the Franklin Avenue area CSO outfalls. A control plan is required for the remaining CSO regulators. The 2005 LTCP addressed these remaining CSOs primarily by sewer separation and CSO storage in a North Tunnel. The objective of the 2012 LTCP Update was to re-evaluate the control plan for the remaining CSO regulators based on higher system flows resulting from the 2009/2011 SWMM model update, elimination of the North Branch Park River CSO regulators, the information gathered from existing sewer separation projects and the lower I/I removal goal for the member communities (from 25 percent to 10 percent reduction).

The 2012 LTCP Update plan was developed using the new information gathered in the first phase of the program to reassess the most economical way to achieve the regulatory objectives in the Consent Order. In essence, the update was a continuation of the previous LTCP and its five major components of sewer separation, storage, consolidation conduits, wet weather treatment capacity, and sewer rehabilitation. The LTCP Update conceptually evaluated several alternative routes for the North Tunnel (and the routing and sizing of consolidation pipes or spur tunnels) to cost-effectively collect and convey wet weather flow from the northern CSO regulators and discharge it into the North Tunnel. In addition to the North Tunnel, two spur tunnels were proposed – the Downtown Spur Tunnel and the Granby Spur Tunnel – to centrally collect and store CSO flows from the Park River Area CSO regulators and the Granby and Gully Brook area CSO regulators, respectively.

For comparative purposes, the LTCP Update also evaluated the relative costs of alternative CSO control approaches for the CSO regulators in each drainage area including sewer separation and satellite storage or treatment facilities. In almost all cases, the use of sewer separation or the construction of satellite CSO control facilities were not cost-effective to control the individual CSO regulators compared to the use of centralized tunnel storage.

SWMM model simulations were performed to determine the optimal size of the North Tunnel and spur tunnels based on the size of the South Tunnel. The model simulations assumed that the dewatering pump station would be sized to maximize the HWPCF treatment capacity during the storm event, thereby minimizing the total system-wide tunnel storage volume required as a portion of the flow that could be treated during the storm.

To control the wet weather flow discharged into the tunnel system, the District will have to install influent control gates at many of the consolidation pipe connections (at the vortex drop connections) to the tunnel system. This is important to be able to divert excess flow (greater than the 1 year design storm) at each CSO regulator away from the tunnel and into the existing CSO outfalls (with the exception of the CSOs that discharge to the North Branch Park River and Wethersfield Cove where all of the structural CSO discharges will be eliminated). Each 1-year control level CSO consolidation pipe would be designed with a high outlet relief (with a discharge to an appropriate waterway or stormwater conduit) so that if system operation of the control gates becomes problematic during more significant storms (greater than 1 year) there is an alternative relief point(s). The North Branch Park River and Wethersfield Cove CSO outfalls will be physically sealed without any high relief points after the tunnel system is completed.

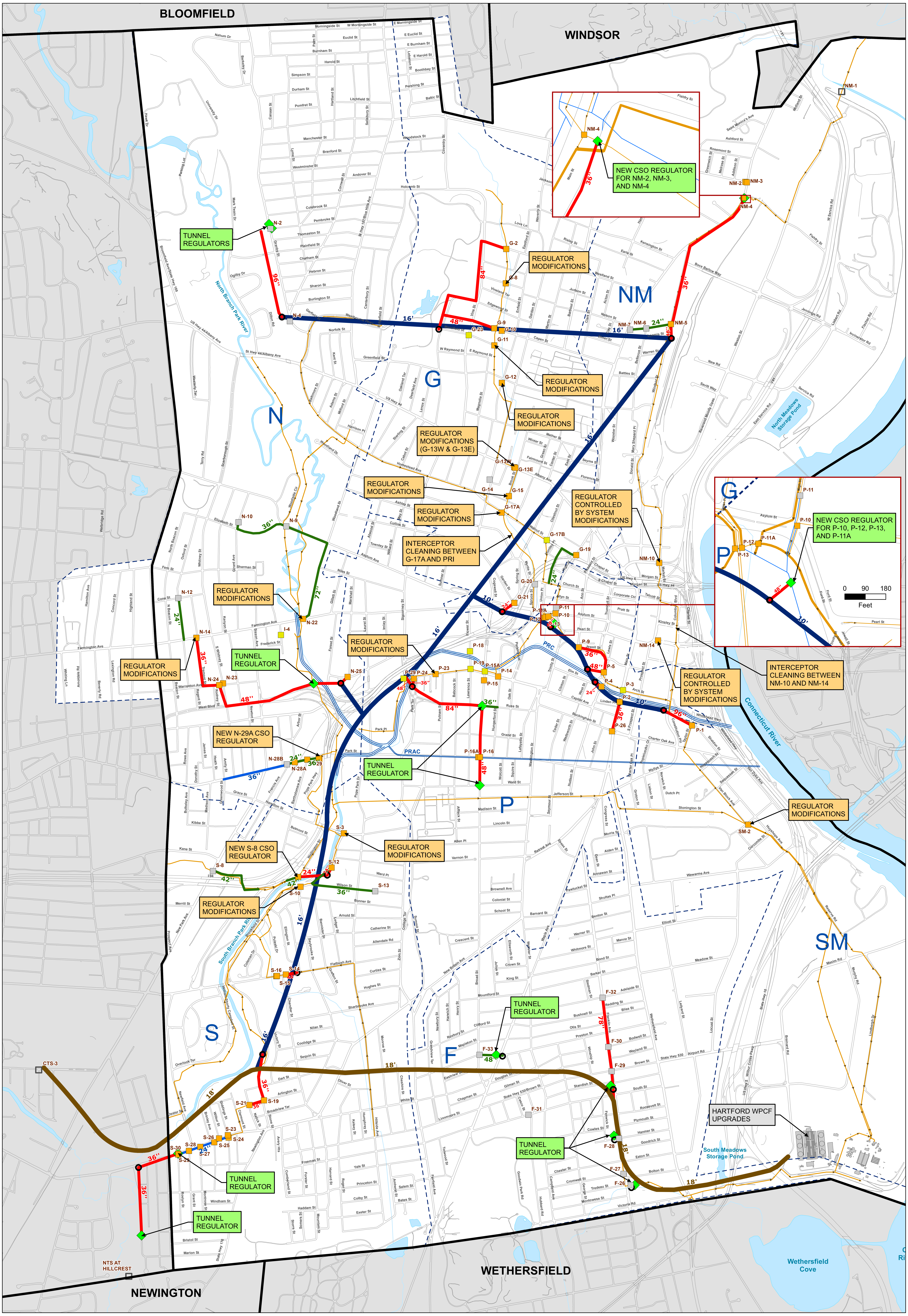
Recommended Plan

The revised 2012 LTCP Update recommended plan was developed based on the alternatives screening, development, and evaluation presented in Sections 6 through 10. The analysis relied on CSO characteristics generated by the 2009/2011 updated SWMM model and incorporated the current/ongoing District combined sewer system and HWPCF improvements.

The goal of the LTCP was also integrated with the goals of the ongoing SSO and Capacity, Management, Operations, and Maintenance (CMOM) programs, all of which are being driven by a separate regulatory consent decree. The goal of the CSO control plan was to capture CSOs resulting from wet weather events up to and including the 1-year storm for most of the overall service area. However, for Wethersfield Cove and the North Branch Park River, the existing CSO regulators (Franklin Avenue area and N-2, N-4, N-9 and N-10) will be completely eliminated (physically sealed with brick and mortar) to meet the objectives of the Wethersfield Cove Study, North Branch Park River water classification, CT DEEP requirements, and Consent Order WC0005434.

Figure ES-1 illustrates the components of the recommended plan. The detailed structural components of this plan are discussed in Sections 9 and 10. The following represent the key milestone dates proposed in this LTCP Update:

- N-9 and N-10 eliminated via New North Branch Interceptor relocation: **December 2019**
- Franklin Avenue Area overflows to Wethersfield Cove via South Tunnel: **December 2022**
- Granby Street Area overflows to North Branch via North Tunnel: **December 2026**



Legend

- NorthTunnel
- South Tunnel
- Consolidation Pipe
- New Combined Sewer
- New Drain
- Existing Interceptor
- Drop Shaft
- New Structure
- Drainage Area

Regulators

- CSO - Controlled to Design Storm
- CSO - Inactive in Design Storm
- CSO - Eliminated (Brick and Mortar)
- SSO

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Feet

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MDC

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure ES-1
Recommended Plan

The following recommendations are listed by project type:

General

- Sediment removal along the upper Connecticut River Interceptor (upstream of I-84) and along Gully Brook Interceptor to achieve the 1 year level of CSO control;
- General recommendation to continue the implementation of the 2007 Interceptor Cleaning Plan to make full use of existing interceptor pipeline capacity;
- Continued implementation of the general sewer cleaning program; the District has experienced a significant decline in system problems that are directly associated with the implementation of this program;
- Consideration and incorporation of green infrastructure-type projects as they arise, where feasible and cost-effective, to provide additional CSO control or to lower overall capital costs;

Wet Weather Treatment Capacity

- HWPCF improvements including a new 200 mgd influent pump station, new screenings and grit removal facilities (200 mgd), and a new 110 mgd wet weather treatment process (chemically enhanced primary treatment), chemical storage and disinfection facilities, and combined effluent pumping station;

Sewer Rehabilitation

- Achieving a 10 percent reduction of I/I in the separated District communities around Hartford; this will be accomplished by the continued implementation of the SSES and CMOM programs;

Tunnel System Storage and Conveyance

- 87 MG of Storage in the deep rock Tunnel Storage System including a new dewatering pump station, connecting drop shafts, and odor control; see Table ES-2.

Table ES-2

Tunnel Storage System Components

Tunnel	Start	End	Diameter (ft)	Length (LF)	Storage (MG)
South Tunnel	HWPCF	West Hartford	18	21,800	41.5
North Tunnel	Brookfield St	Loomis St	16	20,900	31.0
Granby Spur Tunnel	Loomis Street	Granby St	16	9,700	14.5
Total				**52,400**	**87**

- 5,600 foot long, 10-foot diameter shallow-rock Downtown Spur Tunnel from Asylum Street to Columbus Boulevard including drop shafts and odor control; the Downtown Spur Tunnel is conveyance only and not part of the Tunnel Storage System.

New Pipes

- 9,800 feet of consolidation pipes ranging from 36 to 78 inches and associated CSO/SSO/Tunnel Regulators to connect three SSO Regulators (CTS-2, CTS-3, and NTS), CSO regulators in the

South Branch Drainage area (CSO regulators S-19 through S-30), and elimination (via brick and mortar) of all CSO regulators in the Franklin Avenue area;

- 3,400 feet of micotunneled consolidation pipes (24-inch to 48-inch in diameter) to connect the Park River area CSO regulators to the Downtown Spur Tunnel, including new CSO/Tunnel Regulators, modifications to existing CSO regulators, and influent control gates and instrumentation (CSO regulators SM-2, P-2 through P-5, P-9 through P-13, and P-11A);
- 1,400 feet of 24-inch new combined sewer to convey flow from CSO G-19 to the HAIE;
- 3,900 feet of 42-inch and 36-inch new combined sewer and 1,200 feet of 24-inch and 48-inch of microtunneled consolidation pipe for the middle South Branch Park River CSO regulators, connecting drop shafts to the North Tunnel, new CSO/Tunnel Regulators, modifications to existing CSO Regulators, and influent control gates and instrumentation (CSO regulators S-14 through S-16, S-3, S-8, S-10, S-12, and S-13);
- 830 feet of new 24- and 36-inch combined sewer and 1,600 feet of new 36-inch drain along Park Street to control the Park Street area CSO regulators (N-28, N-28A, and N-29);
- 370 feet of 36-inch new combined sewer on Russ Street, 4,000 feet of 36-, 48-, and 84-inch microtunneled consolidation pipe along Russ Street and Broad Street, connection to tunnel shaft at Capital Avenue, new CSO/Tunnel Regulators, modifications to existing CSO regulators, and influent control gates and instrumentation (CSO regulators P-15, P-14 P-16, P-16A, P-23 and P-24);
- 1,000 feet of 24-inch new combined sewer along Oxford Street to eliminate CSO regulator N-12;
- 2,900 feet of 48-inch microtunnel consolidation pipe along West Boulevard and 2,500 feet of 36-inch diameter open-cut consolidation pipe, New North Branch Interceptor Relief Structure, connection to the Hawthorne Street North Tunnel shaft, CSO Regulator modifications, new CSO/Tunnel Regulators, and influent control gates and instrumentation to control Farmington Avenue area CSO regulators (N-14, N-23 through N-25);
- 1,400 feet of 36-inch (open-excavation) combined sewer and 3,100 feet of 72-inch diameter (microtunnelled) combined sewer along Elizabeth Street, Asylum Avenue, and Woodland Street, modifications to existing an existing CSO regulator, and a new Tunnel Regulator to the New North Branch Interceptor (NNBI) to eliminate a troublesome reach of the NNBI, eliminate CSO regulators N-9 and N-10, and control CSO N-22 to the 1 year event;
- 3,800 feet of 36-inch consolidation pipe, 350 feet of 48-inch consolidation pipe, and 1,000 feet of 24-inch new combined sewer, to eliminate CSO regulators NM-6 and NM-7 and convey the flow from all North Meadows CSOs (NM-2 through NM-7) to the North Tunnel;
- 3,500 feet of 84-inch (microtunnel) and 1,300 feet of 48-inch (open excavation) consolidation pipe in the northern Gully Brook area, connection to the Granby Spur Tunnel shaft at Keney Park, CSO regulator modifications, and influent gate controls and instrumentation (CSO regulators G-2, G-8 through G-12 and G-23);
- 2,200 feet of 96-inch (microtunnel) consolidation pipe from CSO regulators N-2 to N-4, new Tunnel Regulators, connection to the Granby Spur Tunnel at the Granby Shaft, influent control

gates and instrumentation to eliminate CSO N-2 and N-4 (permanently close via brick and mortar); and

- Miscellaneous CSO Regulator modifications to CSO regulators G-13W, G-17A, G-10, G-11, G-12, NM-10, NM-14, and P-15 to raise weirs or increase the CSO regulator Outlet Pipes to control CSO discharges to the 1-Year Design Storm.

Sewer Separation

- The District will conclude construction of multiple sewer separation contracts by the end of 2015. Except for the correction of localized sewer capacity issues, no further system-wide sewer separation is recommended.

In summary, the 5 major components of the 2005 LTCP will continue as recommendations of this LTCP Update. However the reliance on sewer separation for CSO control will be modified to the more cost-effective use of tunnel storage and consolidation conduits.

Flexibility of Recommended Plan

The District has developed this LTCP Update recognizing the importance of advancing the Clean Water Project while incorporating flexibility into the implementation plan. The plan was developed assuming that the South Tunnel could proceed to final design and construction now, with appropriate flexibility in the future North Tunnel project to account for potential changes that might be identified in the respective conceptual and preliminary design phases. The South Tunnel size already includes a 48 percent reserve capacity, and therefore, the District does not foresee any circumstances in which the alignment or diameter of the South Tunnel would need to change as the North Tunnel preliminary design advances.

However, similar to the South Tunnel design approach to-date, the North Tunnel project requires a BODR and preliminary (approximately 30 percent) design to provide sufficient analysis of tunnel operation under normal and surcharged (large storm) events to determine the best location, length, diameter and volume of the tunnel. These early design phases will also evaluate surge and confirm the arrangement of tunnel control features to protect the tunnel infrastructure and meet the wet weather control objectives. It is anticipated that the BODR phase will commence in 2014 and the more refined recommended tunnel alignment and volume will be presented in the next LTCP Update, which is planned to be submitted by December 31, 2017.

Green Infrastructure Projects

As mentioned above, part of the recommended plan includes consideration of feasible green infrastructure projects to remove stormwater from the District's combined sewer system. The District is a proponent of green projects and has actively taken part in three during the initial phases of the CWP:

- Hartford "Green Capitols" – project completed around the historic state capitol that included rainwater harvesting system which captures roof water for irrigation, permeable paver and pervious concrete walkway areas, porous asphalt parking areas, urban and residential rain gardens, and a green roof.

- MDC Headquarters Goes Green –project that includes installing porous concrete sidewalks, permeable concrete pavers, and rain gardens outside of the District's headquarters building on Main Street in Hartford. The project has been designed but requires further discussions regarding liability, ownership, and maintenance with the city of Hartford prior to being constructed.

- Rain Barrel Program – the District's ongoing program offering rain barrels to residents of the eight member towns to reduce the stormwater entering the sewer system.
- Victoria Road Greening Project – The District has teamed with the local community in Hartford with plans to build green infrastructure in the existing island at the intersection of Victoria Road and McMullen Avenue. The District is providing the design and construction of the project, while the local residents have agreed to maintain the island after construction is complete. This will require city of Hartford approval, which is not yet attained.
- North Beacon Street Green Demonstration Project – The District designed and constructed two types of pervious concrete pavers within the right-of-way. The city of Hartford approved the pavers, but did not agree to maintain them.

It is important to note that as a sewer and water utility, the District does not intend to take responsibility for the maintenance of green infrastructure projects. This is because the District, as a utility provider, does not own the property within the right-of-way. The District is open to contributing to the planning and construction of green infrastructure projects (that are cost-effective and will provide overall benefit to the Clean Water Project) if the opportunity becomes available; however, another entity must accept ownership and the responsibility for maintaining the new infrastructure. To date, the District has received resistance from municipalities to assume ownership and maintenance of the green infrastructure, which has made it difficult for the District to incorporate large scale green infrastructure projects. CT DEEP also has grant programs available to assist with the planning, design and construction of a green infrastructure project that could be utilized to fund a more comprehensive green infrastructure demonstration project in the city of Hartford.

LTCP CSO Reduction/Benefits

The Recommended Plan (which includes system improvements already implemented since 2005) captures or eliminates CSO volume resulting from the 1-year storm, eliminates 12 CSO regulators for compliance with the Consent Order, and completely eliminates structural CSO discharges to Wethersfield Cove and the North Branch Park River.

The LTCP will reduce annual average CSO volume from the District's combined sewer system from almost 1 billion gallons per year in 2005 to zero in 2026, based on a typical year. Annual average CSO discharges, which currently occur about 64 times per year, will be reduced to zero during a typical year. Table ES-3 provides a summary of the CSO reductions.

Table ES-3
CWP CSO Reduction

Phase of CWP	CSO Volume in Typical Year (MG)	Reduction in CSO (MG)	% Reduction
Start of CWP *(2009 Hydraulic Model Calibration)*	974	-	-
Future Baseline Conditions *(Completion of Ongoing Projects)*	652	322	33%
Completion *(Implementation of All Recommended Improvements)*	0	974	100%

In addition to these capital expenditures, operations and maintenance (O&M) costs will be incurred to support the new facilities and to improve the performance of the sewer system annual maintenance programs including the CMOM and Interceptor Cleaning Plan programs.

Clean Water Project Costs and Schedule

Table ES-4 summarizes the current CWP costs for the total $2.1 billion program (2012 dollars). Approximately $800 million has been spent or is targeted to ongoing projects. A second referendum passed in November 2012 for an additional $800 million.

Figure ES-2 shows the implementation schedule for the proposed LTCP, SSO, and BNR projects. The LTCP improvements projects will end in 2026. The existing consent order, which has various milestone dates for the completion of projects and the elimination of the North Branch Park River and the Franklin Avenue area structural CSOs will be revised upon the adoption of the new schedule, which requires the completion of the system-wide tunnel systems prior to the completion of most of the connecting pipeline projects. The CWP cost will continue to be re-evaluated as the projects move forward through final design, and as details of the SSO improvement projects are developed.

Commitment to Meeting Regulatory Requirements

The District's Recommended Plan is designed to comply with regulatory requirements and is consistent with affordably achieving the Water Quality Standards envisioned for receiving waters within the District's service area. The District's plan to address CSO abatement has evolved into a comprehensive approach to abate CSO and reflects the District's full commitment to this environmental effort.

Consistent with the CWP mission statement, the District plans to rehabilitate and modify its 19th century sewer collection/treatment system to satisfy today's public and private needs and legal requirements. A long series of water quality improvements is expected to restore a cleaner and healthier Connecticut River and surrounding waters to meet federal Clean Water Act regulation goals by 2026.

Table ES-4
Clean Water Project Estimated Costs

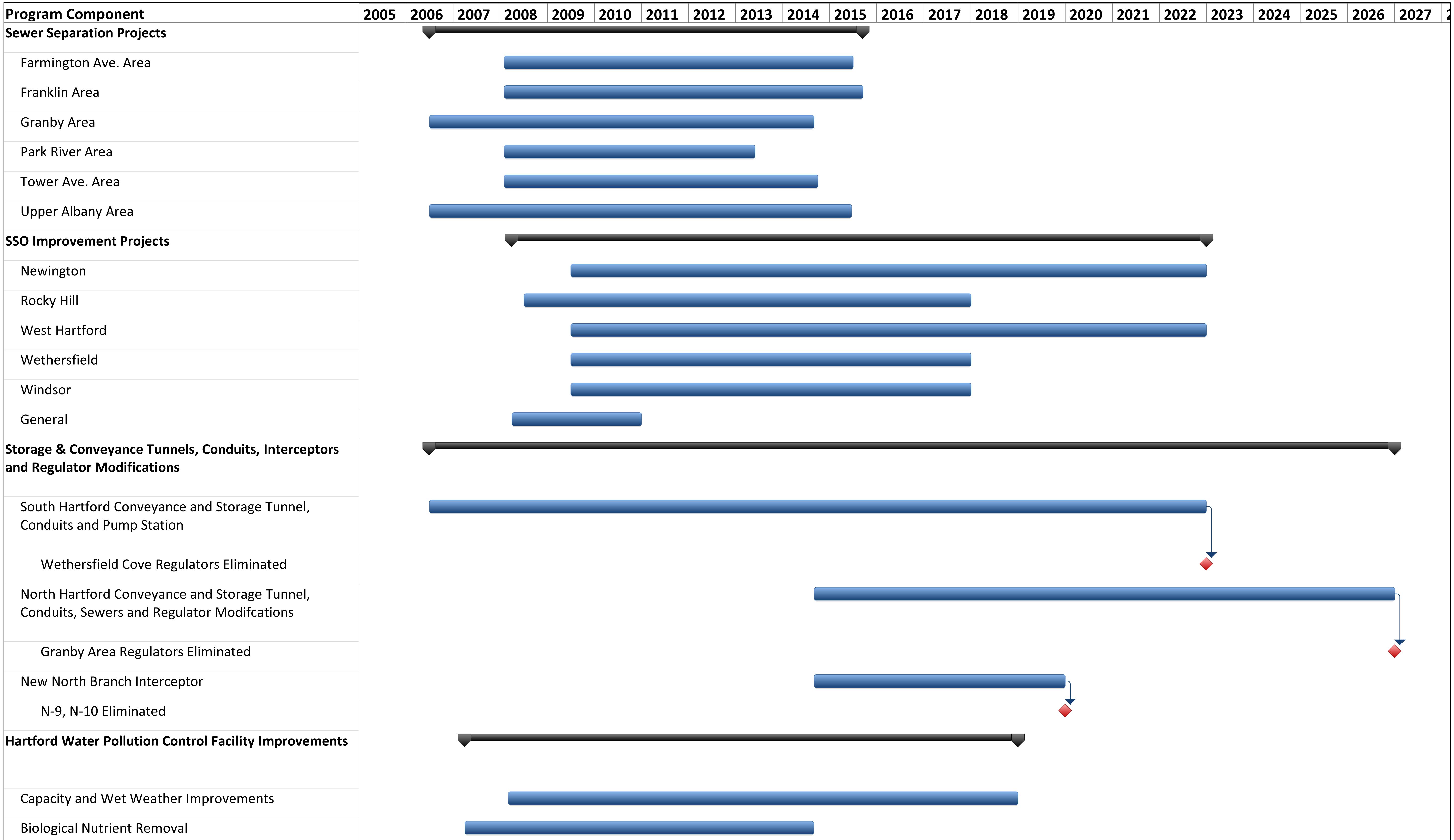
		Estimated Cost
CSO Program		
Sewer Separation Areas		
Franklin		$90,000,000
Tower		29,000,000
Granby		39,000,000
Upper Albany		53,000,000
Park River		11,000,000
Farmington		17,000,000
Consolidation Conduits		35,000,000
North Tunnel System, incl. Conduits, Interceptors and Sewers		565,000,000
South Tunnel, incl Conduits and Pump Station		500,000,000
HWPCF Improvements		489,000,000
Green Infrastructure		3,000,000
	CSO Total	$1,831,000,000
SSO Program		
General		
Sewer Rehabilitation		$128,000,000
Capacity Improvements		40,000,000
Rocky Hill WPCF		54,000,000
Consolidation Conduits to SHCST		5,000,000
	SSO Total	$227,000,000
Biological Nutrient Removal (BNR) Program		
Hartford WPCF		$42,000,000
Rocky Hill WPCF (included above)		
	BNR Total	$42,000,000
	Grand Total	**$2,100,000,000**

Notes:

1. All costs are approximate and represented in 2012 dollars. All costs will need to be confirmed pending the date of DEEP approval of the proposed projects and implementation schedule within this LTCP Update, which will likely extend the schedule of the original LTCP Update submitted in December 2012 by two years.

2. Costs include estimates for final design and construction inspection / administration.

3. Costs include contingencies as appropriate based on level of design for each project.



CDM Smith

Figure ES-2
CWP Schedule

Section 1

Introduction

1.1 Background

The Metropolitan District of Hartford (District) continues to advance their Combined Sewer Overflow (CSO) abatement and control program. The District's efforts in this regard have been ongoing since the development of the EPA's CSO Policy. In 1991, the District submitted the first of three major facility improvement plans, which addressed the EPA's Preliminary CSO Policy at that time. An $80 million Capital Improvement Plan was funded and implemented throughout the decade.

The District has developed and implemented multiple plans over the years in an ongoing effort to manage their collection systems in compliance with state and federal regulations. In October 2002, the State of Connecticut Department of Energy and Environmental Protection (CTDEEP) issued Consent Order WC 5365 requiring the District to develop and submit a number of discrete system evaluations and planning documents and to ultimately revise its CSO control plan. A substantial planning process was followed by the completion of the final document, representing an updated version of the District Long Term CSO Control Plan (LTCP), which was submitted to CTDEEP in October 2005.

Following submission of the October 2005 LTCP to address CSOs in Hartford, the District expanded their efforts to respond to CTDEEP's Water Pollution Control Facility (WPCF) nutrient removal initiatives and an EPA Consent Decree for Sanitary Sewer Overflow (SSO) elimination. Encompassing these three major focus areas, the District developed the Clean Water Project (CWP), which is the District's largest environmental program since the Commission was chartered over 75 years ago. The estimated cost of the CWP is $2.1 billion. Phase I of the CWP was approved by all eight District member towns in an $800 million referendum vote in November 2006. A second $800 million referendum vote for Phase II of the Clean Water Project was sent to the voters in November 2012 and was overwhelmingly approved.

Consistent with the CWP mission statement, the District plans to rehabilitate and modify its 19th century sewer collection/treatment system to satisfy today's public and private needs and legal requirements. A long series of water quality improvements is expected to restore the Connecticut River and surrounding waters to a cleaner and healthier status to meet federal Clean Water Act regulations by 2026. Fully implemented, the CWP will prevent CSO discharges into the District waterways for storms up to and including the 1-year storm event, as identified in the 2005 LTCP, except for in the Granby Avenue area and Franklin Avenue area where implementation of the system improvements are targeted to eliminate CSO discharges to the North Branch Park River and Wethersfield Cove.

1.2 Purpose

The Draft December 2012 LTCP report was prepared to comply with the requirements of Paragraph B.9 of Consent Order WC0005434, dated November 2006. Paragraph B.9 requires the District to provide a 5-year update of the LTCP, due by December 31, 2012, to outline the combined system improvement work completed to-date, identify the effectiveness of the program to reduce or eliminate

CSO discharges, and to recommend any CSO program modifications to meet the water quality goals. The District submitted the Draft 2012 LTCP Update on December 28, 2012.

The Consent Order requires complete elimination of CSO discharges to Wethersfield Cove and to the North Branch Park River. The draft December 2012 LTCP Update report considered system alternatives to achieve complete elimination of the CSO discharges to these specific receiving waters using a May 1989 storm with an estimated average return interval (ARI) of 18-years. This approach for CSO control was based on the 2004 Wethersfield Cove CSO Alternatives Evaluation study where stakeholders involved in the study interpreted complete elimination of CSO discharges into the cove as the 18-year storm control objective. Upon review of the draft December 2012 LTCP Update, CTDEEP has stated that the agency could not approve this control approach (to the 18-year control objective) as it would not achieve complete elimination (i.e., outfall closure by brick and mortar) of the structural CSO regulator discharges to Wethersfield Cove and the North Branch Park River.

Accordingly, per CTDEEP's approval requirements, the District completed further evaluation of system alternatives that would achieve complete elimination (i.e., no discharges) of the structural CSO regulators to Wethersfield Cove and the North Branch Park River. This revised December 2014 LTCP Update report addresses CTDEEP approval requirements (and all other agency comments). Section 11 summarizes the system alternatives evaluated for complete elimination of the CSO regulators that discharge to the North Branch Park River and Wethersfield Cove.

There have been significant program changes to the LTCP since 2005, including the removal of the Park River Auxiliary Conduit (PRAC) as a CSO tunnel storage option, a shift of the North Tunnel to pick up more CSO discharges, and the inclusion of a new deep rock South Hartford Tunnel to address the system-wide CSO and SSO system storage requirements. Treatment and capacity improvements continue to be implemented at the Hartford Water Pollution Control Facility (HWPCF) and the SSO program continues to evolve. In addition, the Stormwater Management Model (SWMM) of the combined sewer system was updated between 2009 and 2011 with new flow monitoring data. Finally, the District has gained valuable experience in implementing some of the 2005 LTCP recommended local sewer separation projects. Accordingly, with this LTCP Update report, the District intends to modify the CWP to incorporate this direct construction experience and additional system knowledge and to continue its effort to develop a cost-effective approach for CSO mitigation.

1.3 General Definitions

The following terms, which are defined below, are crucial to the District's LTCP.

1-Year Design Storm shall mean the design storm used to control all CSO regulators except those that discharge to the North Branch Park River or Wethersfield Cove. The storm is an historic event from October 1951 with a 24-hour depth of 2.4 inches and an ARI of 1 year.

Adit shall mean the connecting tunnel from the bottom of a tunnel drop shaft to the main tunnel storage system.

Consolidation pipe shall mean a new pipe that conveys a portion of the excess wet weather flow from a CSO regulator to either a tunnel storage system or a satellite CSO storage/treatment facility.

Complete Elimination (or elimination) of a CSO shall mean physically closing a CSO regulator (via bricks and mortar) after construction of the CSO system improvements.

CSO Outfall shall mean the permitted (via the National Pollutant Discharge Elimination System program) point of discharge at which combined sewer overflow enters a receiving water.

CSO Regulator shall mean a structure that directs excess wet weather flow from the combined sewer system into a receiving water or the drainage system. The CSO regulator is a designed device to relieve the combined sewer system. All CSO names in this report (e.g., N-2, S-3, etc.) refer to CSO regulators.

Future Baseline Model shall mean the hydraulic model representing the improved system-wide condition if all of the ongoing construction projects in the combined sewer system were completed. The Future Baseline Model also includes the completion of the HWPCF wet weather improvements project, which will allow HWPCF to provide up to 200 million gallons per day (mgd) of peak flow treatment capacity during storm conditions. Section 4.7 provides details of the Future Baseline Model.

New combined sewer shall mean a new pipe (of a larger diameter) constructed to replace existing infrastructure to provide additional conveyance capacity.

Relief pipe shall mean a pipe constructed (hydraulically parallel to the existing pipe) to provide increased conveyance capacity or in-line storage. Relief pipes supplement existing infrastructure and convey flow back into the existing collection system, not to a new facility.

SSO Design Storm shall mean the storm used to control the discharges from structural SSO regulators for the EPA Consent Decree. The storm is an historic event from April 2007 and has been characterized as a storm event with a 25-year ARI.

Tunnel drop shaft shall mean the connection point to the tunnel storage system. Tunnel regulators will direct combined sewer flow to tunnel drop shafts via the tunnel regulator outlet pipe or via new consolidation pipes.

Tunnel Regulator shall mean a structure that directs excess wet weather flow from the sewer system directly to the tunnel storage system.

Tunnel regulator outlet pipe shall mean the pipe connecting a tunnel regulator to a consolidation pipe or a tunnel drop shaft.

Tunnel storage system shall mean CSO and SSO storage provided by deep rock tunnels.

Typical Year shall mean the historical precipitation record from 1976. The typical year was selected in the 2004 Baseline Conditions study using the long term rainfall record at Bradley International Airport. The selection followed the approach described by the EPA's "Combined Sewer Overflows Guidance for Monitoring and Modeling" (USEPA, 1999), which includes analyzing individual storm event return periods, annual precipitation, and simulated CSO volume for each year in the historic record to find a representative typical year.

Wethersfield Cove/North Branch Park River Design Storm (WC/NBPR Design Storm) shall mean the design storm used to compare alternatives for controlling CSO regulators that currently discharge to the North Branch Park River or Wethersfield Cove. This storm is an historic event from May 1989 with 4.9 inches of rain in 17 hours and peak hourly intensity of 1.48 inches and an 18-year ARI. The 2004 Wethersfield Cove Study provided the basis for the selection of this storm. It is important to note that the recommended plan includes complete elimination of the CSO regulators that discharge to the

North Branch Park River and Wethersfield Cove; this design storm only provides the basis for the alternatives analysis cost comparison.

1.4 The District

The District owns and operates a combined sewer system located primarily in the city of Hartford with minor areas of West Hartford. This system dates back to the 19th century, when it was believed that dual-purpose pipes (for sewerage and stormwater conveyance) would result in more manageable and cost-effective collection systems. While the pipes were originally sized to carry both sewage and stormwater, intense storm events have historically taxed the capacity of the District's interceptors and the wastewater treatment facility, which cannot handle the large wet weather flow from the combined sewer system.

The District, chartered by the Connecticut General Assembly in 1929, provides potable water supply and sewerage services on a regional basis. As shown in Figure 1-1, there are eight member communities in the District: Bloomfield, East Hartford, Hartford, Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor.

Six of the eight member communities contribute flow to the Hartford collection system for conveyance to the HWPCF, which was originally built in 1938 to provide primary wastewater treatment, and expanded in 1969 to provide secondary treatment. These six communities include all of the Hartford, all of the West Hartford, most of the Bloomfield and Newington, and portions of the Wethersfield and Windsor sewer systems.

The District also operates sewage collection and treatment facilities in Rocky Hill, East Hartford and the Poquonock area of Windsor. These areas have separate water pollution control facilities, owned and operated by the District, that do not contribute flows to the combined sewer system in Hartford. The Poquonock Water Pollution Control Facility, located in Windsor, treats flow from the northern and western portions of Windsor. The East Hartford Water Pollution Control Facility treats all the flow for East Hartford. The Rocky Hill Water Pollution Control Facility treats all of the flow from Rocky Hill and a portion of Wethersfield.

Hartford and some small portions of West Hartford are the only member communities with combined sewers. However, wet weather flow responses from other member communities have an effect on CSOs located in Hartford. Also, as the District's CSOs are ultimately discharged to the Connecticut River, multiple downstream communities are affected by them.

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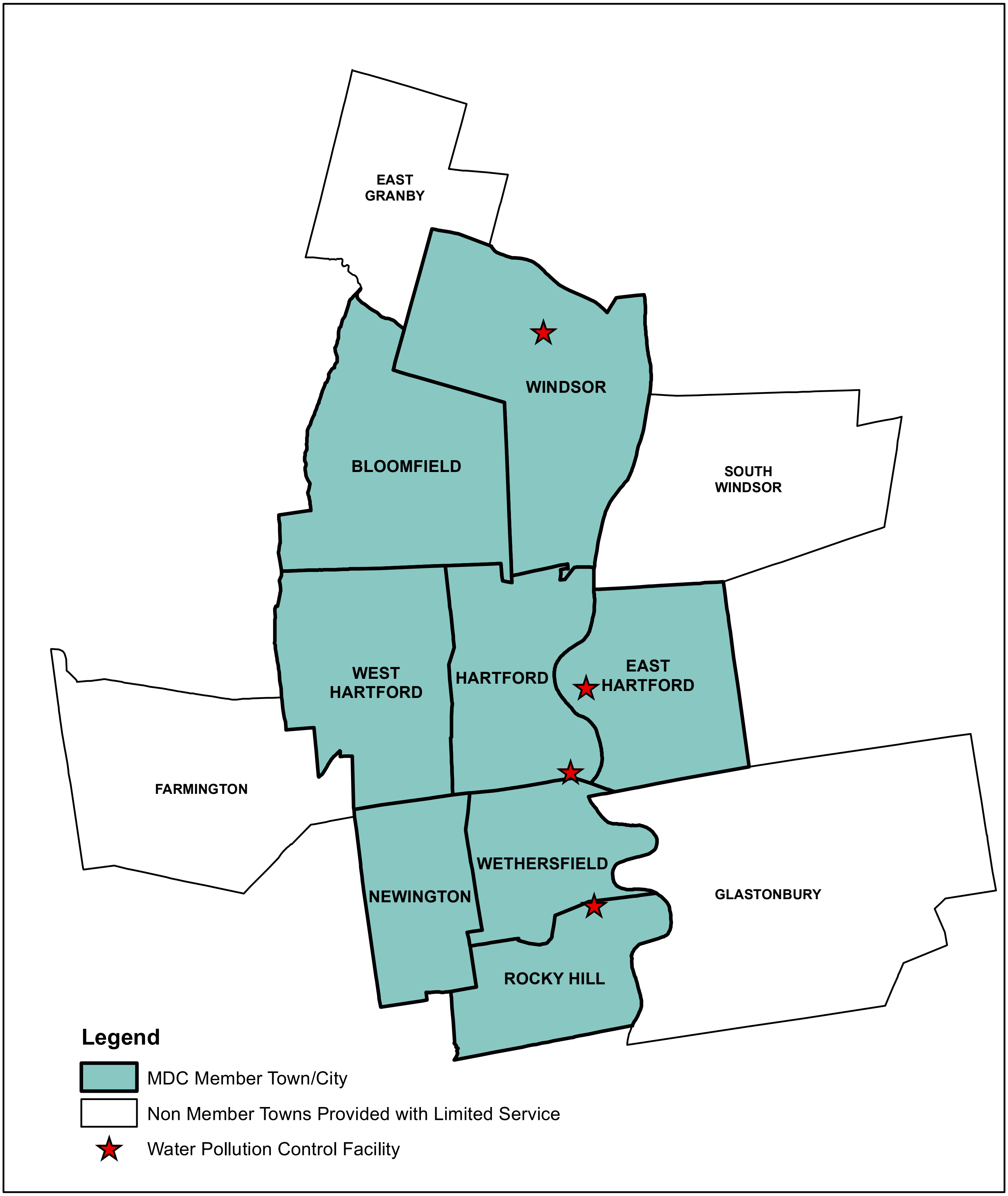

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 1-1
Greater Hartford MDC Service Area

1.5 LTCP Update Approach

The LTCP Update approach was developed to incorporate ongoing program modifications for mitigation of CSO and SSO discharges, updated information on system surcharge problems, recent experience in construction projects, updated system CSO flow and volume information from the SWMM model, and cost-effective approaches to best utilize the recommended tunnel storage system that has evolved from the various regulatory compliance requirements. The overall objectives for CSO control are unchanged, i.e., 1-Year Design Storm for most of the system and elimination of CSO discharges to the North Branch Park River and Wethersfield Cove.

This LTCP Update is focused on optimizing the ongoing CSO abatement program. The SSO program update will be the subject of a separate document. The LTCP Update is not intended to be another comprehensive review of the large matrix of CSO abatement strategies that could potentially be applied in the District system. This review was completed in the 2005 LTCP and the applicability of the selected CSO mitigation strategies for the District has not changed. The intent of this report is to evaluate LTCP program modifications that would integrate well with the use of tunnel storage and meet the District objectives for control of its CSO discharges while minimizing the lifecycle cost of improvements and the financial impact to its member towns.

1.6 Report Organization

This report is divided into twelve sections. The early sections of the report provide a description of the combined sewer conveyance and treatment system and the program improvements completed to-date. The middle sections discuss the current characterization of the system based on the updated computer model used to assist in the analyses. The latter sections of the report provide a summary of the current tunnel storage approach, and an evaluation of the alternatives considered to incorporate control of the various CSO discharges into the tunnel storage plan, and a presentation of the recommended plan, costs and implementation schedule.

Section 2

Combined Sewer System

2.1 General

Well into the 20th century, combined sewer systems (CSS), such as the one constructed in Hartford, were the nationally accepted engineering standard for sewage conveyance systems in older communities in the United States (especially in the Northeast). Efficient use of pipes for dual-purpose conveyance (sewerage and stormwater) meant cost-effective and more manageable collection systems at that time.

The District's CSS is over 100 years old and is located primarily in Hartford, with a small portion in West Hartford. In addition to serving Hartford and West Hartford, the CSS collects separate sanitary flows from the neighboring communities of Windsor, Bloomfield, Newington, and Wethersfield. While these neighboring sewer systems were constructed as separated sanitary sewer systems, they contribute significant wet weather flow into the Hartford CSS, which reduces the overall capacity of the Hartford system to convey and treat its own wet weather flows.

This section discusses the current operation of the combined sewer conveyance system. Section 4 discusses the system modifications that have been completed or will be completed as part of the ongoing sewer system improvements. Section 5 discusses the modifications to the HWPCF that are being implemented as part of the LTCP.

2.2 Combined Sewer System (CSS)

As shown on Figure 2-1, the District's CSS is a network of collection pipes with flow contributions from neighboring communities and interconnected systems within the city. Seventeen major interceptors collect combined sanitary and stormwater flow from numerous trunk sewers, and convey the flow to the HWPCF, located along the Connecticut River in the southeast corner of the city. In general, most of the city is serviced by combined sewers. However, there are some storm sewers located in each of the seven drainage areas, depicted in blue on Figure 2-1.

The existing system has about 5,000 acres of combined sewer system, thirty-eight CSO outfalls, forty-one backwater flood gates, seventeen major interceptors, 220 miles of combined pipe, thirty-three siphons, and more than 6,000 catch basins.

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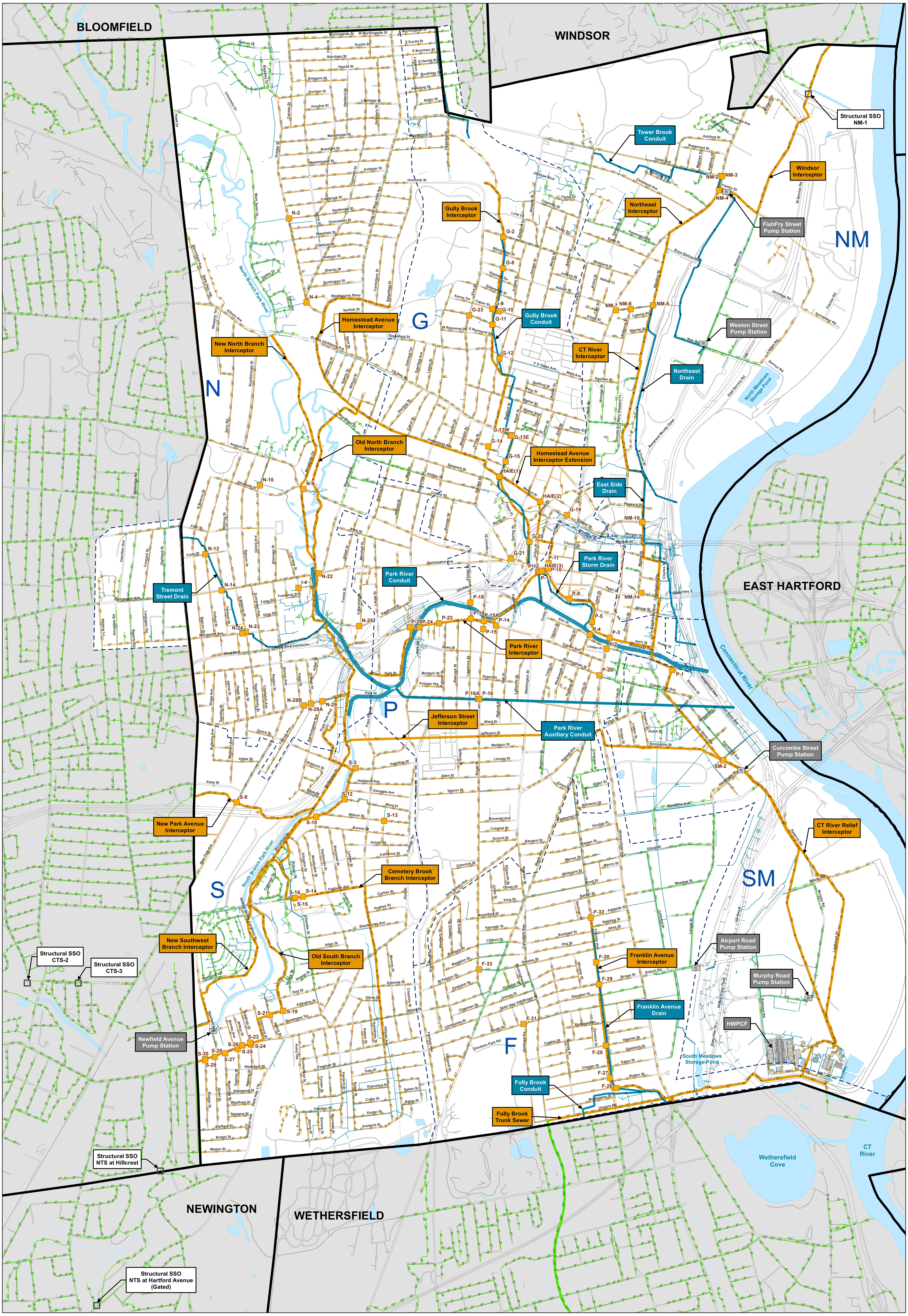

CDM Smith
MDC

Legend
- Combined Sewer Interceptor
- Combined Sewer
- Major Storm Drain
- Storm Drain
- Sanitary Sewer
- Drainage Area
- Pump Station

Regulators
- CSO
- SSO

0 1,000 2,000 Feet

N S E W

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 2-1
Existing Combined Sewer System

2.2.1 Flow from Hartford

The HWPCF has a daily average flow rate of approximately 56 million gallons per day (mgd) based on records for the last three years. This value fluctuates from year to year based on weather patterns and groundwater conditions. During storm events, wet weather flow rates can often exceed 110 mgd. Flow in the District's CSS is comprised of both sewage and stormwater. Hartford's sewage is predominantly domestic, with some commercial and industrial wastewater contribution.

Inflow and infiltration (I/I) also contribute a substantial amount of flow to the CSS. Two major inflow sources in Hartford were Gully Brook and Tower Brook (continuous surface streams), which both discharged directly to the CSS. Tower Brook was removed from the system in 2006 and Gully Brook should be removed by the end of 2015. Other significant sources of wet weather flow in the combined sewer system include public inflow from street drainage and private inflow from building roof leaders and sump pumps located throughout the District's system.

Infiltration, or groundwater that seeps into the sewers, commonly occurs where there are loose joints, broken pipe sections, or root intrusion. Infiltration can also add a considerable amount of excess flow to a collection system, especially in areas with high groundwater tables. From 2005 through 2013, the District has lined over 750,000 linear feet of pipe to reduce infiltration in the system; mostly in the member communities of Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor.

2.2.2 Flow from Neighboring Communities

The District's CSS receives flow from Hartford as well as the following bordering communities: Bloomfield, Newington, West Hartford, Wethersfield, and Windsor. With the exception of the East Ridge system in West Hartford, these neighboring communities have separate sewage and stormwater collection systems. However, these communities discharge significant volumes of I/I to the District's CSS, which uses system capacity and therefore contributes to CSOs.

There are five structural SSOs, from these communities, that could be incorporated into the CSO control plan improvements:

- Flow from Windsor enters the CSS from the northeast through the 33-inch Windsor Interceptor, which delivers flow to the Fishfry Pump Station as shown on Figure 2-1. SSO NM-1 is located along the Windsor Interceptor, in Hartford at the Windsor border, and regulates excess wet weather flow from Windsor. The Fishfry Station pumps the flow into the Northeast Interceptor, which conveys it to the Connecticut River Interceptor.

- From the west, the Hartford CSS receives flow from West Hartford at multiple locations. The major connection point is the 48-inch Center Trunk Sewer, which flows from West Hartford into the 57-inch New Southwest Branch Interceptor with excess wet weather flow from West Hartford controlled by the SSO regulators CTS-2 and CTS-3, as shown on Figure 2-1.

- The 42-inch Newington Trunk Sewer conveys flow from Newington through the southeast corner of West Hartford and flows north into the New Southwest Branch Interceptor, with excess wet weather flow controlled by the SSO NTS at Hillcrest Street (shown on Figure 2-1) and the gated NTS control structure at the Hartford Avenue siphon.

Collectively, flows from the neighboring communities comprise nearly 25 percent of the total dry weather flow conveyed to the HWPCF. Wet weather responses are also significant. Inflow from West Harford and other neighboring communities accounts for approximately one-third of the wet weather flow that is conveyed to the HWPCF under typical conditions. This wet weather flow uses up capacity in the combined sewer interceptor system and therefore contributes to CSOs.

2.2.3 Description of Tributary Areas in the CSS

The city of Hartford is divided into seven drainage areas, all of which have combined sewers. The drainage areas, shown on Figure 2-1 are:

- North Branch Park River;
- South Branch Park River;
- Gully Brook;
- Park River;
- Franklin Avenue;
- North Meadows; and
- South Meadows.

In general, the drainage areas are named for their respective receiving water body with the exception of the Franklin Avenue area, where Folly Brook (and ultimately Wethersfield Cove) is the receiving water body, and North and South Meadows, where the Connecticut River is the receiving water body. Predominantly, stormwater throughout the drainage areas is collected by the CSS for conveyance and treatment at the HWPCF. However, if flows exceed system capacity, overflows occur and CSOs discharge to receiving waters.

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2.2.4 Major Interceptors in Hartford

There are seventeen major interceptors in Hartford with multiple collector sewers. These interceptors, as well as their tributary areas, downstream connector interceptors, and overflow receiving waters, are listed on Table 2-1 and shown on Figure 2-1. Eventually, all sewers converge into three main interceptors that convey flow to the HWPCF. These are the Connecticut River Interceptor (CRI), the Connecticut River Relief Interceptor (CRRI), and the Franklin Avenue Interceptor (FAI).

The CRI originates in the North Meadows drainage area as the Northeast Interceptor, collecting flow from Main Street and Tower Avenue, and the Windsor Interceptor (via the Fishfry Street Pump Station). The CRI also receives significant flow from the Park River Interceptor, and local flow from smaller collector sewers. There are multiple CSO regulators along the CRI that discharge to the Connecticut River.

The CRI passes through the Masseek Street Gate Chamber, a junction chamber constructed to consolidate flow from the Jefferson Street Interceptor and the CRI, and discharges directly to the HWPCF. The Masseek Street Gate Chamber also provides a relief point for the collection system, where wet weather overflows discharge to the Connecticut River. It also allows the District to control the flow entering the HWPCF via sluice gates that can be closed in case of an emergency at the treatment facility.

The CRRI was installed between the Masseek Street Gate Chamber (CSO regulator SM-2 on Figure 2-1) and the HWPCF in the early 1990s to increase flow to the HWPCF. Installation of the CRRI reduced CSS overflow frequency and volume system-wide. Exiting the chamber from the south, the CRI and the CRRI continue on to the treatment facility. Between Masseek Street and the HWPCF, both the CRI and the CRRI are 78-inches in diameter.

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Table 2-1
Major Sewer Interceptors and Receiving Waters in Hartford

Drainage District	Interceptor	Receives flow from...	Connects to...	Overflows to...
North Branch Park River (N)	Old North Branch Interceptor (ONBI)	"N" drainage area sewers	NNBI	North Branch Park River, Homestead Avenue Interceptor
	New North Branch Interceptor (NNBI)	ONBI, Bloomfield Trunk Sewer, OSBI	Jefferson Street Int.	North Branch Park River
	Homestead Avenue Interceptor	Granby Street Trunk Sewer	Homestead Avenue Interceptor Extension	Park River Conduit and Gully Brook Conduit
South Branch Park River (S)	Old South Branch Interceptor (OSBI)	Cemetery Brook Branch Interceptor	NSWBI, NNBI	South Branch Park River
	New Southwest Branch Interceptor (NSWBI)	Oakwood Avenue Int., OSBI, New Park Avenue Interceptor	Jefferson Street Interceptor	South Branch Park River
	New Park Avenue Interceptor	West Hartford sewers	NSWBI	Kane Brook
	Cemetery Brook Branch Interceptor	"S" drainage area sewers	OSBI	Cemetery Brook Conduit
	Jefferson Street Interceptor	NNBI, NSWBI, Hartford Hospital	CRI, CRRI	Connecticut River
Gully Brook (G)	Gully Brook Interceptor	Blue Hills Trunk Sewer	Park River Interceptor	Gully Brook Conduit, Park River Conduit
	Homestead Avenue Interceptor Extension (HAIE)	Homestead Avenue Interceptor	Park River Interceptor	Gully Brook Conduit, Park River Storm Drain
Park River (P)	Park River Interceptor	Nook Farm Sewer, Gully Brook Interceptor, Homestead Avenue Interceptor Extension, Union Place Sewer, "N" & "P" drainage area sewers	CRI	Park River Conduit
Franklin Avenue (F)	Franklin Avenue Interceptor	"F" drainage area sewers, Folly Brook Interceptor	HWPCF	Connecticut River, Folly Brook (to Wethersfield Cove)
	Folly Brook Trunk Sewer	Wethersfield sewers	Franklin Avenue Interceptor	Folly Brook (to Wethersfield Cove)
North Meadows (NM)	Windsor Interceptor	Windsor sewers, Meadow Brook Trunk Sewer, Deckers Brook Trunk Sewer, Island Road Pump Station	Northeast Interceptor	Meadow Brook
	Northeast Interceptor	Windsor Interceptor (Fishfry Pump Station)	CRI	Tower Brook, Connecticut River
	Connecticut River Interceptor (CRI)	Main Street & Tower Avenue sewers, Northeast Interceptor, Park River Interceptor, Jefferson Street Interceptor	HWPCF	Park River Conduit, Connecticut River
South Meadows (SM)	Connecticut River Relief Interceptor (CRRI)	Jefferson Street Interceptor, CRI	HWPCF	Connecticut River

The FAI is the last of the three main lines that connect flow to the HWPCF (though this pipe is small in comparison to the CRI and CRRI) This interceptor collects flow from the Franklin Avenue drainage area and has multiple CSO regulators that discharge into the Franklin Avenue storm drains that discharge to Wethersfield Cove. Downstream of the Franklin Avenue area, the 30-inch Folly Brook Interceptor, which collects sanitary flow from Wethersfield and conveys it north into Hartford, merges into the FAI. The FAI continues after this flow merge directly to the HWPCF.

The approximate breakdown of annual average flow to the HWPCF is about 12 percent from FAI and 44 percent each from both the CRI and CCRI.

2.2.5 Overflow Regulators

The CSS has a number of CSO regulators and SSO regulators. The purpose of these structures is to regulate internal system flow (or head) and relieve excess flow in order to avoid manhole surcharge or flooding in the system. CSO regulators direct excess flow from a combined sewer pipe to a storm pipe or receiving water. SSO regulators direct excess flow from a separated sewer pipe to a storm pipe or receiving water. The CSO regulators are the primary concern of this study.

CSO regulators in the CSS take several different forms, ranging from automatic devices (weirs, raised outlet pipes, float-operated gates, etc.) to mechanical devices that require the conscious actions of an operator to initiate a system release.

Historically, CSO regulators were also installed as a safety device for hydraulic or mechanical CSS features such as siphons and pumping stations. Each District pumping station had an emergency overflow or bypass pipe at the station or at an upstream point in the CSS – these emergency overflow regulators are either removed or the control gates are closed (and only opened manually in the event of a catastrophic storm). Almost every siphon in the CSS has at least one, but often two (upstream and downstream), hydraulic relief mechanisms. Many CSO regulators have sluice gates or valves that are kept closed, but remain available as an emergency relief measure and can be opened if needed.

There are currently a total of 85 CSO regulators in the existing system that discharge through thirty-eight CSO outfalls; see Figure 2-1 for the locations of the CSO regulators. The 85 regulators include three additional CSO regulators from the Homestead Avenue Interceptor Extension project: two in the Gully Brook area (G-17A and G-17B) and one in the Park River area (P-11A). The regulator count does not include regulators that have been completely eliminated to-date through current projects, including P-11 and G-14. Table 2-2 summarizes the regulators in each sewer district.

The District has a regular maintenance and inspection program for all CSO and SSO regulators and gates. The District also installed an Overflow Alarm and Monitoring System, which continually measures depth at the 83 active CSO and all active SSO regulators (Note: the G-13E and G-13W are monitored as one system and I-4 is not monitored. See Section 12 for more discussion on CWP post-construction compliance monitoring). This system is an excellent tool for monitoring the operation of the CSS and helping to diagnose surcharge issues. The meters can identify when an overflow occurs by measuring depth of flow compared to the height of the weir or overflow pipe. The majority of the meters were installed in 2002, with additional monitoring sites added more recently to monitor structural SSO regulators in West Hartford, Newington and Windsor (CTS-2, CTS-3, NTS at Hillcrest, and NM-1). The District also added

Table 2-2
Summary of CSO Overflow Regulators in Hartford

Sewer District	Active
Gully Brook CSO regulators	15(2)
Park River CSO regulators	21(1)
North Branch Park River CSO regulators	14
South Branch Park River CSO regulators	18
Franklin Avenue CSO regulators	8
South Meadows CSO regulators	1
North Meadows CSO regulators	8
Total	**85**

Notes:

1. P-11 in the Park River area was completely eliminated with the installation of the HAEI and is not included in this total.
2. G-14 in the Gully Brook area was completely eliminated with the Burton Street Sewer Separation Project and is not included in this total.

permanent depth and velocity meters at twelve sites in 2008 to continuously measure flow entering Hartford from the major sewer lines in the neighboring communities, including West Hartford, Newington, Windsor, Bloomfield, and Wethersfield.

2.2.6 Pumping Stations

There are 72 wastewater pumping stations throughout the District service area, of which 27 are tributary to the CSS in Hartford. Six pumping stations are located directly in Hartford - Airport Road, Curcombe Street, Fishfry Street, Murphy Road, Newfield Avenue, and Weston Street –and are shown on Figure 2-1.

All 27 of the pumping stations located within the District's CSS tributary area have emergency power connections, and 20 of the stations have on-site emergency generators. In the event of a power outage, stations without an on-site emergency generator have wet well capacities ranging from one to three hours, which allows crews adequate time to respond with mobile generators.

2.2.7 Operational Considerations

2.2.7.1 Hartford Water Pollution Control Facility Wet Weather Capacity

The HWPCF was originally built in 1938 to provide primary treatment to system flow, and was expanded in 1969 to provide secondary treatment. Preliminary treatment (screening and grit removal) was upgraded in 1986. Another expansion took place in 1994, to provide primary treatment and disinfection for wet weather flows.

The wet weather capacity of the facility is about 140 mgd. When the influent flow rate exceeds 90 mgd, HWPCF operators can divert excess flow to a wet weather storage/treatment basin by activating the wet weather pumping station.

Section 5 provides further discussion of the wet weather operation of the HWPCF and the proposed improvements to increase wet weather treatment capacity.

2.2.7.2 Interceptor Sediments

Over time, grit and other solids have accumulated in many pipes in the District's CSS. This is typical in combined sewer systems that are capturing street runoff and are operated under surcharge conditions (when flow velocities are very low and sediment may settle in the pipe). In addition, Gully Brook and Tower Brook were surface streams that entered the sewer system and may have historically contributed significant sediment quantities to the CSS over the years. Tower Brook is now disconnected from the sewer system and Gully Brook will soon be disconnected.

Keeping sediment out of the CSS as a preventative measure is much more cost-effective than cleaning the pipes. More frequent street sweeping would benefit the CSS by removing sand and other material before it is captured in the piping system. However, street sweeping is performed by the city of Hartford and is not controlled by the District.

Since 2009, the District has renewed its efforts to maintain the piping system by the implementation of a comprehensive sewer and interceptor cleaning program. Details of this program are discussed further in Section 4.

It is anticipated that CSS hydraulic characteristics (flow patterns, pipeline velocities, and even sediment loading) will improve as ongoing interceptor extensions, brook disconnections, consolidation pipes, sewer separation, CSO conveyance tunnels and conduits, and the HWPCF Influent Pump Station and Headworks projects (reducing the interceptor surcharge conditions) are completed within the next several years.

Future CSS changes such as the deep rock storage tunnel, consolidation pipes and tunnel drop shafts will also impact sediment accumulations. Sediment deposition at some level will likely always be a maintenance consideration in the CSS, but the locations where sediment may fall out of suspension will shift and change over time as the hydraulics of the CSS are improved or modified by the CWP.

2.3 Flood Control Measure Constraints

Hartford faces flooding risks from both the CSS and the Connecticut River. Rain events that coincide with high river elevations (during river flood events) impact the ability of the CSS to discharge CSO flow by gravity. The District system is equipped with a complex system of diversion structures, flow control and secondary overflow weirs, and pump stations that are required to discharge excess sewer flow to the stormwater system and receiving waters during high river conditions. The city of Hartford is responsible for operations and maintenance of the drainage and flood protection system in the city.

The U.S. Army Corps of Engineers (USACOE) constructed several large scale flood control projects in Hartford to protect the city against high river flow. USACOE constructed the Park River Conduit to help relieve flooding within the city and confine river flows underground. The District's CSO regulators discharge to the Park River Conduit as it flows through the center of the city. The USACOE also built the Park River Auxiliary Conduit, a deep conveyance tunnel designed to provide flood protection against high river elevations (100 year flood level) and large storm events (greater than a 400 year return period). To protect the city from the Connecticut River, the USACOE installed an earthen dike along the river bank.

There are several stormwater storage ponds and storm drains throughout Hartford that receive CSO discharges, including the North and South Meadows Storage Ponds, the East Side Storm Drain, and several other drains. These drains and ponds typically discharge to the Connecticut River by gravity but each storm facility also has a pumping station to allow discharges during high river stages.

Each storm drain outfall is equipped with gates as an additional flood control measure. Typically, an outfall will have both a backwater flap gate and a sluice gate. During low river stage, sluice gates are kept open and flap gates allow storm flows out of the system. During rising river stages, the backwater gates typically prevent river flow into the storm drain system. The District has the responsibility of checking the backwater gates for leakage, and then closing sluice gates if the backwater flap gate is letting river water back into the storm outfall or CSS. Each outfall is tracked by Flood Control Procedures, which is a manual that contains explicit instructions as to which gates need to be closed, and at what critical river stage. To help monitor river stage, District dispatchers regularly check and record the level from the remote level sensor mounted on the Bulkeley Bridge. There is also a river gauge at the HWPCF.

2.4 CSO Receiving Waters and Water Quality Goals

Hartford's CSO regulators discharge to receiving waters around the city. The ultimate receiving water for all discharges is the Connecticut River, but several smaller water bodies are also affected, including:

- Folly Brook, which receives CSO flows from the Franklin Avenue area and discharges into the Wethersfield Cove;
- Meadow Brook and Tower Brook, which receive CSO flows from the North Meadows area;
- Gully Brook, which receives CSO flows from the Gully Brook area; and
- Cemetery Brook and Kane Brook, which receive CSO flows from the South Branch Park River area.

All branches of the Park River are also affected. The North Branch is impacted by CSO flow from a variety of stormwater conduits and drain lines. The South Branch is impacted by CSO flows from Kane Brook, the Cemetery Brook Conduit, and the 48 inch New Britain Avenue Storm Drain. The main branch of the Park River (Park River Conduit) has CSO discharges from the Gully Brook Conduit, the Park River Storm Drain, the North and South Park River branches, and the Southeast Storm Drain. The Park River Auxiliary Conduit gets CSO overflow from two regulators (P-16 and P-16A), as well as excess flows from the North and South Park River Branches.

Connecticut classifies surface water bodies according to water quality and designated uses. Table 2-3 shows the classifications from AA to SB, as well as the designated uses (obtained from the CTDEEP's Water Quality Standards and Classifications document dated February 25, 2011).

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Table 2-3
Inland Surface Water Quality Classifications and Designated Uses

Class	Designated Uses
AA	Existing or proposed drinking water supplies; habitat for fish and other aquatic life and wildlife; recreation; and water supply for industry and agriculture.
A	Habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; navigation; and water supply for industry and agriculture.
B	Habitat for fish and other aquatic life and wildlife; recreation; navigation; and industrial and agricultural water supply.
SA	Habitat for marine fish, other aquatic life and wildlife; shellfish harvesting for direct human consumption; recreation; industrial water supply; and navigation.
SB	Habitat for marine fish, other aquatic life and wildlife; commercial shellfish harvesting; recreation; industrial water supply; and navigation.

Note: The "S" designation before the classification is used to denote coastal waters, which includes freshwater bodies that are tidally influenced, such as the Connecticut River and Wethersfield Cove.

Current classifications for major receiving water bodies for the District CSO regulators are listed in Table 2-4. These water bodies are shown on Figure 2-1.

Table 2-4
Water Quality Classifications

Water Body	Current Classification
Folly Brook	A
Kane Brook	A
North Branch Park River*	A
Connecticut River	SB
Park River	B
South Branch Park River	B
Wethersfield Cove	SB

All of the water bodies listed in Table 2-4 are currently affected by CSOs and, as a result of bacteria loading caused by CSOs, many have C classifications. The Connecticut River, the Park River, and the North Branch Park River and South Branches Park River are on the state 303(d) list. These water bodies are not expected to meet water quality standards after implementation of technology-based controls or best management practices. These water bodies require total maximum daily loads (TMDLs) to be developed to identify daily pollutant loading limits, which may eventually enable these water bodies to meet standards in the future through appropriate allocation of loads.

The Park River is contained in a conduit, as are portions of the South Branch Park River, the North Branch Park River, and Folly Brook. Access to these water bodies is therefore very limited, which eliminates recreational uses, and the conduits do not provide natural habitat for fish or other aquatic wildlife.

Other water bodies, such as the Connecticut River and Wethersfield Cove, are regularly used for boating, fishing, and other types of recreation. In recent years, several studies have been published on water quality in the Connecticut River. While pollutants remain a problem in the river, the overall water quality has shown signs of improvement.

Based on these water quality standards and goals, the input of the Citizens Advisory Committee (created for the LTCP review), and the requirements of the Consent Decree, the District is committed to the goal of completely eliminating CSO regulators that discharge to the Class A open water surfaces of the North Branch Park River (CSO regulators N2, N4, N9 and N10); Wethersfield Cove (all Franklin area CSO regulators); and Kane Brook (CSO regulator S-8).

For the remaining CSO regulators in the system, the District adopted a 1-year control level. This applied to the CSO discharges in the city to the South Branch Park River and the Connecticut River, and to the conduits that convey portions of the South Branch Park River, North Branch Park River, Tower Brook, Gully Brook and Park River. The 1-year level of control for all CSO regulators that do not discharge to the North Branch Park River and Wethersfield Cove was accepted by CTDEEP in its approval of the 2005 LTCP.

Section 3

2009/2011 CSS Model Update

3.1 Introduction

The District has developed various sewer models of its collection system since the 1980s to guide facilities planning for control of untreated wet weather discharges and compliance with regulatory requirements. The 2005 LTCP was based on a model updated between 2003 and 2005 that assembled the various models into a single integrated model and refined model details for improved representation of the system. This model was calibrated to 2003 flow monitoring data. Between 2006 and 2009, the District authorized development of sanitary sewer models for West Hartford, Newington, Windsor, Wethersfield, and Rocky Hill for SSO control planning.

The most recent comprehensive model update was completed between 2009 and 2011. This update integrated the most up-to-date models and information available at the time for Hartford's combined sewer system and the SSO communities. The model was initially calibrated to meter data collected in spring of 2009. In 2011 additional meters were deployed in the Franklin Avenue area for more detailed calibration of the model in support of the sewer separation designs being completed in this drainage district.

This LTCP Update is based on the 2009/2011 model. This new model reflects more current baseline conditions and incorporates the existing sanitary sewer models that drain to the HWPCF: West Hartford, Newington, Windsor, and Wethersfield's Folly Brook sewershed. The updated model also includes 36-inch and larger storm drains in Hartford, Hartford's flood control pumping stations, a moderately detailed representation of the entire Park River system, and a portion of Bloomfield's sewers. Figure 3-1 shows the pipes and areas included in the updated model. This model was used to refine CSO and SSO discharge estimates under current conditions and for analysis of alternatives under the current LTCP update.

This section provides a brief overview of the model, and presents updated estimates of baseline CSO and SSO discharge characteristics. Additional detail is provided in the July 2011 Hartford Model Update and Baseline Conditions Report. In sum, the current model used for this 2012 LTCP Update is a highly sophisticated, georeferenced tool that provides a nearly complete water balance, meaning that nearly all water is accounted for in the system, whether it ends up in the sewer, storm drain, river or ground. The model was developed, calibrated and validated based on an extensive array of data, and capitalizes on the power of scenario management and control rule capability in the MikeUrban software platform. It has proven to be a valuable tool for simulating system conditions and evaluating alternatives for the control of overflows in the wide range of extreme design events required of the District.

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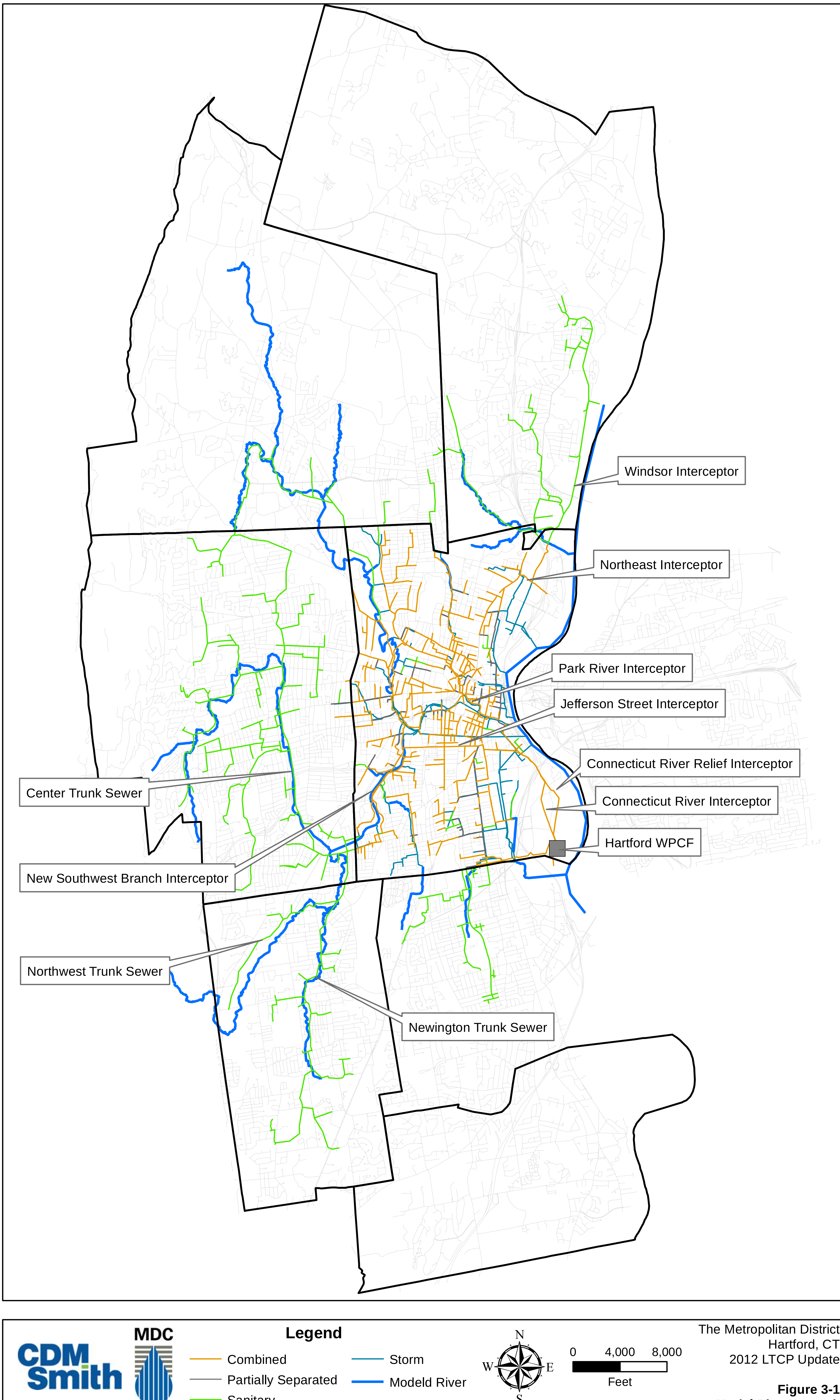

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Figure 3-1
Model Pipe Network

3.2 Overview of 2009/2011 Model Update

The Hartford collection system model as it stood in early 2009 included predominantly 24 inch pipes and larger in the Hartford combined sewer system and was calibrated utilizing temporary project meter data from 2003. The model had 85 miles of pipe, while the Hartford collection system has 220 miles of sewers and 120 miles of drains. The model omitted storm drains with the exception of the Gully Brook Conduit, those in the Franklin Avenue area, and a few other large-diameter conduits, limiting its use for assessing impacts on drainage and flood control facilities. The prior version of the model did not reference asset names from the District's GIS and was poorly geo-referenced given that this was not a priority in developing the multiple versions of the model leading up to the 2003 calibration. In many cases, manhole locations in model space were up to several hundred feet distant from actual geographic locations, which makes it difficult to simulate effects of site-specific projects in the CWP, such as separation. Additionally, many model parameters were developed using older datasets that are superseded by modern higher quality digital datasets.

The District decided to improve the existing Hartford model in 2009 so that it continues to be a useful and effective tool to support the CWP. The improvements included the following efforts:

- Increasing detail to improve understanding of system performance, including addition of sewer pipes 18-inch and larger and drains 36-inch and larger, city of Hartford flood control facilities, and representation of the Park River and Connecticut River;
- Updating the Hartford collection system to 2009 and 2011 conditions using temporary and permanent flow monitoring data;
- Integrating existing sanitary sewer models for areas tributary to the HWPCF; and
- Updating the model's overall architecture to the current standards.

Table 3-1 summarizes the modeled pipes, catchments, calibration and validation in the 2009/2011 Integrated Collection System Model.

Further updates of the model, as described in the 2010 Model Maintenance Protocol, are recommended throughout the duration of the CWP so that planned facilities may be modified as needed, based on changed conditions or as effectiveness of implemented projects is evaluated, in order to meet the objectives of the CWP at the end of the program.

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Table 3-1
Summary of 2009/2011 Integrated Collection System Model

Community	Manholes	Catchments	Sewered Area (mi^2)	Pipe Miles	Pipe Diameters	CSO and SSO Regulators	Calibration Period	Number of Calibration Meters	Validation Period	Number of Validation Points
Hartford	3,200	2,500	13	146	Sewers - 18-inch and greater Drains – 36-inch and greater	**CSO**: 84[1] **SSO**: 1[2]	March – June 2009 (system-wide); March - May 2011 (Franklin area)	27 temporary meters (2009); 17 temporary meters (2011); 12 permanent meters	2008 and July 2009-August 2009;	84 Overflow alarm sites; 3 temporary meters; 12 permanent meters; HWPCF influent data; USGS South Windsor groundwater well
Newington	170	87	11	15	Sewers - 12-inch and greater	**SSO**: 1[3]	Spring 2005 & Fall 2008	2005 - 21 2008 - 7	2004-2008	3 overflow alarm sites; USGS South Windsor groundwater well
West Hartford	440	280	16	38	Sewers – 12 inch and greater	**SSO**: 3[4]	Spring 2005 & Fall 2008	2005 - 35 2008 - 7	2004-2008	3 overflow alarm sites; USGS South Windsor groundwater well
Bloomfield	11	7	20	5	Sewers - 15 inch and greater	0	NA	NA	NA	NA
Windsor	180	120	8	16	Sewers – 12-inch and greater	0	Spring 2005 & 2008 data at NM-1/FM-1	2005 - 18 2008 - 2	May 2008-May 2009	1 overflow alarm site; 1 permanent meter
Wethersfield (Folly Brook)	190	170	3	9	Sewers – 12-inch and greater	0	Nov 2008 – May 2009	5	NA	NA
Total	**4,191**	**3,164**	**71**	**229**	**various**	**89**	**various**	**151**	**various**	**107+**

1) CSO Regulator count differs from Table 2-2 because the 2009/2011 model included P-11 and G-14, which have since been eliminated, and did not include P-11A, G-17A, and G-17B from the HAIE.
2) SSO Regulator NM-1 is located in Hartford, but regulators the Windsor sewershed.
3) SSO Regulator NTS-Hartford Ave (gated) is located in Newington.
4) SSO Regulators CTS-2, CTS-3, and NTS-Hillcrest are located in West Hartford.

3.3 Data Sources

The model is based on existing data that was gathered from the District's GIS, available record drawings, temporary and permanent flow meters, and targeted field verification. A summary of key data sources is provided below. Additional detail is provided in the July 2011 Hartford Model Update and Baseline Conditions Report.

3.3.1 Flow Metering Data

Data from the following sources were collected for use in model calibration and validation:

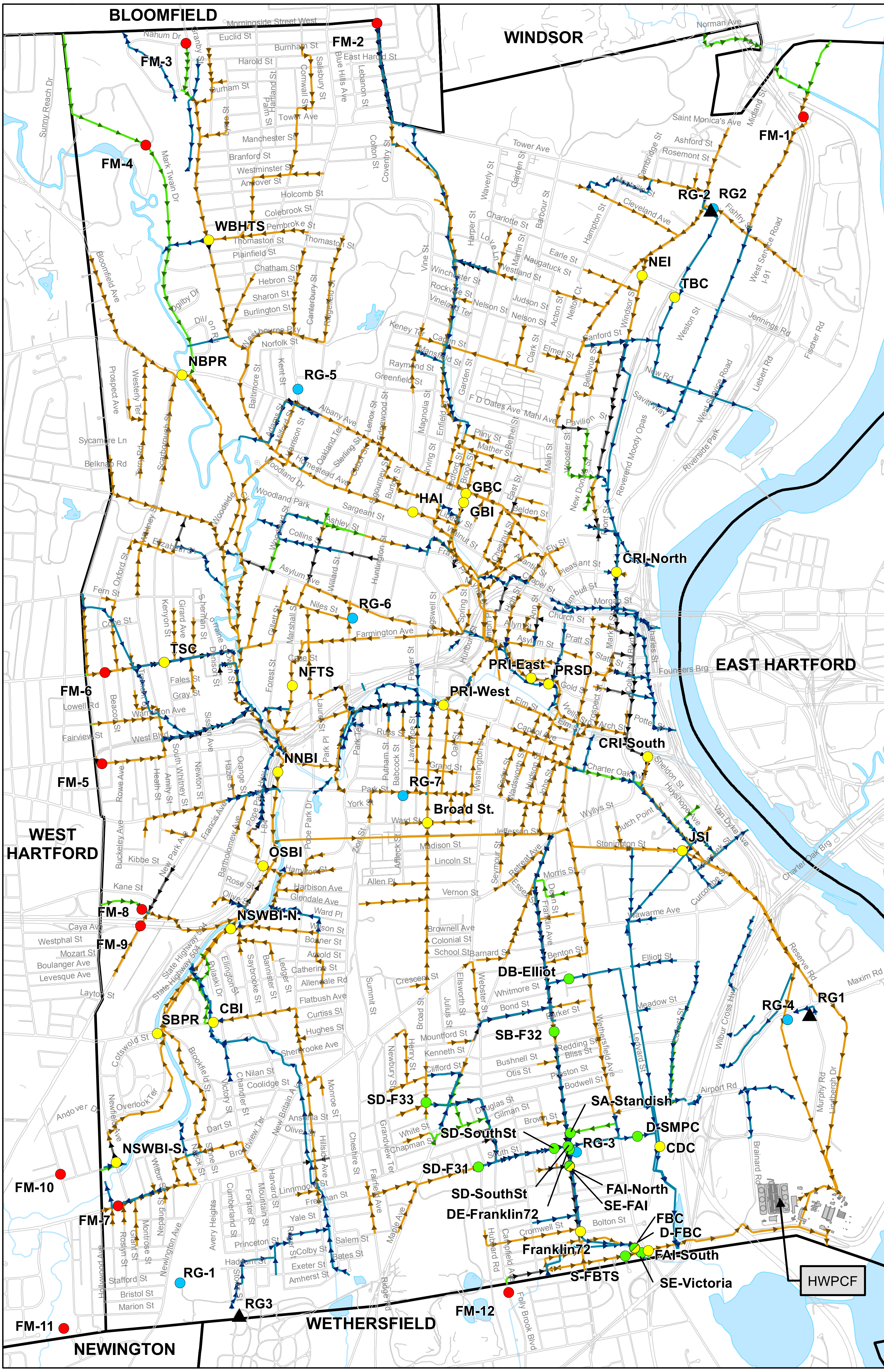
- Twenty seven temporary flow meters deployed throughout Hartford in spring 2009;
- Seventeen temporary flow meters deployed in the Franklin area in spring 2011;
- The District's 12 permanent flow meters (FM meters), which can remain in use and can be used to support future model refinement and validation;
- The District's influent flow meter at the HWPCF; and
- The District's Overflow Alarm and Monitoring System level sensors at CSO and SSO regulators.

Figure 3-2 illustrates the temporary and permanent flow metering locations as well as temporary and permanent rain gauge locations. In addition to the CSO regulators in Hartford, the District's Overflow Alarm system monitors the following structural SSO regulators:

- Church Street in Wethersfield (overflow gate is closed)
- CTS-2 located on the Center Trunk Sewer in West Hartford
- CTS-3 located on the Center Trunk Sewer in West Hartford
- Elm Street in Wethersfield (overflow gate is closed)
- Goff Brook in Wethersfield (overflow gate is manually operated)
- NM-1 on the Windsor Interceptor near Meadow Brook
- NTS at Hillcrest on the Newington Trunk Sewer in West Hartford
- NTS at Hartford Avenue siphon in Newington(overflow gate is closed)

The model also draws upon the data used to calibrate and validate the SSO models in West Hartford, Newington, Windsor and Folly Brook (Wethersfield), as well as the Park River model. These include:

- 74 SSES meters and three rain gages deployed in spring 2005 in West Hartford, Newington, and Windsor;
- 14 flow meters and 10 rain gages deployed in West Hartford and Newington in fall 2008;
- 5 flow meters deployed in the Folly Brook watershed area of Wethersfield in November 2008 through May 2009, and 1 additional meter deployed in March 2009 through May 2009;
- Overflow Alarm and Monitoring System measurements at structural SSO regulators as noted above (2002-2009);
- USGS South Windsor well 1934-2009;
- USGS Park River gages 1936-1986; and



CDM Smith

MDC

Legend

- Temporary Flow Meter - 2009
- Temporary Flow Meter - 2011
- Permanent Meter
- Temporary Rain Gage
- Permanent Rain Gage
- Combined
- Partially Separated
- Sanitary
- Storm

N
W E
S

0 1,150 2,300
Feet

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Figure 3-2
Flow Meter and Rain Gauge Locations

- USGS Connecticut River gages 01190070 Connecticut at Hartford and 01184000 Connecticut at Thompsonville.

More detail on the SSO system data may be found in the Hydraulic Modeling Report for West Hartford, Newington, and Windsor Collection Systems dated March 2009.

It is noted that meter data is vital to model calibration and validation but is not without error. The District is fortunate to have multiple datasets to draw upon for comparison and evaluation of system performance. This leads to more robust model calibration and validation.

3.3.2 Precipitation Data

Temporary rain gages were deployed by Flow Assessment Services, LLC at three sites in 2009 and two sites in 2011. These were installed at the District's Operations and Maintenance Facility on Maxim Road in the southeast portion of Hartford (RG-1), the Fishfry Pumping station in northeast Hartford (RG-2), and at Cedar Hill in southwest Hartford (RG-3). Temporary and permanent rain gage locations are shown in Figure 3-2. The District maintains seven rain gages throughout Hartford as well. Data from these gages was used if it was determined to be of sufficient quality.

The source of the rainfall data used in the modeling analysis for the LTCP Update is a combination of the Brainard Field data and Bradley International Airport data.

3.4 Model Development

A significant effort was put into developing the hydraulics and hydrology for the updated model, drawing from the many data sources available so that appropriate detail may be represented accurately. Details of model development are provided in the 2011 Hartford Model Update and Baseline Conditions Report. Below is a brief summary of a few features worth noting for this 2012 LTCP Update, not discussed in other sections of this report.

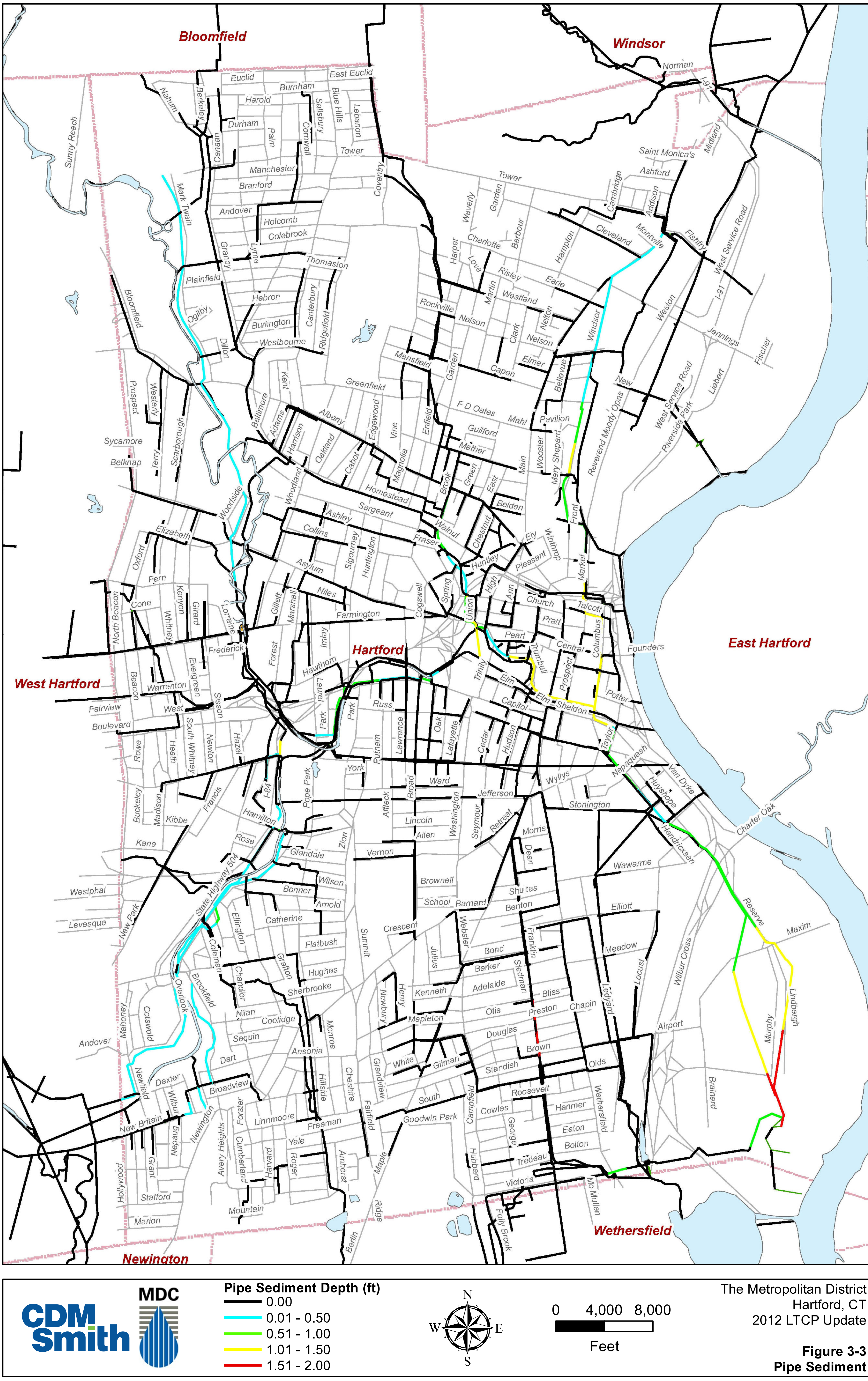
3.4.1 Sediment

Sediment depths were explicitly added to the model along the principal interceptors in order to better represent the true hydraulics of the system. The CRI and CRRI are prone to sediment accumulation because of the downstream hydraulic conditions at the HWPCF. This hydraulic condition will be addressed with the construction of the new influent pump station as part of the wet weather expansion project at the HWPCF.

Sediment depths in the current model, as shown in Figure 3-3, were based on past interviews with Operations staff conducted for the 2003 model. These values were adjusted as appropriate during calibration within reasonable limits to help match meter data or to reflect local field investigation results.

3.4.2 Integration of SSO Models

Sewer models of West Hartford, Newington, Windsor and the Folly Brook portion of Wethersfield were developed between 2006 and 2009 to facilitate SSO mitigation studies. These models represent all 12 inch and larger sanitary sewers tributary to HWPCF in these communities, and were merged with the updated Hartford model. Limited detail was added in Bloomfield to connect north-draining sewers in West Hartford to the Hartford system via the Bloomfield Trunk Sewer.



Pipe Sediment Depth (ft)

- 0.00
- 0.01 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00

N
W E
S

0 4,000 8,000

Feet

CDM Smith

MDC

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 3-3
Pipe Sediment

3.5 Hydrology

The hydrologic model component simulates rainfall-runoff, groundwater infiltration, evaporation and other losses. Figure 3-4 shows the catchments developed for the model. There are more than 3,000 catchments in the model. These and all pipe features are now georeferenced. Groundwater infiltration was explicitly modeled through water table dynamics between each aquifer and catchment in the model.

3.6 Model Calibration and Validation

The Hartford model was calibrated to dry and wet weather flows for spring and summer 2009 and validated to 2008 depths from the District's Overflow Alarm and Monitoring System. The Franklin Avenue area was further calibrated to spring 2011 meter data. (The separated areas of West Hartford, Newington, Windsor and Folly Brook that are connected to the Hartford model were calibrated to different periods, as summarized in Table 3-1). The model was adjusted within reasonable limits to minimize differences between observed and modeled timing of peaks and troughs, peak flow rates, peak velocity, depth and total volume at each metered location. Calibration was assessed by evaluating differences between observed and modeled values in accordance with USEPA's Combined Sewer Overflows: Guidance for Monitoring and Modeling (1999) guidelines.

There is a large dataset available for validation in the District's system. This enables comparison between modeled and observed values for a wide range of conditions outside of the calibration period. The data includes overflow alarm data at CSO regulators, SSO regulators, permanent meter data at the borders of the Hartford system, and HWPCF flow data. The level of validation completed for the 2009/2011 model far exceeds normal engineering practice.

The detailed results of calibration and validation are presented in the 2011 Hartford Model Update and Baseline Conditions Report. As discussed in the 2011 report, there is a reasonably good match between modeled and metered for calibration as well as for the significant validation effort. Overall, the model represents the District HWPCF system very well and is a vastly improved tool for use in facilities planning and to support design. The model performs best in the areas with the largest flows and in downstream interceptors. As can be expected, the match for calibration and validation in local upstream sewers, and pipes and drains with limited information available may not be as good. As with any model, there are some areas where the match could be improved with additional information, field investigations and metering. A systematic field verification effort coordinated between District operations, survey crews, GIS, and engineering departments is also recommended to confirm model configuration since there were cases where field conditions did not match GIS or record drawings. The model can be used to prioritize these investigations.

It should be noted that it is reasonable to assume that the model adequately reproduces system response for the 1-year design storm given the range of storms seen in calibration and validation. Extrapolation to the more extreme events required for the District to control would understandably produce less accurate results since such extreme events did not occur during the metering periods. However, the model still remains the most reliable tool for estimating flows in these extreme events. It should be further noted that the model was peer-reviewed by two university professors with extensive modeling and facilities planning experience. This review further strengthens the confidence in the model, which is a highly sophisticated and advanced tool for supporting the District's facilities planning for the Clean Water Project.

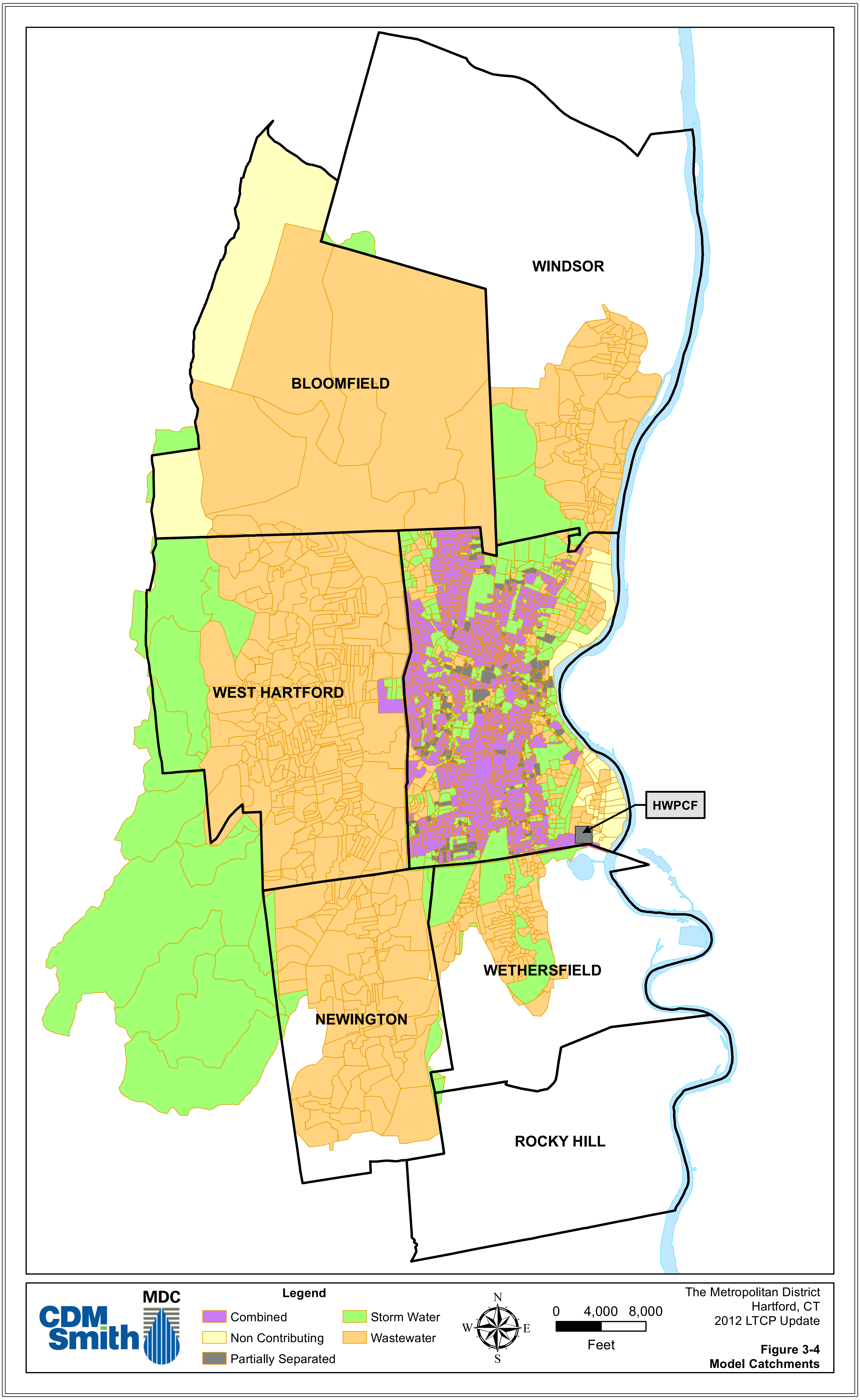

WINDSOR
BLOOMFIELD
WEST HARTFORD
WETHERSFIELD
NEWINGTON
ROCKY HILL
HWPCF
MDC
CDM Smith
Legend
Combined
Non Contributing
Partially Separated
Storm Water
Wastewater
N
W
E
S
0 4,000 8,000
Feet
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Figure 3-4
Model Catchments

3.7 2009/2011 Conditions

3.7.1 Introduction

In order to put the updated overflows in context, the CSO estimates using the updated model were compared with prior estimates from the 2003 model. The 2009/2011 model was used to establish updated CSO baseline conditions for the 1-Year Design Storm and the Typical Year (1976). More detail on the 1-Year Design Storm and Typical Year selection may be found in the 2004 Baseline Conditions Report.

Detailed results by CSO regulator along with a comparison with results presented in the 2004 Baseline Conditions Report are summarized below. Explanations for variations are provided in the 2011 Hartford Model Update and Baseline Conditions Report.

Generally, system overflows predicted by the updated 2009/2011 model are higher than those predicted by the 2003/2004 model. There are a number of reasons why the 2009/2011 model estimates are slightly higher. These include the following:

- **More Data:** The updated model is based on significantly more field data, as described previously. This includes but is not limited to temporary flow meters, which were installed and maintained by a metering firm with a reputation for high quality data, as well as longer-term validation using several data sources. The amount of data used for the current modeling effort cannot be overstated.
- **Superior Model and Software:** The updated model is state of the art, incorporating current modeling knowledge and detail. It is based on an EPA SWMM5 hydraulic and hydrologic engine and is judged to be superior in its estimation of flows compared to the XP SWMM software, which was used for the 2003 modeling. In particular, XP SWMM has been found to be less robust in its modeling of soil moisture and infiltration due to a weakness in its application of the Green Ampt equation. The XP SWMM software is also not regularly supported or updated to reflect the state of the art in collection system modeling. XP SWMM was utilized previously at the District's request since this was the platform of the pre-2003 models.
- **Improved System Understanding:** In updating the model, CDM Smith benefited from the years of experience it has gained with the District's system, as well as from support of the District Operations staff that assisted with field verification of facilities and CSO regulators.
- **Improved Representation of Neighboring Communities:** The 2003 model estimated flows from communities bordering Hartford based on very limited information. The 2009 model incorporates detailed models of the West Hartford, Newington, Windsor, and Folly Brook systems developed between 2006 and 2009 based on over 75 meters.
- **Improved Simulation of Groundwater:** The 2009/2011 model provides improved simulation of groundwater and its influences based on the information learned in the SSO modeling of the neighboring communities and updated data.

3.7.2 Regulator Summary by Drainage Area

Table 3-2 presents an overall assessment of CSO discharge by drainage area. Overall, the 2003 model predicted a 1 year total of overflows of 93 MG compared to the 2009/2011 model predicted total overflow volume of 98 MG. The total overflows include combined sewer overflows in the Hartford combined system as well as at the structural SSOs in Windsor, West Hartford and Newington.

Table 3-2
Overflows by Drainage Area

Statistics from 2004 Baseline Report

1-Year Storm Results	
Area	**Volume (MG)**
North Branch	12.2
Gully Brook	9.5
Park River	36.0
North Meadows	9.4
South Branch	9.6
Franklin Avenue	6.4
South Meadows	1.6
West Hartford-Newington	8.0
Total (MG)	**92.7**

Updated 2009/2011 Model

1-Year Storm Results	
Area	**Volume (MG)**
North Branch	12.2
Gully Brook	20.7
Park River	25.8
North Meadows	5.1
South Branch	8.1
Franklin Avenue	15.0
South Meadows	8.6
West Hartford-Newington	2.1
Total (MG)	**97.6**

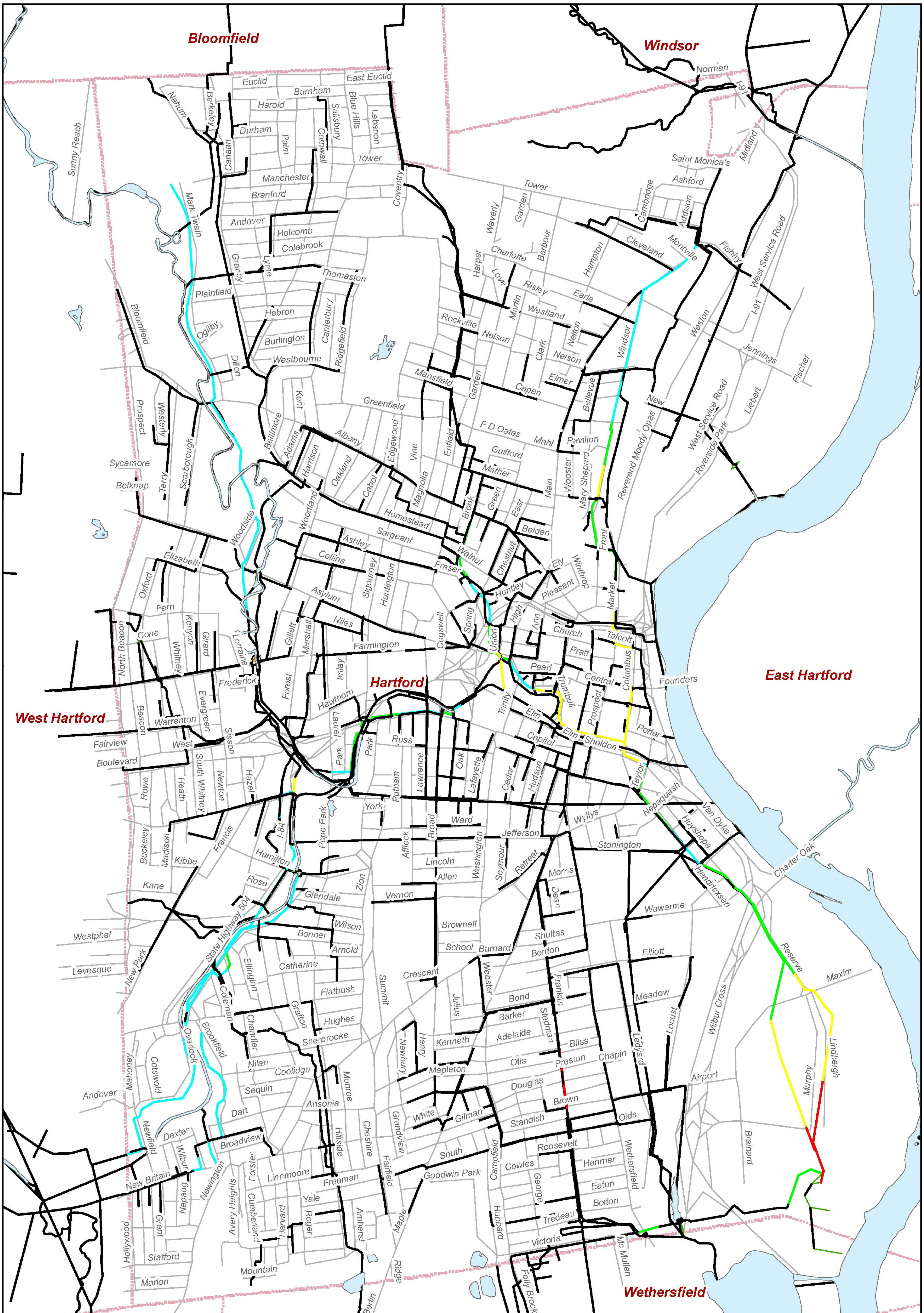
As shown in this table, the Park River drainage area generally accounted for the largest volume in the 1-Year Design Storm. However, its overall overflow volume decreased as a percentage of the total system volume after the 2009/2011 model update, and other areas increased, mostly due to additional detail that was incorporated into the model to distinguish between the drainage areas.

3.7.3 Overflows by CSO Regulator

Table 3-3 presents the CSO volumes, peak flows and duration of overflow for each CSO regulator in each drainage area. Peak flows decreased at some CSO regulators, but increased at most compared to the baseline reported in 2004, with the location of the largest overflows in each drainage area shifting to other locations in some cases. The peak flows in the new model are higher generally due to improved representation of the hydrology in the combined system. Durations of overflows predicted by the updated model are substantially lower in many cases.

It should be noted that most of the Gully Brook CSO regulators (with the exception of G-21) discharge into the Gully Brook Conduit (GBC), which is then regulated again at G-20. G-21 overflows into the GBC downstream of G-20. Therefore, the total in Table 3-3 for the Gully Brook area is only a total of G-20 and G-21 flows and volumes. The other individual Gully Brook CSO regulator statistics are presented for information. With the updated model, the Gully Brook area became more of a significant contributor to system-wide overflows. The encouraging aspect of these updated results is that the District will eliminate its largest overflow as soon as G-20 is eliminated. The Homestead Avenue Interceptor Extension, which is the first step towards enabling the Gully Brook Disconnection, has already been built.

The North Branch Park River area totals remained about the same. The North Meadows/South Meadows areas went up by 2.7 MG mostly due to SM-2 volume, which increased significantly. This volume was offset by reductions at NM-2, 3, and 4, which were lower due to the Tower Brook disconnect project, which was completed after the 2004 report and before the 2009/2011 update. NM-1 is lower due to improved representation of the Windsor system as a result of the SSO modeling.



Pipe Sediment Depth (ft)

- 0.00
- 0.01 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00

N
W E
S

0 4,000 8,000

Feet

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Figure 3-3
Pipe Sediment

Table 3-3
1-Year Storm Overflow Summary By Drainage Area

Baseline Statistics From 2004 Baseline Report
Gully Brook Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
G-2	2.8	0.4	5.3
G-8	2.6	0.2	3.6
G-9	14	0.3	4.8
G-10	2.4	0.2	3.5
G-11	2.0	0.3	6.3
G-12	6.2	0.2	3.0
G-13	3.2	0.9	14
G-14	7.2	< 0.1	0.91
G-15	0	0.0	0
G-19	2.0	< 0.1	2.7
G-20	18	9.5	93
G-21	5.0	< 0.1	1.8
G-23	0	0.0	0
Total (MG)		9.5	
% of System Total		10.2%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
Gully Brook Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
G-2	2.5	2.4	48.0
G-8	1.8	0.3	6.5
G-9	1.8	0.3	7.8
G-10	1.8	0.2	4.2
G-11	1.8	0.3	6.9
G-12	1.3	0.1	4.2
G-13E	2.0	1.3	29.1
G-13W	2.0	0.3	6.0
G-14	6.3	0.9	15.2
G-15	0.0	0.0	0.0
G-19	0.8	< 0.1	1.1
G-20	11.5	20.3	253.2
G-21	4.0	0.4	7.6
G-23	0.0	0.0	0.0
Total (MG)		20.7	
% of System Total		21.1%	
System Total (MG)		98	

Note: The G total only includes G-20 and G-21 since G-20 includes the volume from all other regulators other than G-21.

Baseline Statistics From 2004 Baseline Report
North Branch Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
N-2	3.8	2.0	36
N-4	4.0	0.5	12
N-9	5.0	0.8	6.2
N-10	1.8	0.2	6.2
N-12	6.8	0.2	3.2
N-14	10.0	3.7	29
N-22	4.8	0.4	5.6
N-23	5.0	0.4	5.1
N-24	2.8	0.3	5.5
N-25	8.6	2.3	25
N-27	2.8	< 0.1	0.59
N-28A	4.2	1.0	15
N-29	4.2	0.3	3.8
Total (MG)		12.2	
% of System Total		13.1%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
North Branch Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
I-4	0.0	0.0	0.0
N-2	2.3	2.6	48.5
N-4	1.5	0.8	23.2
N-9	2.0	0.8	16.2
N-10	0.8	< 0.1	1.6
N-12	5.0	0.3	4.3
N-14	4.5	1.6	32.6
N-22	2.3	0.4	6.9
N-23	5.3	0.6	7.2
N-24	2.5	0.9	15.5
N-25	4.8	2.3	44.5
N-27	closed	closed	closed
N-28A	2.3	0.6	9.7
N-28B	1.8	0.9	20.1
N-29	4.3	0.6	7.1
Total (MG)		12.2	
% of System Total		12.5%	
System Total (MG)		98	

Table 3-3
1-Year Storm Overflow Summary By Drainage Area

Baseline Statistics From 2004 Baseline Report
North and South Meadows Drainage Areas

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
NM-1	7.0	1.2	12
NM-2	9.2	0.3	4
NM-3	16.2	1.3	8.0
NM-4	16.0	1.7	11.1
NM-5	10.2	2.0	19.0
NM-6	4.6	0.3	6
NM-7	3.6	0.3	6.2
NM-10	16.6	2.3	17.7
NM-14	2.2	0.0	0.2
SM-2	9.4	1.6	16
Total (MG)		11.0	
% of System Total		11.9%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
North and South Meadows Drainage Areas

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
NM-1 (SSO)	0.0	0.0	0
NM-2	2.0	0.3	6
NM-3	2.0	0.1	2.7
NM-4	2.3	0.7	15.5
NM-5	2.3	1.7	29.4
NM-6	2.0	0.2	5
NM-7	1.5	0.2	5.8
NM-10	7.3	1.8	20.5
NM-14	0.5	< 0.1	0.6
SM-2	9.0	8.6	61
Total (MG)		13.7	
% of System Total		14.0%	
System Total (MG)		98	

Baseline Statistics From 2004 Baseline Report
Park River Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
P-1	15.6	20.2	102
P-2	2.6	0.3	6
P-3	0.0	0.0	0.0
P-4	2.4	0.5	9.9
P-5	5.8	2.8	34.0
P-9	2.2	0.3	7
P-10	3.0	0.5	9.8
P-11	0.0	0.0	0.0
P-12	13.0	4.0	29.5
P-13	8.6	0.4	7
P-15	41.4	1.6	6
P-15A	0.0	0.0	0.0
P-16	17.8	4.3	39.9
P-16A	6.6	0.5	7.8
P-18	0.0	0.0	0
P-19	1.2	< 0.1	0.5
P-23	0.0	0.0	0.0
P-24	0.0	0.0	0.0
P-26	8.4	0.5	10
Total (MG)		36.0	
% of System Total		38.7%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
Park River Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
P-1	7.8	6.1	48
P-2	1.5	0.7	16
P-3	0.0	0.0	0.0
P-4	2.3	0.3	5.9
P-5	13.8	3.0	23.5
P-9	4.3	0.8	14
P-10	4.5	0.7	13.0
P-11	0.8	< 0.1	1.0
P-12	11.0	5.3	42.9
P-13	4.8	1.4	21
P-14	1.3	0.2	7
P-15	4.8	1.7	30
P-15A	0.0	0.0	0.0
P-16	9.3	2.5	37.6
P-16A	1.5	0.3	8.1
P-18	0.3	0.0	0
P-19	0.0	0.0	0.0
P-23	1.3	0.2	6.7
P-24	2.8	1.5	21.3
P-26	2.0	0.9	20
P-29	0.3	0.0	0
Total (MG)		25.8	
% of System Total		26.3%	
System Total (MG)		98	

Table 3-3
1-Year Storm Overflow Summary By Drainage Area

Baseline Statistics From 2004 Baseline Report
South Branch Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
S-3	0.0	0.0	0
S-8	0.0	0.0	0
S-10	2.4	0.2	4.2
S-12	5.4	0.2	2.2
S-13	2.6	< 0.1	2.7
S-14	0.0	0.0	0
S-15	14.8	3.2	12.6
S-16	10.2	1.7	14.0
S-19	3.6	< 0.1	1.3
S-21	5.2	0.2	3
S-23	2.8	0.1	3
S-24	0.0	0.0	0
S-25	1.4	0.0	0.0
S-26	9.8	0.4	3.7
S-27	16.6	0.8	5.4
S-28	34.8	1.6	4
S-29	14.6	0.3	2.1
S-30	18.0	0.7	2.7
Total (MG)		9.6	
% of System Total		10.3%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
South Branch Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
S-3	1.5	0.1	2
S-8	2.3	0.4	7
S-10	0.0	0.0	0.0
S-12	2.3	0.2	5.1
S-13	1.8	0.3	8.0
S-14	1.0	< 0.1	2
S-15	15.3	1.9	8.0
S-16	11.8	2.0	15.0
S-19	3.3	0.4	8.0
S-21	3.0	0.4	7
S-23	1.8	0.2	5
S-24	0.8	< 0.1	1
S-25	1.5	< 0.1	1.8
S-26	4.5	0.4	4.8
S-27	11.0	1.1	8.2
S-28	1.0	< 0.1	1
S-29	3.5	0.3	4.3
S-30	2.0	< 0.1	1.8
Total (MG)		8.1	
% of System Total		8.3%	
System Total (MG)		98	

Baseline Statistics From 2004 Baseline Report
Franklin Avenue Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
F-26 (I-24)	6.0	2.8	23
F-27 (I-21)	1.4	0.3	8
F-28 (I-17)	3.2	0.2	2.5
F-29 (EQ-1)	2.8	1.6	23.2
F-30 (EQ-2)	2.8	< 0.1	13.4
F-31 (EQ-4)	2.4	0.3	6
F320 (Adelaide)	2.0	0.3	9.8
F33 (West Preston-Broad)	0.8	< 0.1	3.9
Total (MG)		6.4	
% of System Total		6.9%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
Franklin Avenue Drainage Area

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
F-26 (I-24)	11.8	2.7	23
F-27 (I-21)	2.3	1.4	21
F-28 (I-17)	3.3	0.7	6.3
F-29 (EQ-1)	3.3	2.7	35.4
F-30 (EQ-2)	3.3	0.9	15.8
F-31 (EQ-4)	4.8	1.6	29
F32 (Adelaide)	4.0	3.9	50.7
F33 (West Preston-Broad)	2.0	1.1	16.2
Total (MG)		15.0	
% of System Total		15.3%	
System Total (MG)		98	

Table 3-3
1-Year Storm Overflow Summary By Drainage Area

Baseline Statistics From 2004 Baseline Report
West Hartford - Newington SSOs

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
CTS-2	NA	NA	NA
CTS-3	NA	NA	NA
NTS	29.6	8.0	9.7
Total (MG)		8.0	
% of System Total		9.0%	
System Total (MG)		93	

Baseline Statistics Using 2009-2011 Model
West Hartford - Newington SSOs

CSO Regulator	1-Year Design Storm 2.40" Total 0.72" Peak Hour		
	Duration (hrs)	Volume (MG)	Peak 15-Min Flow (mgd)
CTS-2	5.0	< 0.1	0
CTS-3	8.8	1.7	8
NTS	14.5	0.4	1.4
Total (MG)		2.1	
% of System Total		2.2%	
System Total (MG)		98	

The Park River and South Branch Park River drainage areas decreased in both volume of overflow and percent of total compared to 2004 reports. The estimates of SSO discharges in the 1-year event decreased significantly due to improved representation of the West Hartford, Newington, and Windsor systems through the SSO modeling studies.

The Park River and South Branch Park River drainage areas decreased in both overflow volume and percent of total system compared to the 2004 model results. The largest decrease in volume for the Park River area was at P-1, which used to be the largest single regulator based on flow, but was surpassed by G-20 in the 2009/2011 update. SSO discharges in the 1-year event decreased significantly due to improved representation of the West Hartford, Newington, and Windsor systems through the SSO modeling studies.

3.7.4 Typical Year Results

The typical year was selected as 1976 for the 2004 Baseline Report. This same year was simulated for the updated typical year results. More detail on the typical year selection may be found in the 2004 Baseline Conditions Report.

The total system-wide overflow volume in the typical year estimated by the 2009/2011 model is approximately 1 billion gallons, which is the same as that presented in the 2004 Baseline Conditions Report. The majority of the typical year volume is discharged at G-20 (195 MG), followed by SM-2 (106 MG) and P-1 (80 MG). These three CSO regulators contribute approximately 40 percent of the total annual volume. As discussed previously, G-20 is already well on the way towards elimination with the construction of the Homestead Avenue Interceptor Extension. The remaining step is to identify and remove any remaining direct sanitary connections to the Gully Brook Conduit before the G-20 weir that diverts the brook into the Park River Interceptor can be removed. SM-2 and P-1 should be reduced by the construction of the wet weather expansion project at the HWPCF.

Approximately 60 rain events lead to CSO in the typical year, which is slightly higher than estimates reported in 2004.

Section 4

CSO Control Plan Progress

4.1 Introduction

In 2005, the District developed a comprehensive LTCP to abate wet weather discharges from the Hartford combined sewer system. The plan included wastewater treatment facility improvements to enhance wet weather treatment and collection system improvements to reduce, control and convey wet weather flow within the piping system. This LTCP was incorporated into a Consent Order from CT DEEP in 2006.

Soon thereafter, the District was required to comply with other regulatory requirements (EPA Consent Decree) regarding the reduction of SSOs in the regional communities and to reduce nitrogen from its HWPCF discharges (General Permit for Nitrogen Discharge). Alternatives and implementation plans were developed to make system structural improvements to address each of these additional regulatory burdens. All three goals – CSO control, SSO elimination, and nitrogen removal – were all incorporated into the CWP, which became a comprehensive plan for the District.

Since 2006, the District has implemented many recommended system improvements. However, the LTCP has also evolved significantly due to modifications of major components of the plan, the integration of system improvements required for the entire CWP (SSOs), rising construction costs and new system information.

This section summarizes the recommendations of the 2005 LTCP, the revisions to the original plan, and the completed and ongoing CSO control plan improvements related to the combined sewer piping/conveyance system. Section 5 discusses the current improvements program at the HWPCF.

4.2 2005 Long Term Control Plan Recommendations

The original 2005 LTCP proposed a program of system improvements designed to prevent CSO discharges for the overall service area for storms up to and including the 1-Year Design Storm, with the exception of the Franklin Avenue area CSO regulators. Based on recommendations from the 2004 Wethersfield Cove Study, the 2005 LTCP included elimination of CSO regulators that discharge to Wethersfield Cove. Subsequent to the 2005 LTCP, the 2006 Consent Order also added complete elimination of the CSO regulators that discharge to the North Branch Park River.

A full range of CSO control alternatives were evaluated during the development of the 2005 LTCP including partial and full sewer separation of the combined sewer system, satellite storage and treatment for wet weather flows, maximization of wet weather treatment capacity at HWPCF, and deep rock tunnel storage. While complete separation of the combined sewer system was not cost-effective, the District elected to separate key portions of the combined sewer system where the District believed that there were a significant number of sewer surcharge and street flooding problems. A Citizens Advisory Committee (CAC) was engaged to provide input into the range of alternatives. Generally, the District and the CAC found that satellite storage and/or treatment facilities were not as desirable compared to the use of a centralized deep rock tunnel storage system to address the District's remaining CSO discharge control objectives (after sewer separation in select areas).

Accordingly, a new deep rock tunnel storage system plan (and associated consolidation pipes), along with select sewer separation, was developed to consolidate the CSO regulators in the north portion of the system. For the southern CSO regulators, the District favored the use of the existing PRAC and new consolidation pipes; this plan used existing infrastructure to reduce costs and avoid the construction of a second tunnel system.

Figure 4-1 shows the recommended plan from the 2005 LTCP, which consisted of components prioritized by phases, as follows:

Early phase projects

- 25 percent reduction of infiltration and inflow (I/I) in the separated District communities that border Hartford and contribute flow to the CSS;
- HWCPF upgrades to ensure reliable secondary treatment and improve wet weather treatment capacity including a new influent pumping station, preliminary treatment, wet weather treatment facility, and improved disinfection facilities;
- Full separation of the Franklin Avenue drainage area eliminating CSO discharges to Folly Brook and Wethersfield Cove (240 acres);
- Local separation in select areas of the combined sewer system to reduce sewer surcharging that was resulting in basement backups and street flooding and to reduce excessive wet weather flow (1,670 acres);
- Disconnection of Gully Brook from the combined system including the construction of the Homestead Avenue Interceptor Extension and new consolidation pipes to collect flow from the Gully Brook CSOs and convey it to the North Tunnel;
- Extension of the Connecticut River Relief Interceptor;
- Partial separation of portions of the Granby Street area and a CSO storage conduit to address the 1-year level of control for this drainage area;

Later phase projects

- 23 MG of storage in new deep rock North Tunnel;
- 26 MG of storage in the existing PRAC;
- 25 mgd pump station to dewater the deep rock tunnel and the PRAC; and
- Approximately 10 miles of new consolidation pipes to connect flow from the affected CSO regulators to either the PRAC or the North Tunnel (to control to the 1-Year Design Storm).

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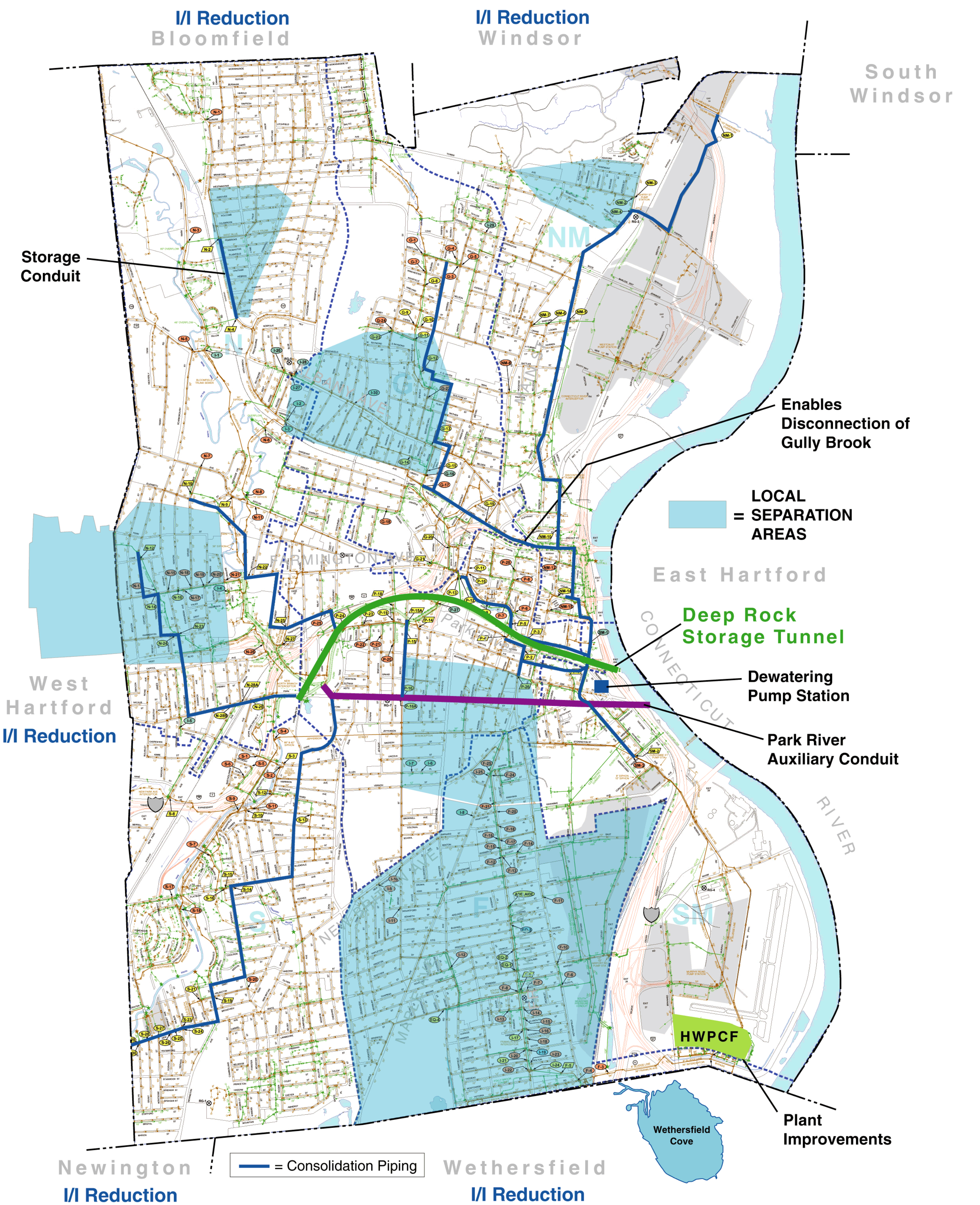

Figure 4-1
2005 LTCP Recommended Plan

4.3 2009 LTCP Project Changes

In 2009, the District completed a summary progress report of the LTCP project changes to date. Elements of the original 2005 LTCP had evolved and/or been further defined through multiple conceptual, preliminary and final designs and the LTCP Value Planning Session held in August 2006, (after the 2005 LTCP was finalized and the SSO Consent Decree was issued). From 2005 to 2008, the LTCP evolved into the CWP and expanded to include SSO abatement in the District's surrounding member towns. The 2009 LTCP Update report addressed many infrastructure changes since the completion of the original 2005 report and provided greater refinement of some of the original recommendations.

The 2009 LTCP Update report also updated the costs of the entire CWP including LTCP, SSO, Capacity, Management, Operations, and Maintenance (CMOM), and other system-wide collection system initiatives and improvements at the HWPCF and the Rocky Hill Water Pollution Control Facility to address nitrogen and SSOs. The 2009 LTCP Update identified the estimated cost of the CWP at $2.1 billion.

This LTCP Update is intended to completely replace and supersede the 2009 LTCP Update.

4.3.1 Removal of the Use of the Park River Auxiliary Conduit (PRAC) in the LTCP

The USACOE designed and constructed the PRAC, a lined deep rock storage tunnel, for flood protection in the 1970s. The 2005 LTCP evaluated and recommended the use of the PRAC for potential dual flood control and CSO storage use because it was existing infrastructure that had an estimated 26 million gallon storage capacity.

While planning level discussions with the USACOE showed that they were open to considering the use of the existing tunnel to help benefit the region in ways other than flood control, it was uncertain whether the PRAC would require structural modifications to be safely dewatered, lay empty for extended periods, and to remain impermeable in the years to come. The PRAC would also have required additional construction to support dual use for flood control and CSO storage, including new access shafts and improvements for plunge pools (energy dissipation), odor control, dewatering (pump station), etc.

A preliminary video inspection of the PRAC was performed via a remote operated vehicle during this period. The inspection revealed that there was considerable sediment and debris in the bottom of the PRAC (especially at the outlet), which would have to be removed to allow an adequate structural evaluation and assessment of CSO storage potential. The cost to perform this initial dewatering, cleaning and inspection was estimated with the help of several specialist contractors and found to be a deterrent given the overall uncertainty of the use of the PRAC. Even after cleaning and inspecting, there was still no guarantee that the PRAC would be available for the intended CWP uses. Further, it was impossible to gauge what repairs or other controls may have been required until after the inspection was complete.

As the CWP evolved, it became clear that the PRAC remained a source of uncertainty, and did not fully address conveyance needs for CSOs and SSOs. Based on these limitations, the results of the 2006 LTCP Value Planning Session, and the more complete solution provided by the SHCST (discussed below), the PRAC was removed from the CWP as an output of the 2006 value planning session.

4.3.2 South Tunnel

The South Hartford Conveyance and Storage Tunnel (South Tunnel) was incorporated into the CWP as a new addition to provide benefits that the PRAC could not. The proposed South Tunnel provides a route for SSO conveyance from Newington and West Hartford to the HWPCF. It also provides an opportunity for CSO storage and conveyance for regulators in the South Branch Park River drainage area. The South Tunnel was also proposed to reduce sewer surcharging and excess flows in the Folly Brook drainage area of Wethersfield by accepting wet weather flows from the Folly Brook Trunk Sewer. This would increase available capacity in the Franklin Avenue Interceptor and help eliminate CSO discharges in the Franklin Avenue drainage area.

Figure 4-2 shows the proposed plan of the two deep rock tunnel systems and associated consolidation pipes from the 2009 LTCP Update. Consolidation Pipe routes for both the north and the south tunnels were updated in this plan based on further evaluations conducted in preliminary design reports based on new topographic survey and an examination of subsurface information.

Since the 2009 LTCP Update, the South Tunnel has also evolved in its alignment and function as part of the LTCP and SSO plans. The final tunnel alignment has been modified based on an evaluation of multiple alternative alignments, an alternative approach for the Folly Brook Trunk Sewer (which eliminated its proposed connection to the tunnel), and modifications to the Franklin Avenue Area CSO separation program. The current alignment and components of the South Tunnel are discussed in Section 7.

4.3.3 Sewer Separation Program

The initial phase of the sewer separation program comprised the development of separate preliminary design reports for each of the five local area separation programs and the Franklin Avenue area (completed in 2008). Topographic survey was used to identify cost-effective routes for the new sewers or drains required to separate the combined sewer system in these areas. New outfalls were identified for the new drains and the pipe program was divided into separate phased construction contracts for appropriate design and bidding by final design engineers.

In some cases, the boundaries of the sewer separation program were expanded to incorporate adjacent combined sewer areas into the local sewer separation programs that could be readily incorporated into the new sewer/drain alignments to further reduce wet weather inflow and to address sewer system surcharges. Figure 4-2 shows the new boundaries of the sewer separation program based on the conceptual and preliminary designs that were completed for these areas, which totaled approximately 2,760 acres.

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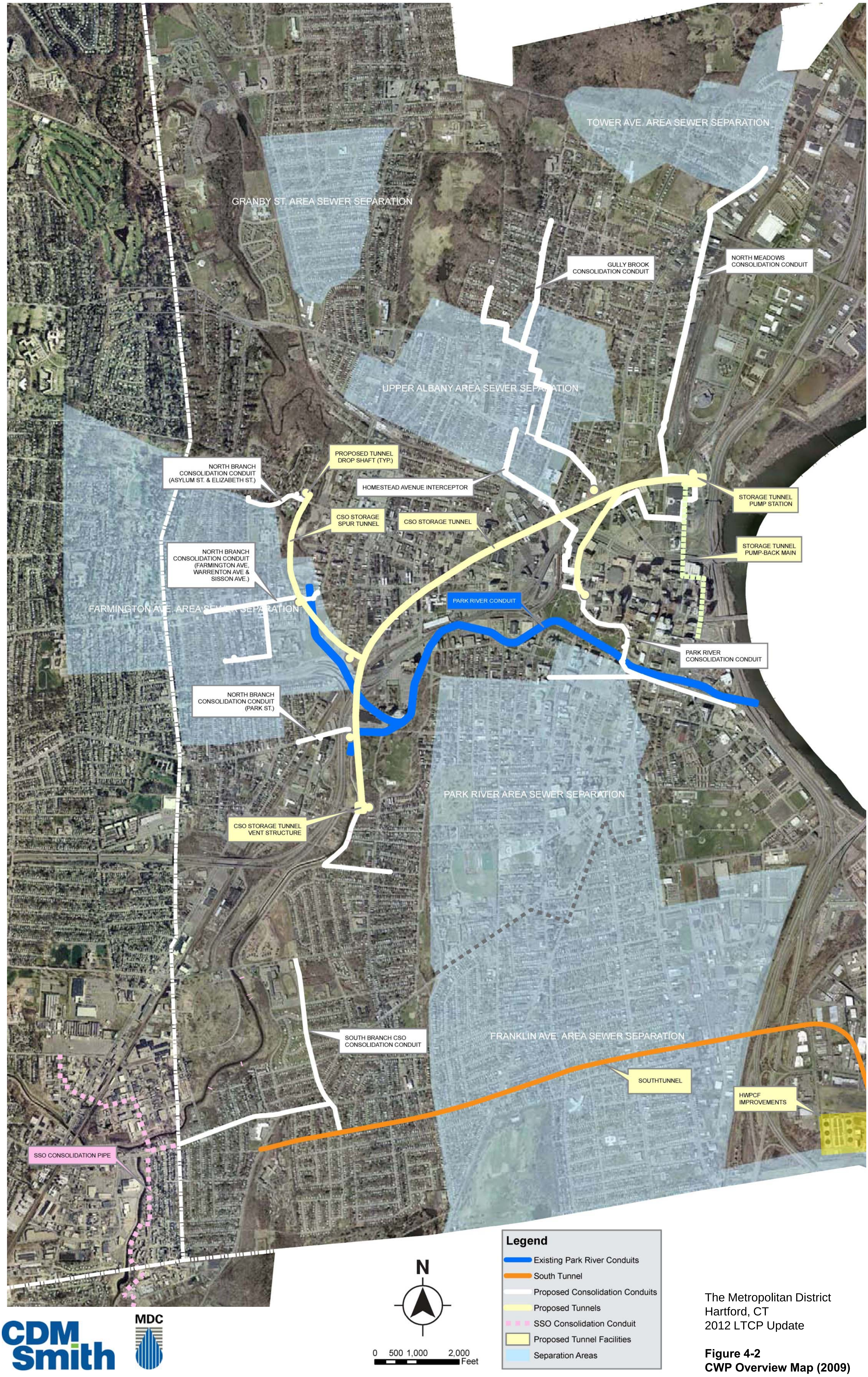

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Figure 4-2
CWP Overview Map (2009)

4.4 Combined Sewer System Projects Progress

The District has constructed many piping projects in the combined sewer system as part of the CWP. To date, Tower Brook (surface stream) flow was removed from the combined sewer system and this flow is now conveyed by a separate drainage system to the Connecticut River. Disconnection of the Gully Brook flow is also near completion with the construction of the Garden Street Sewer, Homestead Avenue Interceptor Extension, Burton Street, Upper Albany #1 (Eastside), and Edgewood Street separation projects. Table 4-1 and Figure 4-3 summarize the CSS projects that will be completed by 2015 and the costs. In total these projects will have separated approximately 600 acres of the combined sewer system, removed Gully Brook and Tower Brook flow, and made other system improvements with a total cost of approximately $260 million.

HWPCF improvements are discussed in Section 5.

4.4.1 North Branch Park River Drainage Area

Granby 2/5 – Northwest and Southwest Sewer Separation

The Granby 2/5 sewer separation project reduces flow to regulators N-2 and N-4 through public right-of-way separation (approximately 19,000 LF of new sewer and storm pipe) and private inflow removal at 170 properties. The project was substantially completed in the summer of 2014.

Farmington 6 Sewer Separation

The District prioritized Farmington 6 Sewer Separation because it provided immediate CSO reduction at N-14 by finishing separation of an upstream area that was partially separated but recombined at the intersection of Farmington Avenue and Prospect Avenue. The project consists of public right-of-way separation (approximately 3,200 LF of new sewer pipe) and private inflow removal at 100 properties. The project is under construction with an expected completion in the fall of 2015.

Farmington 7.1 Partial Sewer Separation

The District expedited the Farmington 7.1 separation area, located in West Hartford, to meet the town of West Hartford's paving program. The project consisted of public right-of-way separation (approximately 2,700 LF of new sewer and storm pipe) and private inflow removal at 60 properties. The area in Farmington 7.1 was only partially separated because the separated flow recombines downstream. The project was completed in the summer of 2013.

Farmington 7.2 Partial Sewer Separation

The Farmington 7.2 separation project consists of public right-of-way separation (approximately 2,800 LF of new sewer and storm pipe) and private inflow removal at 54 properties. Similar to Farmington 7.1, Farmington 7.2 is only partial separation because the separated flow recombines downstream. The project was completed in the spring 2014.

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Table 4-1
Sewer Collection System Improvements Included in the Future Baseline Model

Project Name	Drainage Area	Substantial Completion Year	Cost
Farmington 7.1 Partial Sewer Separation (West Hartford)	North Branch Park River	2013	$2.6M
Farmington 7.2 Partial Sewer Separation (West Hartford)	North Branch Park River	2014	$3.5M
Granby 2/5 - Northwest & Southwest Sewer Separation	North Branch Park River	2014	$35.1M
Farmington 6 Sewer Separation	North Branch Park River	2015	$4.7M
Edgewood Street Sewer Separation	Gully Brook	2011	$3.5M
Homestead Avenue Interceptor Extension	Gully Brook	2011	$31.0M
Garden Street Relief Sewer	Gully Brook	2012	$6.8M
Burton Street Sewer Separation	Gully Brook	2012	$8.6M
East Side Sewer Separation (Upper Albany 1)	Gully Brook	2015	$27.2M
Retreat Avenue Partial Sewer Separation	Park River	2014	$8.9M
Airport Road Pump Station & Force Main Extension	Franklin Avenue	2012	$5.5M
Hartford Area Building Disconnect - Franklin 16, 17, and 18	Franklin Avenue	2013	$1.4M
Upper Franklin Avenue Sewer Separation (Franklin 13)	Franklin Avenue	2015	$42.5M
South Maple Ave Sewer Separation (Franklin 5)	Franklin Avenue	2015	$29.2M
Tower Brook Conduit Extension	North Meadows	2006	$8.2M
Tower Avenue North Sewer Separation	North Meadows	2011	$7.7M
Hartford Area Building Disconnect - Tower Area	North Meadows	2012	$4.4M
Tower Avenue South Sewer Separation	North Meadows	2014	$13.4M

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Figure 4-3
2015 Conditions Model

4.4.2 Gully Brook Drainage Area

Gully Brook, a natural waterway located in the central northern section of Hartford, flows into the District's combined sewer system via the Gully Brook Conduit (GBC). The conduit ranges in size from 84 inches in diameter at its upstream end to 120 inches in diameter at its downstream end. Several sanitary connections discharge dry weather flow to the conduit, which requires the conduit to remain in the combined sewer system via the Park River Interceptor (PRI) and ultimately flow to the HWPCF for treatment. During wet weather events, the flow in the GBC exceeds the capacity of the PRI and discharges at the G-20 CSO regulator.

The original 2005 LTCP recommended removing Gully Brook from the combined sewer system, thus eliminating a peak flow of approximately 38 mgd of clean water during the 1-Year Design Storm. A Gully Brook Disconnect report was prepared to identify the projects necessary to remove Gully Brook from the sewer system. The District has completed, and is currently constructing, several projects in the area to accomplish this goal. Removing Gully Brook will also enable the District to eliminate its largest CSO discharge at G-20.

At the completion of the projects listed below, the District must inspect the remaining system to ensure that all remaining sewer connections and sewer services to the GBC have been eliminated. Once this is confirmed, the District can eliminate G-20. This is expected to occur in 2015.

Homestead Avenue Interceptor Extension

The Gully Brook Disconnect Report recommended the construction of the Homestead Avenue Interceptor Extension (HAIE) as a first step in the process to disconnect the GBC from the combined sewer system. HAIE was substantially completed in 2011. The HAIE removed dry weather sanitary discharge from the 54-inch Homestead Avenue Interceptor (HAI), the 15-inch Walnut Street Sewer, and the 42-inch Chestnut Street Sewer from the GBC. The project redirected dry and wet weather flow (for up to the 1-Year Design Storm) from the three combined pipes to the PRI. During wet weather conditions exceeding the 1-Year Design Storm, the Walnut Street and Chestnut Street sewers overflow to the GBC. The HAIE currently overflows to the Park River Storm Drain at Bushnell Park. There are also several restrictor plates installed along the interceptor at the siphons to minimize downstream surcharging until other system-wide modifications are implemented to accept this flow.

Garden Street Relief Sewer

The Garden Street Relief Sewer project was proposed as a component of the HAIE, but it was separated into its own contract for implementation of the two projects. The Garden Street Relief Sewer controls flow up to the 1-Year Design Storm at regulator G-13 and convey it to the HAI and HAIE, which will alleviate surcharged conditions in the combined sewer in Albany Avenue. The project provides sewer separation on Liberty Street and Garden Street and was completed in 2012.

Edgewood Street Sewer Separation

The District initiated the Edgewood Street Sewer Separation as the first separation project in the Gully Brook drainage area as part of the CWP. The project also served as a private inflow (roof leaders, sump pumps, etc.) removal pilot project for the District. Construction consisted of approximately 3,200 feet of new sewer and storm pipe and private inflow removal at private properties. The District completed the project in July 2011.

Burton Street Sewer Separation

The Burton Street Sewer Separation project was designed in tandem with the Edgewood Street Sewer Separation. The project enabled the District to completely eliminate the G-14 CSO regulator. The Burton Street project consisted of approximately 5,400 feet of new sewer and drain pipes and private inflow removal at private properties. The project was completed in 2012.

Upper Albany #1 - East Side Sewer Separation

The East Side Sewer Separation will remove multiple direct dry weather sanitary sewer discharges from the GBC, including both combined sewers and building lateral connections. The project consists of approximately 15,400 feet of new sewer and storm pipes and private inflow removal at private properties. The project is under construction with an expected completion in the summer 2015.

4.4.3 Park River Drainage Area

Retreat Avenue Partial Sewer Separation

Basement backups at Hartford Hospital and an office building located at 100 Retreat Avenue prompted this partial sewer separation project. The project will separate Retreat Avenue via the construction of a new drain; however, the new drain will connect to the Jefferson Street Interceptor so future work will still be required for complete separation. The project was substantially completed in summer 2014.

4.4.4 Franklin Avenue Drainage Area

Hartford Area Building Disconnect – Franklin 16, 17, and 18

The Franklin Avenue Area Building Disconnect projects consisted on the installation of piping to disconnect the private inflow source within existing properties and buildings in areas where the District had already completed sewer separation. This work was completed in three construction contracts in 2013.

Upper Franklin Avenue Sewer Separation

The Upper Franklin Avenue Sewer Separation project (Franklin Contract #13) consists of approximately 13,000 LF of new sewer and storm pipe and private inflow removal at 400 properties. The project is under construction with an expected completion in the fall of 2015.

South Maple Avenue Sewer Separation

The South Maple Avenue Sewer Separation project (Franklin Contract #5) consists of approximately 13,500 LF of new sewer and storm pipe and private inflow removal at 240 properties. The reduction in combined flow as a result of the project will completely eliminate the F-31 CSO regulator during the WC/NBPR Design Storm. The project is under construction with an expected completion in the spring of 2015.

Airport Road Wastewater Pumping Station and Force Main Project

The Airport Road Wastewater Pumping Station and Force Main Project addressed chronic system surcharging in the Standish Street neighborhood. Both the existing pump station and force main had reached their useful service life and were in need of replacement. This project relocated the force main to discharge to a sewer with more capacity to eliminate surcharging at Standish Street. The project was substantially completed in 2012.

4.4.5 North Meadows Drainage Area

Tower Brook Conduit Extension

The Tower Brook Conduit Extension (TBCE) project was the first project in the Tower Avenue separation area. The District prioritized the project because it provided drainage infrastructure for future projects. The primary accomplishment of the TBCE was to redirect the existing 42-inch Tower Brook Conduit (TBC) from the combined sewer system to the North Meadows Storage Pond. The project also removed public storm drainage and an intermittent brook from the combined system which reduced the overflows at NM-2, NM-3, and NM-4. The District completed work for this project in 2006.

Tower Avenue North Sewer Separation

The Tower Avenue North Sewer Separation project connected new drains to stubs provided under the TBCE project and separated upstream area of CSO regulators NM-2, NM-3, and NM-4. The project consisted only of public right-of-way separation with 5,500 LF of storm pipe. The District removed the private inflow in a separate project, discussed further below. The District completed the Tower Avenue North Sewer Separation project in the summer of 2011.

Tower Avenue South Sewer Separation

The Tower Avenue South Sewer Separation project is the final separation project in the Tower Avenue area. The project included 8,500 LF of new sanitary and storm pipe and private inflow removal at 95 properties. The project was substantially completed in fall of 2014.

Hartford Area Building Disconnect – Tower Area

The Hartford Area Building Disconnect – Tower Area project consisted of the installation of piping to disconnect the private inflow sources within existing properties and buildings in areas where the District had already completed sewer separation. The project was completed in the summer of 2012.

4.5 Sanitary Sewer Overflow Abatement

The 2005 LTCP included a goal of 25 percent reduction of infiltration and inflow (I/I) from the neighboring District member communities to assist in the reduction of total flows to the CSS and to help reduce CSO discharges in Hartford. This assumption was made prior to any computer model or investigations in the member communities. Following completion of the 2005 LTCP, the District entered into a Consent Decree with the EPA (case number 3:06-cv-00728-PCD filed August 17, 2006) to more fully address SSO issues in the member towns.

The CWP has evolved to address the additional work required by the Consent Decree, which focuses on two primary groups of projects: work to be completed on a 5-year schedule in Rocky Hill, Wethersfield, and Windsor; and work to be completed on a 10-year schedule in West Hartford and Newington. Ongoing SSO investigations, including computer model evaluations, have identified the severity of the wet weather issues in the member communities. These investigations have resulted in the District lowering its I/I reduction goal as part of the LTCP to about 10 percent reduction to reflect the significant challenges in addressing private inflow issues.

The District initiated Sewer System Evaluation Surveys (SSES), which resulted in twenty sewer and manhole rehabilitation contracts aimed at reducing the I/I in Newington, Rocky Hill, West Hartford, Wethersfield, and Windsor. The contracts are in various stages and are discussed in detail below.

Figure 4-4 shows the progress of the SSO program. The District has committed $128 million of the Clean Water Project Budget to sewer rehabilitation in the SSO communities.

Capacity Assessment – West Hartford and Newington

Preliminary capacity assessments using the SWMM model were developed for West Hartford and Newington in May 2008. Additional I/I investigations were recommended including a pilot study in four sub-areas to better define the extent and source of I/I (see below). The updated Capacity Assessment for West Hartford and Newington incorporated improvements in the SSO model (discussed below) and was submitted in 2009.

Capacity Assessment – Windsor, Rocky Hill and Wethersfield

Preliminary capacity assessments using the SWMM model were developed in two reports for Windsor, Rocky Hill, and Wethersfield in May 2008. Additional I/I investigations were recommended including a pilot study in sub-areas to better define the extent and source of I/I (see below). The updated Capacity Assessment for Windsor, Rocky Hill, and Wethersfield incorporated improvements in the SSO model (discussed below) and was submitted in 2009.

SSO Hydraulic Computer Modeling and Pilot Investigations

The District continues to work with consultants to revise the SSO hydraulic model to better define existing conditions and to make future recommendations for improvement. Flow monitoring and model re-calibration were completed in 2008 along with pilot investigations in four subareas to better refine the impact of I/I (as discussed above). These results were used to revise and update the model, which was submitted to CTDEEP/EPA in 2009.

SSES – West Hartford and Newington

An SSES was completed in the towns of West Hartford and Newington in May 2008. Recommendations included lining 485,000 linear feet of existing sewer pipe; replacing 30,000 linear feet of sewer; replacing over 1,900 manhole covers; and rehabilitating 280 manholes with new liners. Many of these recommendations are already being implemented by the District as discussed further in the below projects.

SSES – Windsor, Rocky Hill, and Wethersfield

Two SSES reports were completed for the towns of Windsor, Rocky Hill, and Wethersfield in May 2008. Recommendations included lining 258,000 linear feet of existing sewer pipe and replacing 1,800 manhole covers. Many of these recommendations are already being implemented by the District as discussed further in the below projects.

SSES – Folly Brook Area

A Phase I SSES Flow Monitoring Report was completed in May 2008 and Phase II SSES was completed in May 2010. The Folly Brook system is located in Wethersfield and tributary to the HWPCF. Recommendations included lining 61,000 linear feet of existing sewer; 12 point repairs; and lining 210 manholes.

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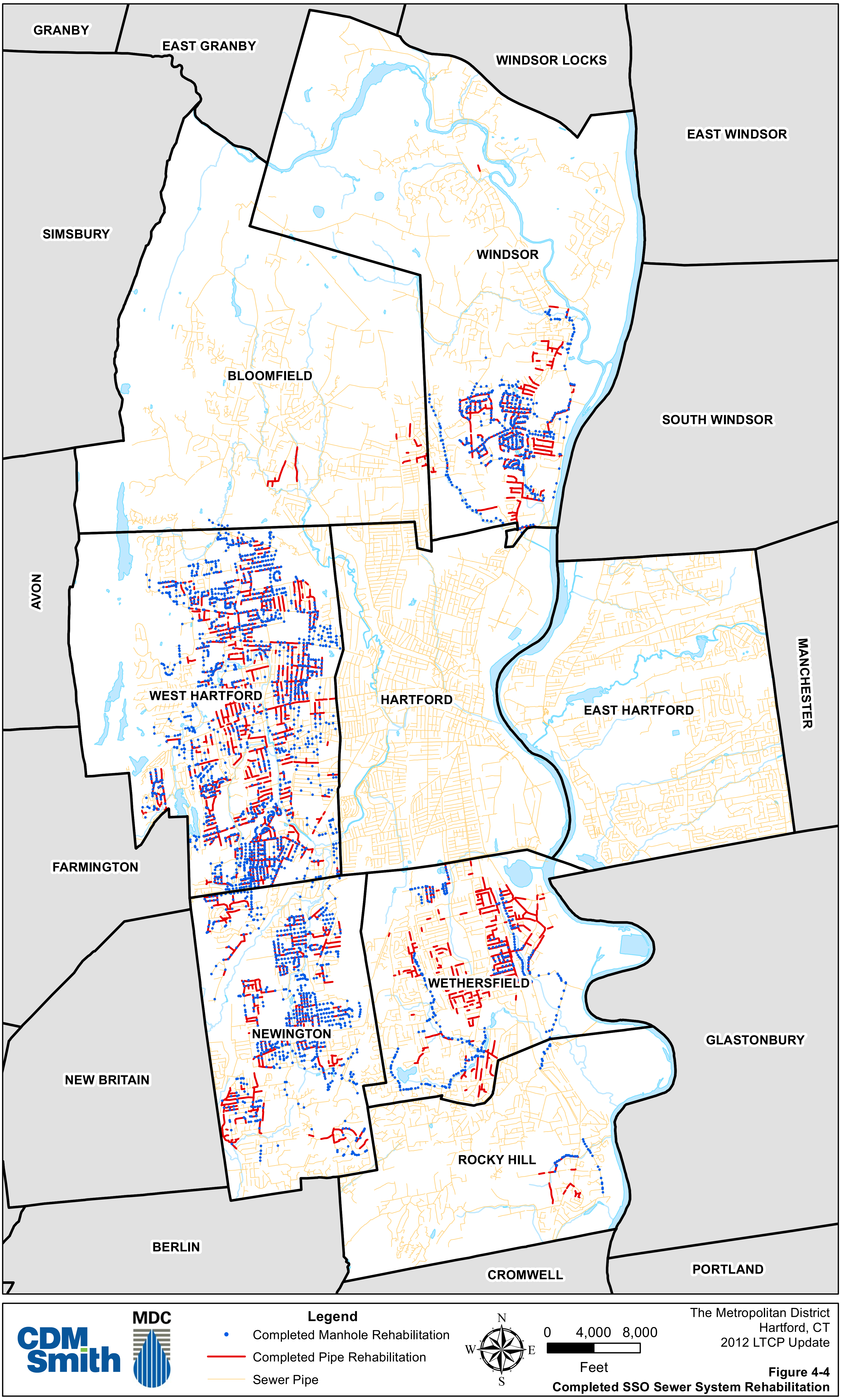

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Figure 4-4
Completed SSO Sewer System Rehabilitation

Sewer Rehabilitation Techniques Pilot Studies and Projects

The District initiated a program to study, implement, and monitor discrete sewer rehabilitation techniques in each of the member communities to determine which rehabilitation approaches and inflow removal strategies work best in the District's sewer systems. The initial pilot studies identified which rehabilitation techniques would be applied in each discrete study subarea. The work was divided into five pilot study contracts (2011-09, 2011-10, 2011-11, 2011-48, and 2011-49) and included lining 75,000 linear feet of existing sewer; 1,200 linear feet of manhole-to-manhole pipe replacements; 30 point repairs; replacing 440 manhole frame and covers; lining 400 manholes; replacing 8,300 linear feet of service laterals; lining 20,000 linear feet of existing service laterals; installing 100 service lateral connection liners (top hats); and removing private inflow at 100 buildings. Construction of the pilot contracts was completed in 2014 and the results are currently being evaluated and will be incorporated in the 2014 SSO Program Master Plan discussed further below.

SSO SCADA Upgrades

The District expanded their Overflow Alarm and Monitoring system to an additional nine regulator structures, four SSOs and five CSOs, in 2007. The same project also included the installation of 12 new flow meters on major trunk sewers influent to the Hartford CSS and upgraded rain gauge capabilities and reporting functions. In 2010, the district further expanded the SCADA system to include the Homestead Avenue Interceptor Extension, a project that reduced total overflow volume but added three new CSO regulator structures.

Pre-SSES Report Rehabilitation Contracts

Prior to the SSES reports, the District pro-actively initiated multiple sewer and manhole rehabilitation contracts to improve their system and address problems from aging infrastructure. The completed work included lining 140,000 linear feet of existing sewer and lining 40 manholes.

Sewer and Manhole Rehabilitation Contract (2005-86)

The work included lining 5,000 linear feet of existing sewer and lining 120 manholes in Windsor. The project was completed in 2010.

Sewer and Manhole Rehabilitation Contract (2005-89)

The work included lining 9,300 linear feet of existing sewer and lining 210 manholes in Rocky Hill and Wethersfield (Rocky Hill sewershed). The work was completed in 2011.

Point Repair and Pipe Replacement Contract (2007-104)

The work included 4,000 linear feet of manhole-manhole sewer replacement; 70 point repairs; and 2,000 linear feet of sewer lateral replacement in Rocky Hill and West Hartford. The project was completed in 2009.

Sewer Lining Contract (2008-44)

The work included lining 240,000 linear feet of sewer in Newington, Wethersfield (Folly Brook sewershed), and West Hartford. The project was completed in 2010.

Sewer Lining Contract (2008-63)

The work included lining 203,000 linear feet of sewer in Rocky Hill, Wethersfield (Rocky Hill sewershed), and Windsor. The project was completed in 2011.

Manhole Replacement Contract (2008-70)

The work included replacing sewer manhole covers on 1,120 manholes in West Hartford and Newington. The project was completed in 2009.

Manhole Replacement Contract (2008-71)

The work included replacing sewer manhole covers on 950 manholes in West Hartford. The project was completed in 2009.

Point Repair and Pipe Replacement Contract (2009-47A)

The work included 34 point repairs and 330 linear feet of manhole-to-manhole sewer replacement in West Hartford. The project was completed in 2014.

Sewer and Manhole Rehabilitation Contract (2009-61)

This contract will complete the remaining SSES recommendations in the Newington sewershed. The work includes lining 53,000 linear feet of existing sewer; one point repair; replacing 100 manhole frame and covers; and lining 100 manholes in Newington. The project also includes 1,000 linear feet of manhole-to-manhole segment replacement in Rocky Hill. The project is in construction and was substantially completed in 2014.

Sewer and Manhole Rehabilitation Contract (2009-96A)

This contract is one of two contracts that will complete the remaining SSES recommendations in the Rocky Hill sewershed. The work includes lining 50,000 linear feet of existing sewer; five point repairs; replacing 230 manhole frame and covers; and lining 90 manholes in Rocky Hill and Wethersfield. The project has been bid and is expected to be awarded in 2014 and completed in 2016.

Sewer and Manhole Rehabilitation Contract (2014B-22)

This contract is the second of two contracts that will complete the remaining SSES recommendations in the Rocky Hill sewershed. The work includes lining 40,000 linear feet of existing sewer; five point repairs; 600 linear feet of manhole-to-manhole sewer replacement; replacing 160 manhole frame and covers; and lining 110 manholes in Rocky Hill and Wethersfield. The project is in design and construction is expected to start in 2015 and be completed in 2017.

Sewer and Manhole Rehabilitation Contract (2012-58)

This contract will complete the remaining SSES recommendations in the Windsor sewershed. The work includes lining 8,900 linear feet of existing sewer; 2,400 linear feet of manhole-to-manhole pipe replacement; seven point repairs; replacing 270 manhole frame and covers; and lining 140 manholes. The project is in design and is expected to be completed in 2017.

Sewer and Manhole Rehabilitation Contract (2012-59)

This contract is one of two contracts that will complete the remaining SSES recommendations in the West Hartford sewershed. The work includes lining 122,000 linear feet of existing sewer; 20 point repairs; 5,300 linear feet of manhole-to-manhole sewer replacement; replacing 485 manhole frame and covers; and lining 200 manholes. The projects are in design and construction is expected to start in 2015 and be completed in 2017.

Future Sewer and Manhole Rehabilitation Contract (West Hartford)

This contract is the second of two contracts that will complete the remaining SSES recommendations in the West Hartford sewershed. The work includes lining 81,000 linear feet of existing sewer; 20

point repairs; 2,300 linear feet of manhole-to-manhole sewer replacement; replacing 70 manhole frame and covers; and lining 30 manholes. The projects are in design and construction is expected to start in 2015 and be completed in 2018.

Future Sewer and Manhole Rehabilitation Contract (Folly Brook)

Two future construction contracts will implement the remaining SSES work in the Folly Brook sewershed. The work includes lining 27,200 linear feet of existing sewer; 12 point repairs; and lining 200 manholes. The project is in design and is expected to be completed in 2017.

Rocky Hill WPCF Master Plan

The District completed a Master Plan for the Rocky Hill Water Pollution Control Facility in April 2011. The master plan evaluated the equipment and treatment processes at the plant and investigated options for wet-weather treatment and biological nitrogen removal capacity and equipment improvements. The Master Plan identified a recommended set of improvements to increase the treatment capacity up to 25 mgd using the MLE secondary treatment process including new aeration tanks and final clarifiers, and improvements to preliminary treatment, electrical and SCADA systems, emergency power, odor control and other ancillary systems. A subsequent BODR recommended increasing the treatment capacity to 27 mgd.

The District completed the design in 2014 and expects to begin construction in 2015 and complete it in 2017.

2014 SSO Master Plan

The District is in the process of updating and consolidating the previously developed SSO elimination plans for the Newington, West Hartford, RHWPCF, and Windsor sewersheds. The 2014 SSO Master Plan will utilize new flow metering data, SSO records, and the pilot study results (discussed above) to determine and prioritize the necessary work in each of the SSO communities to comply with the Consent Decree requirements. The final report will be completed by December 2014.

4.6 Capacity, Management, Operations, and Maintenance

Pursuant to the terms and conditions of the EPA Consent Decree, the District submitted for approval a CMOM Assessment and Corrective Action Plan to EPA and CT DEEP on February 9, 2007. The District is still awaiting approval from the EPA on this document but has initiated many of the activities as part of the routine maintenance programs.

The District has increased sewer cleaning, inspection and repair activities in Hartford and the neighboring towns. Table 4-2 summarizes the extent of CMOM activities within the system completed as part of the CWP. In 2013, the District cleaned approximately 600 miles of sewer, or nearly 50 percent of its system. A qualitative assessment by District staff reports that the extra effort is reducing the occurrence of surcharge in the trunk sewers tributary to Hartford and the District has plans to sustain this level of effort. The results of this effort are discussed further in Section 6 relevant to new information on system complaints and sewer system surcharging.

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Table 4-2
CMOM Progress

CMOM Task	2006	2007	2008	2009	2010	2011	2012	2013	Total
Pipe Segments Cleaned (LF)	2,026,370	1,704,890	3,183,610	3,088,450	3,997,420	3,110,550	3,781,542	3,181,269	**24,074,101**
Pipe Segments Televised (LF)	914,530	467,970	402,280	624,230	533,790	677,610	702,881	784,971	**5,108,262**
Pipe Segments Repaired (LF)	3,300	3,740	550	10,600	10,230	5,700	6,781	5,140	**46,041**
Pipe Segments Lined (LF)	43,300	69,340	37,600	237,190	199,350	28,190	36,303	59,878	**711,151**
Pump Stations Inspected (EA)	876	876	876	888	888	888	876	912	**7,080**
Manholes Inspected (EA)	6,215	2,599	4,780	10,752	4,850	0	6,818	6,734	**42,748**
Manholes Repaired/Replaced (EA)	276	154	136	159	537	8	218	277	**1,765**

4.7 Future Baseline CSO Conditions

4.7.1 Assumptions

The combined sewer system improvement projects discussed above were incorporated into the existing SWMM5 hydraulic model to establish the Future Base Line Model. This simulation represented the improved system-wide condition if all of the ongoing construction projects in the combined sewer system were completed (but no new sewer separation projects were initiated), as summarized in Table 4-1. The model simulation also assumed that the HWPCF wet weather improvements projects would be completed and that the plant could provide up to 200 mgd of peak flow treatment capacity during storm conditions.

Recent model simulations using the updated SWMM model show that if all of the current interceptor sediment is removed to a maximum of depth of only six inches, CSO volumes would be reduced by about 6 million gallons for the 1-Year Design Storm. This is about a 5 percent reduction system-wide CSO reduction. There are many challenges to removing the sediment from the interceptors system-wide and to maintain minimal sediment depths. Surcharge within the system during storm events will continue to temporarily reduce flow velocities and promote the settlement of solids in the upstream interceptor (upstream of CRI and CCRI), which will require continued maintenance. Accordingly, for the purposes of this study, and as a conservative planning measure, removal of the sediment as a system-wide CSO control alternative was not considered effective. However, it is recommended that the District continue to clean sediment from the interceptor and the sewers on a frequent schedule, assess the sediment loadings that reoccur within the pipelines, and adjust the LTCP, as necessary, if sediment can be adequately controlled through typical maintenance procedures.

This Future Baseline Model simulation represents the baseline conditions that will be used to evaluate the alternatives and develop recommendations for further CSO control in the Hartford CSS as discussed later in this report.

4.7.2 Future Baseline Results

The CSO regulators in the Future Baseline Model were placed into 3 categories: CSO regulators with discharges during the design storm (referred to as active regulators), no discharges during the design storm (inactive), and eliminated. The 1-Year Design Storm is the design storm for most of the Hartford CSO regulators. However, the District intends to eliminate (physically seal) the North Branch Park River CSO regulators (N-2, N-4, N-9 and N-10) and the Franklin Avenue area (F-series) CSO regulators. The Wethersfield Cove/North Branch Park River Design Storm (WC/NBPR Design Storm, defined in Section 1) provided the basis for establishing a base condition and comparing control alternatives. Section 11 presents further analysis of other historic storms to fully accommodate the recommended plan of completely eliminating these specific CSO regulators.

Active CSO regulators in the Future Baseline Model are those that need to be addressed in the proposed recommendations in this report. Inactive regulators will be sufficiently addressed when the District completes all ongoing projects. Eliminated regulators are those that will be completely eliminated via the ongoing projects.

Figure 4-3, which shows the projects included in the Future Baseline Model, also identifies the status of each CSO regulator. CSO regulators shown as grey-colored boxes were eliminated by the improvements undertaken by the District since 2005 – including G-20, which was the diversion of Gully Brook into the sewer system; and G-14 and P-11, which were eliminated by the Homestead

Avenue Interceptor Extension and Garden Street Sewer. CSO regulators shown in yellow-colored boxes are those CSO regulators that are not active during the design storm. The CSO regulators shown in an orange-colored box are active during the respective design storm and require further system control improvements.

Table 4-3 summarizes the CSO regulator status by drainage area and Table 4-4 provides the Future Baseline overflow volume, flow rate, and duration for each CSO regulator (SSO flows are not included). It should be noted that the duration of the CSO discharges at some CSO regulators extend for a longer period of time than many of the other CSO regulators. This is the cumulative effect, in the simulation model, of the extended period of infiltration and other inflow (sump pumps, etc.) after the storm event.

Table 4-3
Summary of Overflows by Drainage Area during Design Storm[1]

Drainage Area	Active During Design Storm	Inactive During Design Storm	Completely Eliminated
North Branch Park River	13	1	0
South Branch Park River	17	1	0
Gully Brook[(2)]	10	4	2
Park River[(3)]	16	5	1
Franklin	7	1	0
North Meadows	8	0	0
South Meadows	1	0	0
Total	**72**	**12**	**3**

Notes:

1) Either 1-Year Design Storm or Wethersfield Cove/North Branch Park River Design Storm

2) G-14 is one of the two CSO regulators eliminated in the Gully Brook area. It was included in the 2009/2011 model but has already been eliminated and is included as eliminated in the Future Baseline Model. (G-20 is the other regulator that will be eliminated but has not yet).

3) P-11 is the eliminated regulator in the Park River area. It was included in the 2009/2011model but has already been eliminated and is included as eliminated in the Future Baseline Model.

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Table 4-4
CSO Flows and Volumes in Future Baseline Model

Regulator Information				Design Storm				Typical Year		
	Regulator	*Origin of Flow*	*Receiving Water*	*Design Storm*	*Peak Flow (mgd)*	*Volume (MG)*	*Duration (hours)*	*Peak Flow (mgd)*	*Cumulative Annual Volume (MG)*	*Number of Events*
Franklin	F-26	Franklin Avenue Area/Wethersfield	Wethersfield Cove	WC/NBPR	42	10.9	21	29	21.4	23
Franklin	F-27	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	26	4.1	6	36	7.2	11
Franklin	F-28	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	7	2.6	14	7	6.4	20
Franklin	F-29	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	39	6.1	13	37	11.4	20
Franklin	F-30	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	21	4.2	13	25	13.3	20
Franklin	F-31	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	0	0	0	0	0	0
Franklin	F-32	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	58	5.4	7	47	8.4	14
Franklin	F-33	Franklin Avenue Area	Wethersfield Cove	WC/NBPR	17	2.6	5	17	3.7	10
Gully Brook	G-2	Gully Brook Area/Bloomfield	Gully Brook Conduit	1-Year	48	2.4	3	56	11.7	27
Gully Brook	G-8	Gully Brook Area	Gully Brook Conduit	1-Year	6	0.3	2	7	1.2	17
Gully Brook	G-9	Gully Brook Area	Gully Brook Conduit	1-Year	8	0.3	2	8	1.2	18
Gully Brook	G-10	Gully Brook Area	Gully Brook Conduit	1-Year	4	0.2	2	4	0.5	15
Gully Brook	G-11	Gully Brook Area	Gully Brook Conduit	1-Year	6	0.3	2	6	1.1	17
Gully Brook	G-12	Gully Brook Area	Gully Brook Conduit	1-Year	3	0.1	1	3	0.2	5
Gully Brook	G-13E	Gully Brook Area	Gully Brook Conduit	1-Year	0	0	0	0.4	<0.1	1
Gully Brook	G-13W	Gully Brook Area	Gully Brook Conduit	1-Year	1	<0.1	0.5	4	<0.1	1
Gully Brook	G-14	Gully Brook Area	Eliminated	1-Year	ELIM	ELIM	ELIM	ELIM	ELIM	ELIM
Gully Brook	G-15	Gully Brook Area	Gully Brook Conduit	1-Year	0	0	0	0.4	<0.1	1
Gully Brook	G-17A	Gully Brook Area/North Branch Park River Area	Gully Brook Conduit	1-Year	7	0.1	1	10	0.3	2
Gully Brook	G-17B	Gully Brook Area	Gully Brook Conduit	1-Year	0	0	0	0	0	0
Gully Brook	G-19	Gully Brook Area	Gully Brook Conduit	1-Year	1	<0.1	0.8	2	<0.1	1
Gully Brook	G-20	Gully Brook Area	Eliminated	1-Year	ELIM	ELIM	ELIM	0	0	0
Gully Brook	G-21	Gully Brook Area	Gully Brook Conduit	1-Year	8	0.4	4	9	1.7	33
Gully Brook	G-23	Gully Brook Area	Gully Brook Conduit	1-Year	0	0	0	0	0	0
North Branch Park River	I-4	North Branch Park River Area	Park River Conduit	1-Year	0	0	0	0	0	0
North Branch Park River	N-2	North Branch Park River Area/Bloomfield	North Branch Park River	WC/NBPR	157	8.2	3	38	2.9	5
North Branch Park River	N-4	North Branch Park River Area	North Branch Park River	WC/NBPR	58	2.7	3	33	1.7	5
North Branch Park River	N-9	North Branch Park River Area/West Hartford	North Branch Park River	WC/NBPR	17	2.1	5	18	1.7	4
North Branch Park River	N-10	North Branch Park River Area	North Branch Park River	WC/NBPR	24	0.6	1	3	<0.1	1
North Branch Park River	N-12	North Branch Park River Area	Park River Conduit	1-Year	4	0.3	5	5	1.7	39
North Branch Park River	N-14	North Branch Park River Area/West Hartford	Park River Conduit	1-Year	32	0.9	3	24	2.5	14
North Branch Park River	N-22	North Branch Park River Area	Park River Conduit	1-Year	7	0.4	2	8	1	7
North Branch Park River	N-23	North Branch Park River Area	Park River Conduit	1-Year	7	0.6	5	8	3.5	32
North Branch Park River	N-24	North Branch Park River Area/West Hartford	Park River Conduit	1-Year	15	0.8	3	17	2.8	18
North Branch Park River	N-25	North Branch Park River Area/Park River Area	Park River Conduit	1-Year	45	2.3	5	50	13.3	34
North Branch Park River	N-28A	North Branch Park River Area	Park River Conduit	1-Year	10	0.6	2	12	3	18
North Branch Park River	N-28B	North Branch Park River Area	Park River Conduit	1-Year	20	0.9	2	27	2.3	8
North Branch Park River	N-29	North Branch Park River Area	Park River Conduit	1-Year	7	0.6	4	8	6.5	32
North Meadows	NM-2	North Meadows Area	North Meadows Storage Pond	1-Year	2	0.1	1	4	1.1	6
North Meadows	NM-3	North Meadows Area	North Meadows Storage Pond	1-Year	1	<0.1	1	2	1	7
North Meadows	NM-4	North Meadows Area	North Meadows Storage Pond	1-Year	7	0.3	2	11	31.2	25
North Meadows	NM-5	North Meadows Area/Windsor	North Meadows Storage Pond	1-Year	27	1.4	2	29	15.5	14
North Meadows	NM-6	North Meadows Area	North Meadows Storage Pond	1-Year	5	0.2	2	5	2.6	16
North Meadows	NM-7	North Meadows Area	North Meadows Storage Pond	1-Year	6	0.2	2	7	1	8
North Meadows	NM-10	North Meadows Area	Connecticut River	1-Year	20	1.5	4	37	49	24
North Meadows	NM-14	North Meadows Area	Connecticut River	1-Year	1	<0.1	0.5	1	<0.1	1

Table 4-4
CSO Flows and Volumes in Future Baseline Model

Regulator		Origin of Flow	Receiving Water	Design Storm	Peak Flow (mgd)	Volume (MG)	Duration (hours)	Peak Flow (mgd)	Cumulative Annual Volume (MG)	Number of Events
Park River	P-1	Park River Area	Park River Conduit	1-Year	44	4.2	4	50	37	19
	P-2	Park River Area	Park River Conduit	1-Year	16	0.7	2	20	2.2	9
	P-3	Park River Area	Park River Conduit	1-Year	0	0	0	0	0	0
	P-4	Park River Area	Park River Conduit	1-Year	6	0.3	2	8	0.9	18
	P-5	Park River Area	Park River Conduit	1-Year	24	3.3	13	36	55.2	55
	P-9	Park River Area	Park River Conduit	1-Year	19	1.6	7	22	16.1	38
	P-10	Park River Area	Park River Conduit	1-Year	16	1.4	7	20	14.1	38
	P-11	Park River Area	Eliminated	1-Year	ELIM	ELIM	ELIM	0	0	0
	P-11A	Park River Area	Park River Conduit	1-Year	42	3	3	94	19	22
	P-12	Park River Area	Park River Conduit	1-Year	69	8.3	9	74	102.7	45
	P-13	Park River Area	Park River Conduit	1-Year	24	1.3	2	37	4.5	17
	P-14	Park River Area	Park River Conduit	1-Year	7	0.2	1	10	0.5	5
	P-15	Park River Area	Park River Conduit	1-Year	31	1.7	5	38	9.6	34
	P-15A	Park River Area	Park River Conduit	1-Year	0	0	0	0	0	0
	P-16	Park River Area	Park River Auxiliary Conduit	1-Year	38	2.5	9	45	22.7	57
	P-16A	Park River Area	Park River Auxiliary Conduit	1-Year	8	0.3	2	10	0.8	7
	P-18	Park River Area	Park River Conduit	1-Year	0	0	0	1	<0.1	1
	P-19	Park River Area	Park River Conduit	1-Year	0	0	0	0	0	0
	P-23	Park River Area	Park River Conduit	1-Year	7	0.2	1	9	0.2	1
	P-24	Park River Area	Park River Conduit	1-Year	21	1.5	3	23	8.4	19
	P-26	Park River Area	Park River Conduit	1-Year	20	0.9	2	25	3.7	16
	P-29	Park River Area	Park River Conduit	1-Year	0	0	0	0.9	<0.1	2
South Branch Park River	S-3	South Branch Park River Area	South Branch Park River	1-Year	2	0.1	2	4	0.3	6
	S-8	South Branch Park River Area/West Hartford	Kane Brook	1-Year	7	0.4	2	8	0.8	6
	S-10	South Branch Park River Area	South Branch Park River	1-Year	0	0	0	0	0	0
	S-12	South Branch Park River Area	South Branch Park River	1-Year	5	0.2	2	7	0.9	15
	S-13	South Branch Park River Area	South Branch Park River	1-Year	8	0.3	2	9	1.3	15
	S-14	South Branch Park River Area	South Branch Park River	1-Year	2	0.1	1	5	0.2	7
	S-15	South Branch Park River Area	South Branch Park River	1-Year	8	1.9	15	8	26.6	64
	S-16	South Branch Park River Area	South Branch Park River	1-Year	15	2	12	15	21.3	54
	S-19	South Branch Park River Area	South Branch Park River	1-Year	8	0.4	3	9	3	39
	S-21	South Branch Park River Area	South Branch Park River	1-Year	7	0.4	3	8	2.8	31
	S-23	South Branch Park River Area	South Branch Park River	1-Year	5	0.2	2	6	1.1	18
	S-24	South Branch Park River Area	South Branch Park River	1-Year	1	<0.1	1	0.8	<0.1	3
	S-25	South Branch Park River Area	South Branch Park River	1-Year	2	0.1	2	2	0.2	10
	S-26	South Branch Park River Area	South Branch Park River	1-Year	5	0.4	5	5	4.7	34
	S-27	South Branch Park River Area	South Branch Park River	1-Year	8	1.1	11	9	18.8	62
	S-28	South Branch Park River Area	South Branch Park River	1-Year	1	<0.1	1	1	<0.1	6
	S-29	South Branch Park River Area	South Branch Park River	1-Year	4	0.3	4	5	2.5	32
	S-30	South Branch Park River Area/West Hartford	South Branch Park River	1-Year	2	0.1	2	2	0.6	20
SM	SM-2	South Meadows Area	Connecticut River	1-Year	51	5.1	4	54	34.1	17

4.8 Current CSO Control Benefits

Table 4-5 summarizes the CSO reduction achieved by the ongoing LTCP improvements in the Future Baseline Model during the 1-Year Design Storm. Significant CSO reduction will be achieved in the Gully Brook area with the elimination of Gully Brook from the sewer system and completion of the Homestead Avenue Interceptor Extension, Garden Street Sewer, and miscellaneous local area separation projects.

The North Branch, North Meadows, and Franklin Avenue CSOs are partially reduced due to the upstream sewer separation projects. CSO reduction was also achieved in the South Meadows area because of upstream system improvements and as a result of the improved HWPCF operations. Park River CSOs increased due to the elimination of the orifice restrictor plates along the HAIE, which is now conveying unrestricted flow down to the Park River Interceptor. The flows discharged from the HAIE CSO regulators are included in the Gully Brook area total.

Table 4-5
1 Year CSO Volume (MG) Comparison

Drainage Area	2009	Future Baseline
North Branch	12.2	11.4
Gully Brook	20.7	7.0
Park River	25.8	28.4
North Meadows	5.1	3.8
South Branch	8.1	8.1
Franklin Avenue	15.0	10.9
South Meadows	8.6	5.1
Total	**95.5**	**74.7**

Table 4-6 summarizes the CSO reduction achieved by the LTCP improvements in the Future Baseline Model during the typical year (as defined in Section 1). Typical year flow rates are also included in Table 4-4 for each individual CSO outfall.

Table 4-6
Typical Year CSO Volume (MG) Comparison

Drainage Area	2009	Future Baseline
North Branch	56	43
Gully Brook	225	37
Park River	276	279
North Meadows	114	102
South Branch	86	85
Franklin Avenue	111	72
South Meadows	106	34
Total	**974**	**652**

System-wide, the CSO volume in a typical year has been reduced by 322 million gallons or a 33 percent reduction in average annual CSO overflow with the system improvements implemented (by ongoing projects) as part of the District's LTCP. Significant reductions have come from the elimination of Tower Brook and Gully Brook flow and the reduction of inflow from the sewer separation projects.

Section 5

Hartford Water Pollution Control Facility and Improvements

5.1 General

The HWPCF is located on the Connecticut River in the southeast corner of Hartford. The HWPCF was originally built in 1938 to provide seasonal primary treatment, and was expanded in 1969 to provide year round primary and secondary treatment. The plant was upgraded in 1986 to improve preliminary treatment (screening and grit removal), and in 1994 to provide treatment and disinfection for elevated wet weather flows. Figure 5-1 shows a site plan of the existing HWPCF.

This section discusses the existing facilities as they were in 2005, at the time of the 2005 LTCP. In addition, the section discusses the ongoing facility improvements that are being implemented to address the goals of the LTCP – reliable secondary treatment and enhanced influent pumping, preliminary treatment, and wet weather treatment for better and increased treatment capacity for CSOs and SSOs– and the nitrogen reduction program.

5.2 Description of 2005 HWPCF Systems

Information in this subsection is excerpted from operations and maintenance manual data from the 1969 facility expansion (secondary treatment upgrade), installation of the current grit removal system (circa 1986), and the 1994 addition of wet weather treatment processes. This section describes the system at the time the 2005 LTCP was completed. Some data have been generalized, but provides a good overview of the existing facility operations related to wet weather treatment.

5.2.1 Type of Facility

The 1969 HWPCF improvements were designed on the basis of an average flow rate of 60 mgd. The facility is a secondary treatment facility utilizing the step aeration activated sludge process. The facility also has the capability to be operated utilizing the contact stabilization modification of the activated sludge process. The facility provides for removal, treatment, and disposal of settleable and floating solids and for the reduction of suspended and dissolved organic material. Thickened primary sludge, raw secondary sludge, scum, and waste activated sludge are dewatered by centrifuge and then incinerated. The effluent is disinfected by chlorination on a seasonal basis prior to discharge to the Connecticut River.

5.2.2 Flow Pattern

Untreated wastewater first passes through four mechanically cleaned bar screens (discussed in wet weather pump station below). Grit is removed in four vortex grit chambers. After passing through the grit chambers, the flow proceeds to twelve rectangular primary settling tanks equipped with chain type collectors and helical skimmers. From the primary tanks, the flow is pumped to six aeration tanks for secondary treatment. From the aeration tanks, the flow proceeds to six circular final settling tanks. The final effluent is chlorinated and then discharged to the Connecticut River. During high river stages, the effluent is pumped to the river.

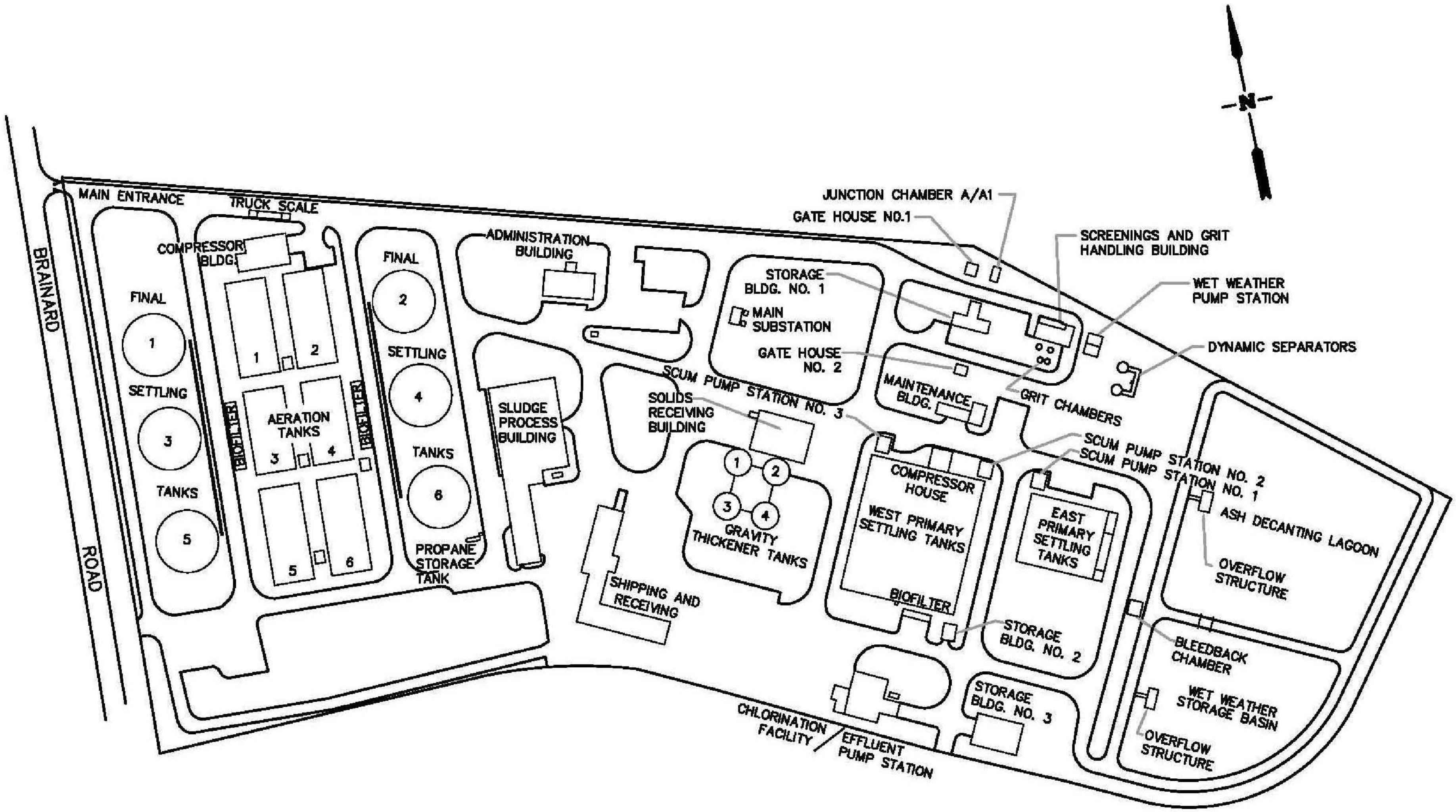

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Figure 5–1: Site Plan – Existing Conditions (2005)
Hartford Water Pollution Control Facility

5.2.3 Screening and Grit Handling

The Screenings and Grit Handling Building and Grit Chambers provide preliminary treatment for the raw sewage which enters the HWPCF. The design capacity of the screening and grit removal system with all units in service is 109 mgd.

The first step in preliminary treatment is removal of large solids by screening. These solids, or screenings, are removed by four mechanically cleaned reciprocating rake type bar screens automatically. Screenings are lifted out of the channel by the screens and deposited on a conveyor which transports them to a washer/ compactor. From the washer/compactor, the screenings discharge to a dumpster in the truck loading bay.

Following screening, sewage passes through four circular vortex type grit chambers for removal of heavy inorganic silts, sands, and gravel. Each of the four grit chambers has a maximum design capacity of 37.5 mgd. The grit chamber sump is pumped out periodically to remove accumulated grit, which is washed, concentrated and dewatered before the remaining grit is trucked off-site for disposal.

5.2.4 Wet Weather Operations

5.2.4.1 Wet Weather Pump Station

During wet weather conditions, the District's interceptors often experience flows exceeding HWPCF secondary treatment capacity. Flows over 90 mgd bypass secondary treatment and are conveyed to the Wet Weather Pump Station (WWPS). To provide treatment to the excess flow, the WWPS conveys excess flow through a pair of dynamic separators. From the dynamic separators, flow discharges into the Wet Weather Storage Basin (WWSB) for storage and is directed back to the head of the facility for treatment following a storm event. If the WWSB's capacity is exceeded during a storm event, the basin overflows to the secondary effluent pump station wet well, is chlorinated, and mixed with final effluent before discharge to the Connecticut River.

The WWPS is located in the north of the site, east of the screenings and grit handling building. This one story building consists essentially of a generator and electric room, and a substructure containing a valve pit, and a wet well with four CSO pumps. The wet well is divided into two sections. The smaller section, to the north, receives influent flows from the 54 inch diameter influent conduit through an opening in the north wall of the station. Influent flow to the wet well is controlled by a sluice gate. The sluice gate operator is a manual crank type and is located at ground level.

Flows exit the bottom of the small wet well into the large wet well where it is pumped to the dynamic separators via the four CSO pumps. The pumps are non-clog, submersible type with a rated capacity of 20 mgd at 27.5 feet of head and are driven by 134 horsepower electric motors. When primary flow exceeds 90 mgd, the wet weather pumps start and increase speed until primary flow is reduced to 90 mgd. The WWPS pumps have an approximate maximum combined capacity of 50 mgd based on readings from the WWPS magnetic flow meter, which gives the HWPCF a total peak flow capacity of 140 mgd during storm events.

5.2.4.2 Dynamic Separators

The dynamic separators are located south of the WWPS. Two units, each 30 feet in diameter, receive wastewater pumped from the WWPS during high wet weather flow periods, and discharge, by gravity flow, to the WWSB. The dynamic separators are intended to remove gross solids, sand and grit from the influent wastewater using a combination of vortex and gravitational forces.

The dynamic separators are automatically controlled under normal operations. A flow control valve in a vortex flow splitter box controls their operation and directs flow to either of the two separators.

5.2.4.3 Wet Weather Storage Basin

Wastewater from the dynamic separators flows by gravity to a former ash storage lagoon, now known as the Wet Weather Storage Basin, through the lagoon gating chamber. The WWSB has a storage volume of approximately 4.74 million gallons. When the capacity of the storage basin is exceeded, overflow is directed by an overflow weir to the secondary effluent pump station. This overflow is mixed with final effluent before disinfection and discharge to the Connecticut River. Seasonal chlorination is provided for disinfection, from May 1 through September 30.

5.2.4.4 Bleed Back Chamber

After a storm, stored wet weather flow is bled back to the main treatment processes via the bleed back gating chamber. The chamber has sluice gates to direct the bleed back flow to the desired area of the facility depending upon how fast storm flows subside. Initially, the flow will be sent to the influent channel of East Primary Settling Tanks. Once the facility flow has subsided below 60 mgd, flow can also be bled back to the headworks of the facility before the screens. These sluice gates are manually operated with remote indication of sluice gate position at the Sludge Processing Building, and on the Lagoon Monitoring Panel in the WWPS.

5.3 HWPCF Facility and High Flow Management Improvements

The District currently has a number of improvement projects in the design and construction phase, with some improvements recently completed and operational to address the goals of the LTCP and nitrogen removal goals. The HWPCF Master Plan completed in 2009 recommended improvements to a variety of systems. The Master Plan recommended that the HWPCF provide Biological Nutrient Removal (BNR) treatment to a typical sustained flow of up to 90 mgd and a peak wet weather flow capacity of up to 200 mgd (with flows above 90 mgd processed through a new wet weather treatment train). The Wet Weather Expansion Project (WWEP) Basis of Design Report (BODR) completed in February 2012 further progressed design on a number of Master Plan components including influent pumping, screening and grit handling, wet weather treatment, primary treatment and effluent pumping. Per the Basis of Design Report, wet weather facilities are being designed to a total influent capacity of 200 mgd. Much of the facility will be designed and constructed with the flexibility to allow for possible future mechanical and electrical upgrades to support a potential future capacity of 250 mgd (without requiring expansion of the structural components of the facilities). Figure 5-2 shows the site locations of some of the major HWPCF improvements that are being implemented.

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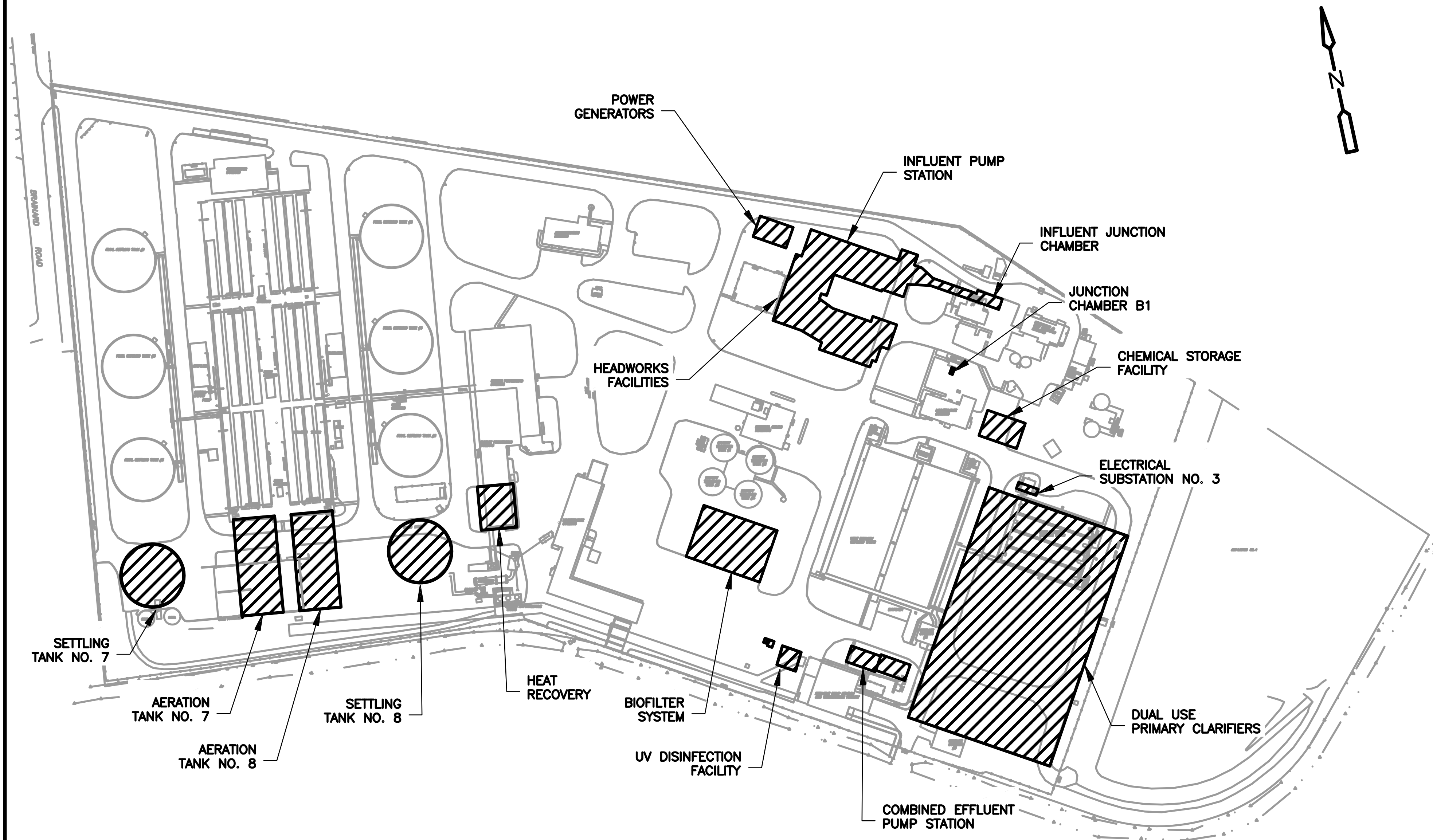

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FIGURE 5–2: SITE PLAN – ONGOING IMPROVEMENTS
HARTFORD WATER POLLUTION CONTROL FACILITY

5.3.1 New Headworks Facility

The 2012 WWEP BODR includes new headworks facilities with influent pumping and preliminary treatment. A new dual purpose (dry and wet weather) influent pump station will be constructed, including six new pumps with a total influent capacity of 200 mgd. Structurally, the new pump station will be constructed to allow future expansion to 250 mgd (sizing of wet well to allow additional future pump and diameter of pipes).

Construction of new influent pumping facilities will also permanently lower the typical operating hydraulic grade line (HGL) in the Connecticut River Interceptor and the Connecticut River Relief Interceptor. The 2005 LTCP noted that the high tailwater condition created by the existing HWPCF operating hydraulics may have contributed to sediment deposition within the pipes. The lower operating HGL, created by the new influent pumping station, in the upstream interceptors should allow better system hydraulics such that higher (unimpeded) pipe velocities may be maintained during typical flow conditions, which will help reduce sediment deposition in the interceptors. Minimizing sediments will maximize conveyance capacity in the interceptors.

The pump station will be a dry-pit/wet-well station. Six submersible type pumps mounted in a dry pit arrangement, each with a capacity of 42 mgd, will be provided, yielding a total firm pumping capacity (with one unit out of service) of 200 mgd and a total station capacity of 250 mgd. Each pump will be driven by a variable frequency drive (VFD) to maximize operating flexibility by allowing all pumps to vary their speed to match incoming flow rates and maintain the desired levels in the wet wells and sewers. The pump selection and design will allow for the future replacement of impellers, motors, and VFDs for all six influent pumps to achieve an ultimate peak flow rate of 250 mgd (with one unit out of service).

Design is complete for Contract 2012-20 'Influent Pumping Station, Headworks Facilities and Odor Control', which includes the new influent pumping station with flow capacity of 200 mgd. Construction notice to proceed was given in Spring 2014, and construction will be complete in 2017.

5.3.2 New Screening and Grit Removal Facilities

New screenings and grit handling facilities are required to meet the higher influent flow conditions and because the existing facility is too low hydraulically to allow for gravity flow through the rest of the plant processes. Large debris such as wood boards, tree branches, logs, bricks, rocks, and other similar material, commonly conveyed by combined sewer systems, will be removed by the 3-in. bar racks located upstream of the fine screens.

Fine screening will include five multiple rake bar screens with 1/4-inch openings. Each screen will have a capacity of 52.5 mgd and be provided with VFDs to allow for flexibility in cycle speeds. Firm capacity will accommodate the influent peak flow of 200 mgd (with one unit out of service), while total capacity will accommodate the future peak flow of 250 mgd. Fine screenings will be conveyed to common screenings processing equipment via sluice troughs, which use plant effluent and gravity as the means for screenings transport. The screenings will be processed by three screenings handling units with integrated grinders, washers, and compactors to reduce mass and volume, and allow the screenings to be classified as municipal solid waste (as opposed to the current classification of special waste).

Grit removal will be by four 24-foot-diameter centrifugal vortex type grit chambers, each rated for 70 mgd. Firm capacity will accommodate the 200 mgd influent peak flow, while total capacity will accommodate the 250 mgd future peak flow. Each grit tank will be equipped with two 500 gallons per minute (GPM) recessed impeller pumps designed for this type of harsh service.

As part of Contract 2012-20 'Influent Pumping Station, Headworks Facilities and Odor Control', the construction for new grit and screening facilities is underway, with expected completion in 2017.

5.3.3 Wet-Weather Flow Treatment

The 2012 WWEP BODR includes modification to the existing primary clarifiers for chemically enhanced primary treatment (CEPT) to provide wet weather treatment, along with new headworks and preliminary treatment facilities. Sodium hypochlorite will be added to the wet weather clarifier influent to allow disinfection contact time in the clarifiers. The wet weather treatment process will treat all flows above 90 mgd, therefore, with a total plant influent flow of 200 mgd including plant recycle flows, up to 110 mgd will be treated by wet weather.

Eight rectangular Dual Use Primary Clarifiers (PCs), with a total surface area of 75,000 square feet, will be constructed east of the existing West PCs and immediately south of the existing East PCs. The eight PCs will have the capacity to process the peak influent flow of 200 mgd. Additional PCs will be required in the future if the peak flow is increased to 250 mgd.

Six PCs will have the ability to operate in CEPT mode during wet weather events. Although only one to five CEPT tanks are needed to meet the wet weather peak flow conditions up to 110 mgd, the plan allows for one PC to have standby CEPT capabilities. During dry weather periods, the Dual Use PCs will be designed to operate without chemical addition at a surface overflow rate (SOR) of 1,200 gallons per day per square foot (GPD/ft2).

During wet weather periods, as flows increase to near the secondary treatment capacity, some PCs will progressively switch to operate as CEPT clarifiers (i.e., coagulants and flocculants will be added). Under those conditions, CEPT clarifiers are anticipated to operate at SORs of up to 3,765 GPD/ft2. Flow will be conveyed by gravity from the new Headworks Facilities to the Dual Use PCs via two 84-in. conduits. During dry weather operations, flow will be split proportionally among the eight Dual Use PCs. During wet weather operations, progressively more influent gates in a CEPT-equipped tank will open as that tank begins CEPT operation.

Under dry weather operation, all Dual Use PC effluent will be conveyed by gravity to secondary treatment via two 66-inch conduits. Under wet weather operation, flow exceeding the secondary treatment flow set point will be conveyed to the wet weather disinfection basin.

New chemical storage facilities, including tanks and containment areas for the coagulation, flocculation and disinfection of wet weather flows, will be constructed. Ferric chloride or alum will be used as coagulants, an anionic polymer as flocculant and sodium hypochlorite as disinfectant.

Design is complete for Contract 2012-21 'Wet Weather Treatment Facilities', including the dual use primary clarifiers, disinfection tank, and chemical facility. Bidding is being held in fall 2014, with construction through 2015-2018.

5.3.4 Effluent Pumping Station Modifications

The 2012 WWEP BODR also includes new effluent pumping station facilities, capable of discharging the additional wet-weather flow. A new centralized Combined EPS (EPS) will be provided to pump both the final effluent (FE) and the wet weather effluent (WWE) to the Connecticut River when the river is at stages that preclude gravity discharge. Seven new 40 mgd submersible, tube-mounted, mixed-flow type pumps equipped with electric motors and VFDs will be provided, with six installed and one un-installed spare. Firm capacity (with five of the installed pumps on duty and one of them on standby) will allow for pumping the WWE and FE combined peak flow of 200 mgd. Each pump will be capable of pumping up to 41.6 mgd, which allows for pumping the 250 mgd future peak flow with all six pumps in service.

As part of Contract 2012-21 'Wet Weather Treatment Facilities', the bid period for new effluent pumping facilities is underway, with construction through 2015-2018.

5.4 Other Facility Improvements

5.4.1 Biological Nutrient Reduction (BNR)

The 2009 HWPCF Master Plan recommended step-feed BNR to provide a moderate to high level of total nitrogen removal on a year-round basis necessary to consistently achieve the calendar year 2014 total nitrogen limits. The BNR improvements are designed for a sustained capacity of 90 mgd and a peak hour capacity of 120 mgd.

The operation will include BNR mode for the vast majority of the year with contact-stabilization mode to accommodate higher flows or poor settling sludge. Secondary treatment construction completed in 2012 (Contract 2009-57 'Aeration and Final Settling Tanks Improvements Project') includes two new aeration tanks and two new final settling tanks, along with improvements to return activated sludge (RAS) and waste activated sludge (WAS) process. With the new tanks, the HWPCF now has eight aeration tanks and eight final settling tanks. Depending on nitrogen credit costs and actual treatment results with the new tank construction, the Master Plan recommended two additional final settling tanks (so a total of 10 final settling tanks) to meet the 2014 total nitrogen limits.

Construction of Contract 2011-02 'Phase II BNR Improvements' was completed in 2014, which includes upgrades to the existing Compressor Building and original six aeration tanks, including new blowers, additional aeration mixers, modernization of air system control and monitoring, new RAS and WAS pumps and piping, and other related improvements.

5.4.2 Effluent UV Disinfection and Outfall

The 2009 HWPCF Master Plan recommended ultraviolet (UV) light for secondary effluent disinfection, using vertical bulb technology. As one of the fast-track projects identified in the HWPCF Master Plan, design of the new UV Improvements was completed in 2010, and construction completed in 2012. The new UV facility is rated to treat sustained flow of 90 mgd and peak flows of up to 120 mgd, using three channels each with a 40 mgd flow capacity.

The HWPCF has been seasonally operating (May 1st through September 30th) the new UV treatment for secondary effluent disinfection prior to discharge into the Connecticut River since 2012.

As part of the ongoing design for wet weather improvements, a structural evaluation and physical inspection of the outfall was completed by the design engineer in 2012. Evaluation of the outfall showed that the existing outfall structure can discharge up to 250 mgd.

5.4.3 Odor Control Improvements

The 2009 HWPCF Master Plan presented an overall approach to provide odor control facilities for the HWPCF. An odor control scrubber system for the sludge processing building areas was constructed in

2012. The 2011 WWEP BODR includes odor control to treat exhaust air from the new influent pumping station, headworks facility (grit and screenings), and dual use primary clarifiers, and design for these odor control facilities is included in Contract 2012-20 'Influent Pumping Station, Headworks Facilities and Odor Control'. The new WWEP odor control facilities will be located south of the HWPCF existing gravity thickeners and the new facilities will include a biofilter treatment system comprised of fans, humidification chamber, spray water recirculation pumps and biofilter media cells. . Construction notice to proceed was given in Spring 2014, and construction will be complete in 2017.

5.4.4 Incinerator #3 Improvements and Energy Recovery

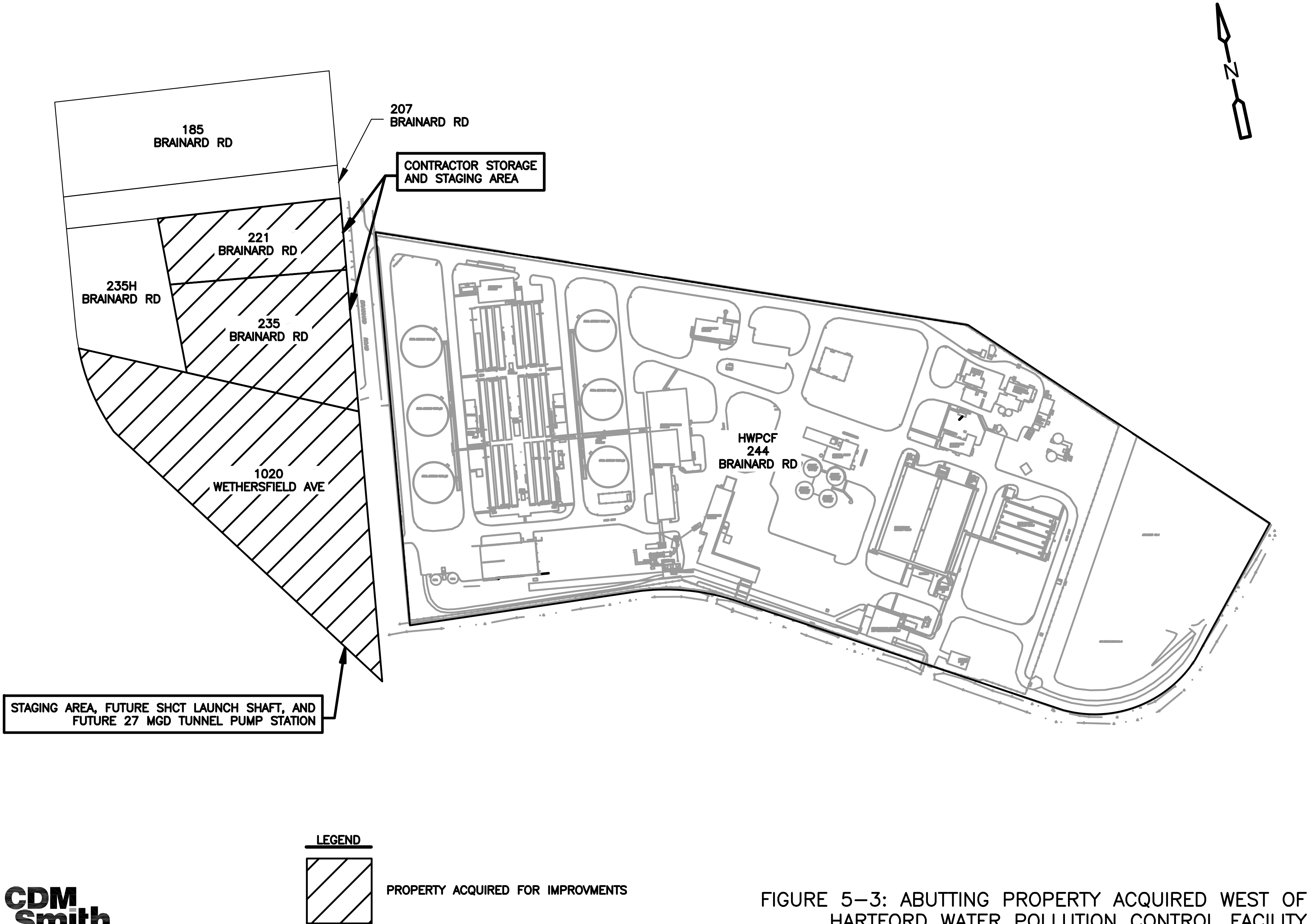
In 1997, the CTDEEP issued a Consent Order requiring the District to re-apply for incinerator air emission permits, including a Best Available Control Technology (BACT) assessment. The BACT resulted in proposed incinerator upgrades which were implemented along with new permits for Incinerators #1 & #2 in 2001. Additionally, Contract 2009-77 'Incinerator No. 3 Upgrades and Heat Recovery Facility' construction was completed in 2013. The upgraded Incinerator # 3 provides the ability to operate any two of the three incinerators in tandem. The new Heat Recovery Facility is located adjacent to the Sludge Processing Building. The new Heat Recovery Facility will provide a system to recover heat (energy) from the incinerator exhaust gas for steam production. The steam will be fed to a steam turbine generator for power production to offset a portion of the power HWPCF purchases from the public utility grid. The new turbine generator has a capacity to produce 1.7 megawatts of power, or approximately 40 percent of the HWPCF's electrical demand.

All three incinerators are now upgraded and fully operational. The Heat Recovery Facility has been operational since 2013.

5.4.5 Adjacent Property to HWPCF and Coordination with the South Hartford Conveyance Tunnel (SHCT) Project

As discussed in Section 4, there are a number of other improvements projects planned, in design or construction phases or completed that improve the collection systems contributing sanitary wastewater and combined stormwater to the HWPCF influent flow. One significant component of the District's LTCP is a conveyance tunnel to bring combined stormwater flow to the HWPCF, which will significantly reduce the occurrences of CSOs. The South Hartford Conveyance and Storage Tunnel (SHCST) is currently at 30 percent design. The SHCST is being coordinated with HWPCF improvements; specifically the HWPCF WWEP, since the SHCST's effluent pump station will discharge into the influent flow of the HWPCF, affecting capacity of the headworks and wet weather treatment facilities.

The launch shaft for the SHCST and the tunnel pump station will be located on the property west of the HWPCF (see Figure 5-3). In preparation for these permanent structures, the District purchased properties on the west side of Brainard Road, directly across from the HWPCF site. Temporary uses of these recently-purchased properties include construction contractor laydown areas for the WWEP, contractor parking for the various HWPCF construction activities and temporary laydown areas for ongoing HWPCF construction projects. The 2009 Master Plan considered these properties as possible locations for WWEP components, including a possible location for headworks and/or primary settling tanks, however, after considering alternative locations within the HWPCF existing site boundary, all WWEP components will be constructed within the existing HWPCF property boundary.



CDM Smith

FIGURE 5–3: ABUTTING PROPERTY ACQUIRED WEST OF HARTFORD WATER POLLUTION CONTROL FACILITY

Section 6

Sewer Separation

6.1 Introduction

The city of Hartford has a predominately combined sewer system, with a few areas with separate sanitary and storm sewers. The surrounding communities that discharge sewage to the system are separated, except for the East Ridge area of West Hartford. Combined sewers were designed to collect both sanitary sewage and stormwater, and convey these flows to the local treatment facility. Under dry weather conditions, sewage is conveyed to the treatment facility. During wet weather conditions, stormwater enters the collection system and combines with sewage. Combined flow can exceed pipe capacity, which limits the amount of flow delivered to the treatment facility and causes overflows. The goal of sewer separation is to have two separate pipe systems: one dedicated to sewage and the other to stormwater.

Historically, city-wide sewer separation has been used by many communities to eliminate CSOs altogether. Separation was viewed as a positive way to prevent untreated CSO discharges from entering local water bodies. However, views on separation have recently changed, with regard to how stormwater discharges affect water quality. Sewer separation may remove the sanitary component from the overflow, but still allows untreated stormwater runoff – containing sediment, petroleum products, litter, and other items – to be discharged to local receiving waters. City-wide separation can also be very expensive and disruptive during construction. Finally, there are varying levels of effective separation that can be achieved based on the amount of private inflow and infiltration that can actually be removed from the system.

This section discusses the use of sewer separation as a CSO control strategy in Hartford. Sections 7 and 8 discuss the use of tunnel storage and satellite treatment and storage as other strategies that were also considered to control the District CSO discharges.

6.2 2005 LTCP Recommendations and Implementation Experience

6.2.1 2005 LTCP Recommendations

The 2005 LTCP recommended complete separation of the Franklin Avenue area combined sewer system and local sewer separation in other key drainage areas. Complete separation was thought to be the final solution to eliminate the Franklin Avenue area CSO regulators from discharging into Wethersfield Cove.

One of the major drivers influencing the selection of sewer separation as the appropriate CSO control strategy in the 2005 plan was the District perception that there were frequent upstream sewer surcharging and basement backups occurring in the system. Sewer separation (which provides additional system conveyance capacity) is typically a very practical approach to help address sewer system surcharging. Exposure to sewage in private basements is considered a more serious public health risk than exposure to CSO discharges in waterways. Sewer separation could also help to alleviate some of the reported street flooding that was occurring in the roadways (although this wasn't the highest priority for the District as the city of Hartford is primarily responsible for stormwater management and flood control in the city).

6.2.2 LTCP Implementation Experience

As the District implemented the proposed sewer separation projects from planning through design and construction, several technical, financial, political and social challenges arose.

6.2.2.1 Technical Challenges

Sewer separation is most effective at removing public inflow such as catch basins, cross connections, and drainage connections from utility vaults. These inflow connections are generally readily identifiable through evaluation of record plans, survey, and field investigations. It is estimated that removing public inflow can eliminate approximately 60 percent of the extraneous flow. However, since model simulations indicated that this removal rate was not high enough to achieve the CSO control goals of the CWP, the 2005 LTCP included assumptions that the sewer separation program would include removal of all identified public and private inflow and infiltration connections from the sewer system to achieve greater than 80 percent separation efficiency.

The District experienced technical challenges associated with this approach including:

- **Identification and elimination of private inflow sources**
  Addressing private inflow sources (e.g., sump pumps, basement drains, roof leaders, yard drains, etc.) requires extensive coordination with property owners to schedule property inspection and to facilitate construction of the improvements. This is especially difficult with out-of-state owners, bank owned properties, rental properties, uncooperative management companies, and property owners that refuse entry. The District does not have the legal authority to inspect a property without the owner's permission, which can limit the efficacy of any private inflow removal program. When the District can inspect a property and identify the solution for the disconnection, further challenges arise such as existing electrical/plumbing code issues, asbestos, interior and exterior restoration, historical building concerns, and old foundations. If the District can overcome all inspection/design obstacles, the actual construction work on private property exposes the District to potential liabilities and future claims regarding issues with property restoration, damaged foundations, and water in the basement.

- **Identification and elimination of public infiltration sources**
  Defective and leaking sewer mains and manholes contribute to public infiltration. Defects can include cracked pipe joints, offset joints, lateral connections to the sewer main, manhole connections, manhole covers, manhole wall defects, etc. Sewer separation in the District has typically required the installation of a new larger drain pipe in the roadway with the inflow connections redirected into the new drain pipe. Without the inflow connections, the existing combined sewer becomes a sanitary sewer. This approach leaves the District with old infrastructure that would still have extraneous flow into the system through the various pipe defects listed above. Even with a comprehensive sewer rehabilitation program implemented as part of the sewer separation projects, it is difficult to permanently remove more than 10 to 30 percent of the existing pipe infiltration.

- **Identification and elimination of private infiltration sources**

Private infiltration into the sewer system can come from service laterals that are defective or leaking (from cracked pipe joints, offset joints, broken pipes, or root intrusion due to trees located on private property, etc.). Studies have shown that up to 50 percent or more of infiltration in a sanitary sewer system may come from leaking private service laterals. The service laterals from the main to the building are owned and maintained by the customer. Therefore, similar to private inflow connections, the District has no legal authority to replace or rehabilitate service laterals over an owner's objections. Excavation of the pipe can be disruptive and create property restoration (and resolution) issues. Trenchless rehabilitation techniques are available to reduce the surface disruptions to the property but these also have technical limitations regarding the length of host pipe size and distance that can be lined from the sewer main towards the building. These limitations require either the installation of a service lateral cleanout on private property or access into the basement, neither of which the District has a legal authority to complete without authorization from the property owner.

6.2.2.2 Cost and Schedule Challenges

The District has seen a dramatic increase in project costs for sewer separation. Bid prices received by the District in the competitive bidding process were higher than the cost originally developed in the 2005 LTCP and subsequent preliminary design reports. In addition, construction durations to date have taken at least 50 percent longer than anticipated. The following items have adversely impacted project costs and schedule:

- Level of effort and time required to identify private property inflow sources. This includes inspection time, final design time, and outreach efforts to reach the property owner (especially difficult since Hartford has numerous multi-tenant occupied buildings).

- Level of effort to remove the private property inflow sources. The solutions to remove roof leaders, sump pumps, and foundation drains can be costly. The District is committed to leaving private properties in the same or better condition than the pre-construction condition. As the property owner's permission is required to complete the work, final solutions represent compromises that benefit the project and minimize impacts to the property owner, but require additional project costs.

- The District must obtain permits to work in the city of Hartford streets and then comprehensively coordinate with the city. One condition of the permit is that all excavated trench material (native backfill) be replaced. This has a three-fold impact on project costs - native soils be removed from the site, new materials must be purchased and transported to the site for backfill, and disposal costs of the native excavated soils can vary tremendously. The disposal costs, in particular, are a large strain on the project as the excavated material may be typically classified as either "polluted" or "contaminated" in accordance with CT DEEP criteria. The cost of soil disposal (typically out of state) and replacement is borne by the District.

- Restoration of the public ways. Sewer separation with private property inflow removal is very disruptive to the public right-of-way. It is not uncommon for over 75 percent of the roadway and sidewalks to be impacted by excavation associated one of the utilities (sewer, water, gas, electric, phone) and/or water or sewer service line work. Final restoration requirements from the city of Hartford includes a minimum of full width pavement and overlay, replacement of concrete reinforced driveway aprons, sidewalk panel replacements, restoration of concrete road base when encountered, and in some cases full road reconstruction that is sometimes attributed to poor existing conditions. These levels of surface restoration work add time and cost to the projects.

- The city of Hartford Obstruction Permits and Tree Ordinance are two additional impacts that add cost to the project. They are based on area impacted and the value of a replacement tree.

- Longer construction durations for various factors (i.e., utility conflicts, community events, unknown soil conditions, contractor performance, and city work hour limitations, etc.) have had a major impact on cost and schedule.

- Utility companies have limited resources to maintain the pace of relocating their utility line to resolve identified conflicts with the new sewers or drains. This has resulted in project delays, change orders, and increased costs for the sewer separation projects. This issue is further exacerbated by unknown utility conflicts that are found during construction but not identified during design by the utility companies. The utility company's inability to relocate their respective utility lines to match the pace of the District's ongoing separation contracts is a significant issue. To reduce the pace of active sewer separation projects under construction at the same time (to benefit the individual utility companies) would add additional delays and costs to the program.

6.2.2.3 Political and Social Challenges

The District has seen a dramatic increase in the level of political discussions on the implementation of the sewer separation projects, which has added time and costs to the project. Whether real or perceived, disruptions associated with the sewer separation projects have led to vocal business and resident concerns. The social and political challenges include the following:

- Ownership of any new separated drain. The District and the city of Hartford continue to discuss this issue and currently there is a substantial difference of opinion on the pipe design standards and who owns and maintains the new infrastructure.

- Impacts to school bus routes, public transportation routes, commuter delays, and loss of access to business associated with direct construction impacts.

- Compensation requests for lost business due to construction operations. The District received numerous compensation requests and these requests created a negative perception of the impact of the sewer separation projects.

- Dust, rodents, and impacts to private properties (i.e., complaints of cracked foundations, water in basement, landscape restoration, dislocation of rats from the sewer into residential structures, etc.) created by construction.

- Longer commute times and more construction vehicles increasing air pollution.

Accordingly, these cost and construction challenges caused the District to reconsider the overall effectiveness of the sewer separation approach in key areas for CSO control. This reconsideration resulted in the development of a case study report of other CSO control strategies focused on alternatives to separation in the Franklin Avenue area.

6.2.3 Franklin Avenue Area Re-Evaluation

In 2012, a discrete study was completed for the Franklin Avenue drainage area to examine the ongoing costs of sewer separation, reassess the sewer system surcharge problems, and to evaluate options to integrate the CSO control plan for this area into the South Tunnel storage system. This was summarized in a memorandum dated June 2012, entitled "Franklin Avenue Area/Wethersfield Cove CSOs - Updated Alternatives Assessment for CSO Abatement". The study was initiated after the District received some very high bids on the Franklin Construction Contract No. 4, which caused the District to reconsider the need for the project since District Operations staff indicated that they knew of few, if any, surcharge problems in the contract area.

After an assessment of the problems in the Franklin Avenue area, the recommendation of this study was to discontinue the sewer separation program and to convey and connect the remaining CSO regulators into the South Tunnel. This recommendation was based on the minimal number of documented sewer surcharge problems in the area and the rising costs of sewer separation, as well as the proximity of the South Tunnel to the Franklin Avenue area.

The evaluation of separation costs and system problems is discussed further as part of the system-wide analysis conducted for this 2012 LTCP Update.

6.3 Sewer Separation Costs and Efficacy

6.3.1 Updated Costs

As part of the Franklin Avenue area update, itemized bid costs received for the sewer separation projects to-date were analyzed to identify any trends. Because of the complexity of the bid item cost inclusions (which changed between projects) and the very different range of pipe lengths and diameters between projects, it was difficult to ascertain any specific trends looking at individual bid items. However, categorical costs between the bids (for items such as pipe, policing, pavement, etc.) remained consistent from project to project. Specific items that were unique to the projects included the amount of sewer rehabilitation and private inflow implemented in each project.

Based on this analysis, the costs were considered more holistically based on a per acre cost. Table 6-1 shows the results of this analysis. These per acre costs are generally consistent between the projects, with the only significant outlier being the Franklin Contract No. 4 project, which may have been because of the additional new storm drain required to convey the flow to the existing drainage system. Because of its high cost, this project was not awarded.

Table 6-1
Cost per Acre for Previous Separation Projects

Contract	Area (acres)	Total Project Cost	Cost Per Acre
Franklin 5	72	$29,200,000	$410,000
Franklin 13	121	$42,600,000	$350,000
Franklin 4	78	$43,700,000	$560,000
Upper Albany 1 - East Side	78	$27,200,000	$350,000
Farmington 6	26	$8,600,000	$330,000
Farmington 7.2	14	$3,500,000	$250,000
Tower South	44	$13,400,000	$300,000
Total	**433**	**$168,200,000**	**$390,000[1]**

1. Average based on total project costs and total acres

As a comparison, the estimated cost per acre, based on other projects in New England, in the 2005 LTCP was about $150,000 per acre (in 2012 dollars). Accordingly, the cost of sewer separation was significantly more expensive in Hartford than in other New England cities.

6.3.2 Re-Evaluation of System Problems and Complaints

6.3.2.1 General

As noted earlier, one of the reasons the District elected to pursue the sewer separation strategy for CSO control was to address sewer backups and system surcharging reported during the 2005 LTCP.

Past reports of sewer system problems were not well documented and verified by District Operations staff prior to 2004. The surcharge issues identified in the 2005 LTCP were derived from past experience versus a comprehensive examination of system problems. Since 2005, when the LTCP was submitted, and as part of its CMOM program, beginning in about 2007, the District Operations staff now investigates each and every sewer system surcharge complaint received from the public. The staff identifies whether each problem is associated with a storm condition and whether it's a local sewer service problem, a temporary blockage, or a main-line sewer backup caused by a storm event. This field information is carefully logged in the work order system now so that the data can be retrieved and reviewed.

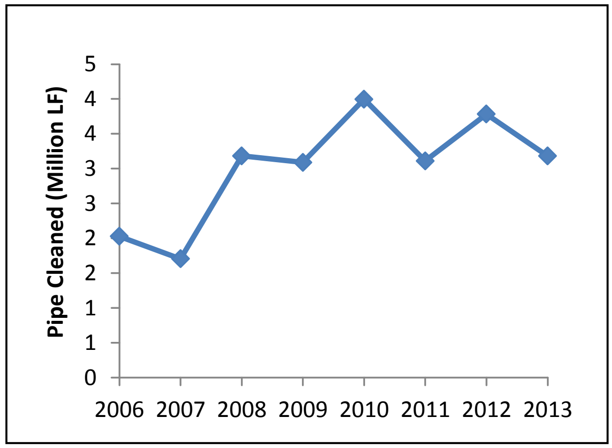


Figure 6-1
District Pipe Cleaning by Year

In 2008, the District had initiated a comprehensive sewer cleaning program as part of its CMOM program. The District increased sewer cleaning by more than 1 million linear feet per year (more than a 50 percent increase in linear feet cleaned in prior years). As shown in Figure 6-1, the District has maintained this aggressive cleaning program since 2008. This cleaning program has been successful and has reduced sewer backups and surcharge issues.

6.3.2.2 Work Order Evaluations

To confirm the benefits achieved by the sewer cleaning program and the more comprehensive investigation and documentation of sewer complaints, work orders from the Operations Division were compiled and evaluated to identify those complaints that were directly attributable to main-line system sewer problems and not associated with temporary blockages or service connections. To reflect the current maintenance conditions in the system, only sewer backup related work orders reported after January 2009 through July 2012 were included in the analysis.

The work order system includes emergency structural repairs, routine cleaning, debris removal, etc. As previously mentioned, it was important to only identify work orders that were a sewer backup resulting from a surcharged main sewer. All work orders that indicated any other type of work were eliminated from this analysis.

The more difficult task, however, was eliminating the sewer backups that were caused by internal plumbing and/or the service connection rather than main line surcharging. The Maintenance and Operations Division is very diligent and timely in its investigations of system complaints and most work orders were categorized (or noted) to allow a ready differentiation between the different complaint issues. The District's field crews typically arrive at a property within a couple of hours of receiving a complaint and inspect the main sewer to look for surcharging or any signs of recent surcharging. If there are no visible signs of surcharge, it is noted on the work order as a service connection problem; those work orders were eliminated from this analysis.

The precipitation on the day of the complaint or the day prior was used as a second filter to assure a complaint was wet-weather related. Distance weighted interpolation using four rain gauges in and around Hartford provided an estimate of rain at each complaint location. If precipitation on the day prior or the day of the work order did not exceed 0.1 inches, the work order was eliminated from the analysis.

The only exception to the above criteria was any sewer backup related to the rain event on June 22, 2012. The Operations and Maintenance staff described this event as an extremely intense rainfall that led to wide-spread problems in the city. Local rain gauges suggest the storm was a 15-year 30-minute event. However, only gauges outside the city recorded rainfall at sub-daily intervals during that storm, so the intensity could have varied throughout the city. Because of the numerous complaints, the response time for this storm event was greater than normal and all sewer backup related work orders for the event were included, regardless of the status of the main sewer upon District inspection. For comparison, the work orders generated by this storm event were reported in this analysis separately.

The results were plotted and discussed in a meeting with field staff from the District's Maintenance and Operations Division. The approach taken to compile and categorize the complaints was discussed with the field staff and they made suggestions/comments on the approach. Maps of the complaints were also reviewed to confirm the findings and to obtain staff insight, based on field experience, on problem areas that would confirm the evaluation of the work orders to identify surcharge issues.

6.3.2.3 Surcharge Issues by Drainage Area

Table 6-2 summarizes the number of complaints in each drainage area and Figure 6-2 shows the backups on a city-wide scale. In all drainage area, the majority of the complaints are related to the June 22, 2012 storm. The number of complaints is significantly different than the perception of the problems that were prevalent in 2005. The immediate conclusion could be that the District's CMOM program of sewer cleaning is yielding significant benefits. The District should continue its aggressive cleaning schedule and routinely monitor the sewer system surcharge issues to see if there are any different trends.

Table 6-2
Hydraulic Capacity Related Sewer Backups by Drainage Area from January 2009 to July 2012.

Drainage Area	Work Orders from 6/22/2012 Storm	Other Work Orders from 2009	Total
North Branch Park River	15	10	25
South Branch Park River	8	8	16
Park River	8	4	12
Gully Brook	6	3	9
Franklin	0	7	7
North Meadows	4	1	5
South Meadows	1	1	2
Total	**42**	**34**	**76**

Many of these surcharge problems have been or will be corrected by the ongoing sewer separation projects. There are a few areas, especially in the North Branch Park River, that indicate that there is a local problem such as an undersized pipe, but there are no large clusters of backups that substantiate a need for any wide-spread sewer separation based on sewer complaint records. In the future, if smaller areas are identified with surcharging problems, the District will implement corrective action most likely through a CIP project.

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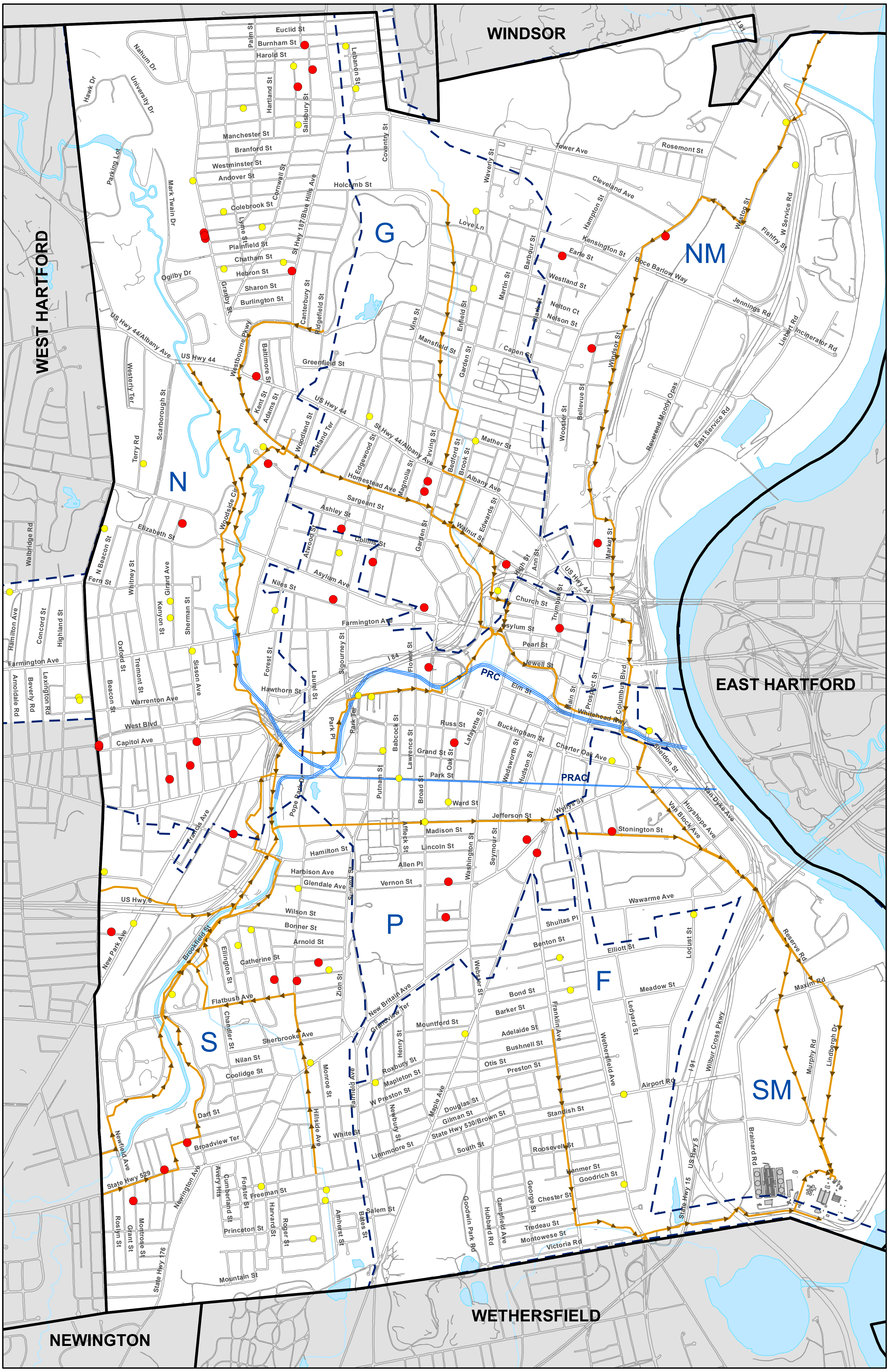

MDC

CDM Smith

Legend

- MDC Work Order - 6/22/2012 Event
- MDC Work Order - Other Event
- Combined Sewer Interceptor
- Drainage Area

N E S W

0 1,150 2,300

Feet

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 6-2
Sewer Backups Since 2009

6.4 Separation Efficacy

As discussed above, the efficacy of sewer separation decreases as the capability to eliminate private inflow diminishes. The District has experienced many challenges to removing both public and private inflow. The original 2005 LTCP target goal of 85 percent sewer separation was established to minimize basement backups. During the 2009/2011 model update, the sewer separation goal was increased to 95 percent removal in the Franklin Avenue area in order to control the CSO regulators to the Wethersfield Cove/North Branch Park River Design Storm. In addition, the efficacy of sewer separation was considered at 60 percent and 80 percent inflow elimination. Based on current District experience and challenges, the goal of 95 percent sewer separation efficacy (to eliminate CSO regulators in the Franklin Avenue area) is probably unattainable. A more realistic upper limit goal for any sewer separation projects in the future is likely to be about 80 percent inflow removal.

Accordingly, for this report, two new goals were established based on a review of the current sewer separation programs. One is an 80 percent sewer separation goal based on elimination of public and most private inflow, and a substantial decrease in infiltration. The other goal was 60 percent sewer separation, which reflected only public inflow removal. These goals represent the range of possible sewer separation efficacies that may eventually be achieved if sewer separation was pursued as a strategy for the District in the remaining portions of the combined sewer system.

The SWMM5 model was used to test the benefits of these separation goals and to determine if sewer separation implemented to either goal would control CSO regulators to either the 1-Year Design Storm or the WC/NBPR Design Storm. Based on this analysis, Table 6-3 shows the CSO regulators that could potentially be controlled by sewer separation and whether these CSO regulators discharged flow under either 60 or 80 percent sewer separation approaches. Sewer separation can only control some of the CSO regulators with the 1-Year Design Storm level of control; sewer separation is not a viable alternative for any regulator that must be completely eliminated.

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Table 6-3
CSO Regulators Potentially Controlled Using Sewer Separation (and Costs)

CSO Regulator	CSO Regulator Condition Under Two Separation Levels [1]		Combined Acreage (acres)	Estimated Separation Cost to Control CSO Regulators (millions) [2]
	60% Sewer Separation	80% Sewer Separation		
N-22	Active	No Discharge	27	$11
G-19	No Discharge	No Discharge	18	$5.8
NM-7	Active	No Discharge	36	$15
NM-14	No Discharge	No Discharge	5	$1.6
P-2	Active	No Discharge	79	$32
P-4	Active	No Discharge	35	$14
P-14	No Discharge	No Discharge	59	$19
P-16A	Active	No Discharge	43	$17
S-12	Active	No Discharge	19	$8
S-13	Active	No Discharge	51	$20
S-14	No Discharge	No Discharge	291	$93
S-25	Active	No Discharge	6	$3

Note: (1) These are the only CSO regulators that can be controlled to their respective design storm if sewer separation is implemented. Sewer separation does not work for the remaining CSO regulators in the system.

(2) Based on an average cost of $400,000 per acre for 80 percent separation and $320,000 per acre for 60 percent separation.

Table 6-3 shows that thirteen CSO regulators that could potentially be controlled by sewer separation and it shows the estimated costs for separation of the upstream tributary area based on a $400,000 per acre construction cost for 80 percent sewer separation and $320,000 per acre construction cost for 60 percent sewer separation. The 60 percent costs were derived from the current sewer separation project bid prices that indicated that private inflow removal costs are nearly 20 percent of the total project costs for separation.

For some CSO regulators, the upstream tributary area is not well defined as these regulators are either along the main-line interceptor and/or have other tributary areas that are also regulated in part by upstream CSO regulators (such as S-14). The costs for the potential strategy to separate these CSO regulators will be compared to other CSO control strategies discussed later in this report to develop the best alternative for each CSO regulator.

6.5 System-Wide Sewer Separation Costs

For comparison, Table 6-4 shows the city-wide sewer separation costs if this public and private CSO control strategy were applied across the system. However, based on the model simulations discussed above, there would be remaining CSO discharges at most CSO regulators (with the exception of those listed in Table 6-3) that would still need to be captured/controlled by another technology. So sewer separation, if implemented system-wide, would not meet the control objectives.

Table 6-4
City-Wide Sewer Separation Costs

Drainage Area	Total Area (acres)	CSS Area (acres)	Total Cost ($)
North Branch Park River	2,340	1,500	$600,000,000
Gully Brook	1,330	800	$320,000,000
North Meadows	2,360	300	$120,000,000
Main Branch Park River	1,270	1,000	$400,000,000
South Branch Park River	1,560	900	$360,000,000
South Meadows	1,420	100	$40,000,000
Franklin Avenue	1,340	600	$240,000,000
Total	**11,620**	**5,200**	**$2,080,000,000**

6.6 Conclusion

As a result of this analysis, sewer separation is not necessarily required to address system surcharge problems (as once concluded in the 2005 LTCP) based on a more recent review of sewer complaints. Past sewer system surcharge issues may have been a result of a decreased maintenance schedule, which seems to have been addressed more recently by the District's renewed aggressive sewer cleaning program. The District should continue to monitor the program and the work order/complaints to ensure that this trend continues and to initiate an annual review of all work orders to identify any grouping of surcharge areas and to develop programs, most likely through CIP funding, to resolve these localized problems.

The District's recent sewer separation projects have also demonstrated technical, financial, political and social challenges that have affected the costs for the separation program. These challenges have also lowered public acceptance of the wide-spread impacts associated with the construction of new piping systems.

However, sewer separation may still be cost-effective compared to other alternatives in select areas. The analysis performed in this section identifies those CSOs that may potentially be controlled to the 1-Year Design Storm using separation as a control strategy and identifies the estimated cost of sewer separation (based on the updated construction costs) for each of these unique areas. The cost of the alternative CSO control strategies is considered in Section 10 for each of these CSO regulators to see if sewer separation is the most cost-effective solution.

Section 7

Tunnel Storage Systems

7.1 Background

Storage of wet weather overflows in tunnels below ground has become one of the standard methods of controlling CSO discharges in the last 30 years. Some communities are taking advantage of existing conduits, and many are constructing new storage tunnels for the sole purpose of reducing CSO discharges. Tunnels vary in depth and diameter, but most used for CSO storage tend to be deep rock tunnels 100 to 200 feet below grade and have large diameters, from 12 to 28 feet or more. Tunnels have been chosen by these communities over other alternative means of control due to cost-effectiveness, the potential for capture and treatment of stormwater, and implementability, among other benefits.

This section presents the general tunnel layouts that were considered for the District's combined sewer system. Consolidation pipes to connect the CSO regulators and costs are discussed in Section 9.

The Hartford CSS has several relatively shallow overburden and soft rock tunnels. The 72 inch Jefferson Street Interceptor is a soft rock tunnel constructed in 1934. The primary purpose of this tunnel is for use as a conveyance interceptor. Several other interceptors and overflow conduits can be considered small diameter tunnels. Section 6 of the 2005 LTCP explored the potential for limited in-line storage in these tunnels. However, the available storage volumes are small and this option did not yield substantial benefits.

The 2005 LTCP also considered the use of several existing near-surface conduits in Hartford that had significant pipeline volume with the potential to be used for CSO storage. These included the Gully Brook Conduit and the Park River Conduit (PRC), but both conduits were already filled during larger storm events based on model simulations. The most significant opportunity for existing pipeline storage was the PRAC, which is an existing deep rock tunnel that has an estimated 26 million gallon storage capacity – primarily used for the Hartford stormwater system under river flood conditions. Thus the PRAC was typically under-utilized and this conduit became the basis for the 2005 LTCP recommendation for CSO storage.

However, use of the PRAC was subsequently removed from consideration based on a review by the 2006 CSO Long-Term Control Plan Value Planning Study committee. The committee was tasked to review the use of the PRAC versus the construction of a new South Tunnel to convey SSOs to the HWPCF (and for storage of CSOs that were originally going to be discharged to the PRAC). Given some existing implementation concerns at the time regarding the use of the PRAC, and the necessary consolidation piping that was going to have to be constructed to convey flow from the southern sources to the PRAC in the center of the system, the 2006 Study recommended the construction of a new South Tunnel, in addition to the 2005 LTCP recommendation for a deep rock tunnel in North Hartford.

The North Tunnel and the South Tunnel were originally conceived as separate tunnel storage and conveyance systems, each with its own dewatering pump station. In 2012, CDM Smith and Hatch Mott McDonald (HMM) completed the draft Feasibility Study: Connection of South and North Hartford

Conveyance and Storage Tunnels for the District to review four tunnel alignments and to examine the potential benefits of connecting the two tunnels. This June 2012 study was completed concurrently with the ongoing South Hartford Storage and Conveyance Tunnel Draft Basis of Design Report (South Tunnel BODR, September 2012, AECOM and Black/Veatch). The feasibility study reviewed existing subsurface rock profile information for routing considerations and concluded that it made sense to connect the two tunnels to operate them as one single conveyance and storage tunnel system with a single dewatering pump station to save costs. The study also identified an improved North Tunnel route, which was considered for this LTCP Update. This north tunnel is referred to as the North Hartford Conveyance and Storage Tunnel (NHCST or North Tunnel).

7.2 South Hartford Conveyance and Storage Tunnel

The South Hartford Conveyance and Storage Tunnel (SHCST or South Tunnel) was originally conceived to provide a route for SSO conveyance from Newington and West Hartford to the HWPCF. The South Tunnel has also been considered for CSO storage and conveyance for CSO regulators in the South Branch Park River and Franklin Avenue drainage areas, and also to help reduce sewer surcharging and excess flows in the Folly Brook area of Wethersfield (by accepting wet weather flows from the Folly Brook Trunk Sewer). In 2011, a separate recommendation was developed to resolve the Folly Brook Trunk Sewer surcharging by the construction of a new relief sewer; thus, a connection to the South Tunnel to alleviate Folly Brook area surcharging was deemed unnecessary. In early 2012, a separate study of CSO control alternatives for the Franklin Avenue area was also completed. This study concluded that use of the South Tunnel to store the CSO discharges from the Franklin Avenue area was more cost-effective than the proposed complete sewer separation plan to eliminate the CSO discharges from this area.

Multiple tunnel alignments were being considered in early 2012 for selection as the final alignment of the deep rock South Tunnel. The Franklin Avenue study and the proposed Folly Brook trunk sewer relief project helped to guide the selection of the final alignment, along with an assessment of easement availability for tunnel shafts, and subsurface/rock profiles. Subsequently, the South Tunnel Basis of Design Report (BODR) and 30% design have solidified the alignment of the South Tunnel, as shown in Figure 7-1. The tunnel starts (downstream) in a wooded area across on Brainard Road across from the HWPCF and ends (upstream) at an unused parking lot along Talcott Road in West Hartford.

The South Tunnel will be approximately 21,800 linear feet long, approximately 175 deep, and will have an internal finished diameter of about 18 feet. The proposed South Tunnel would be excavated via a tunnel boring machine (TBM). The tunnel will be designed to receive only wet weather flows with a storage volume of about 41.5 million gallons to meet and exceed the storage requirements for the SSO regulators and CSO regulators in the southern portion of the District's system.

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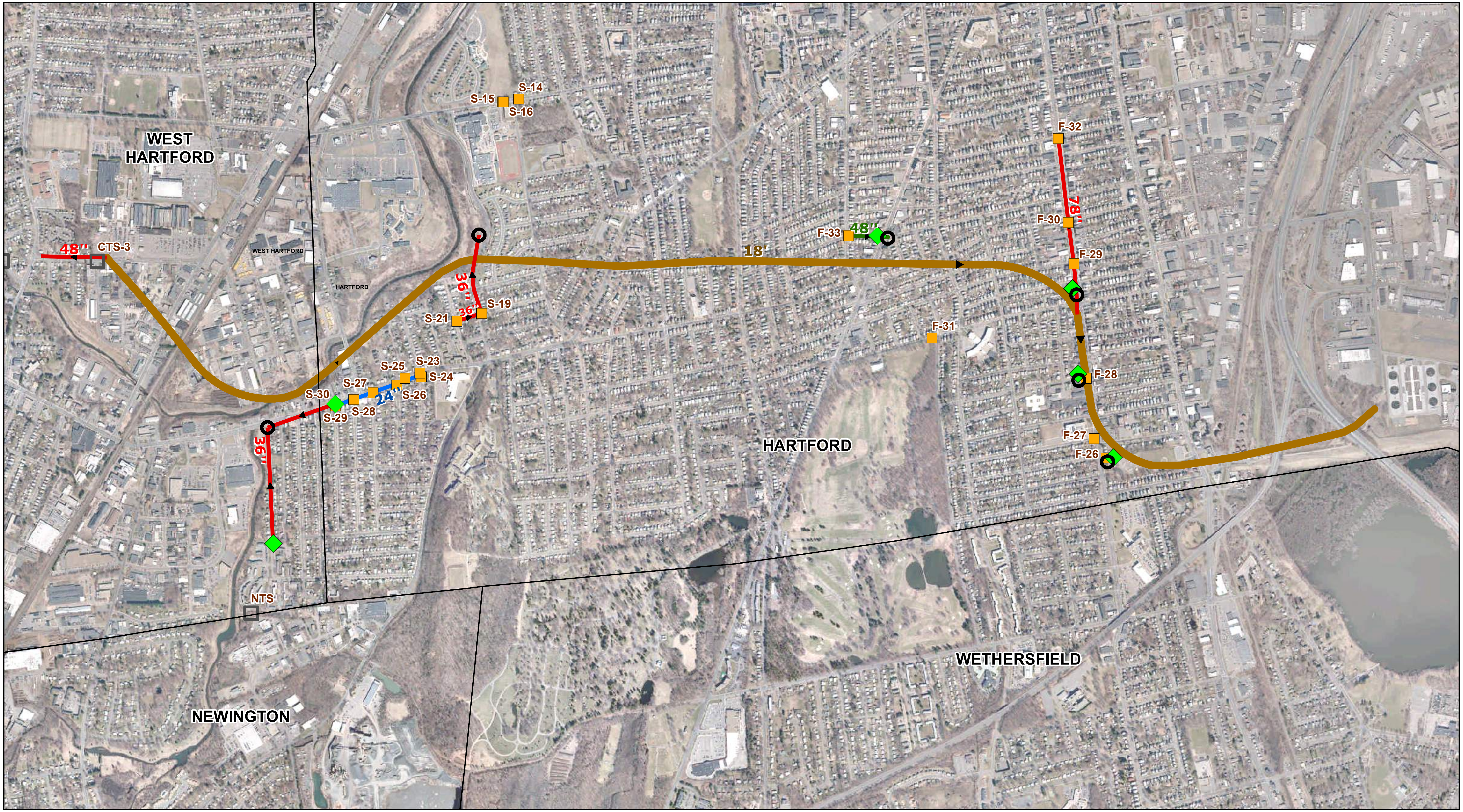


CDM Smith

MDC

Legend

South Tunnel

Consolidation Pipe

New Drain

Drop Shaft

Tunnel Regulator

CSO

SSO

N
W E
S

0 650 1,300

Feet

The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 7-1
SHCST 30% Design Alignment

The tunnel alignment was routed partially under Franklin Avenue and past the larger CSO regulators near Broad Street and West Preston Street to optimize the collection of the Franklin Avenue area CSO regulators. The CSO regulators along Franklin Avenue will be collected by a near surface consolidation pipe (microtunneled 66-inch pipe) and three new vortex tunnel drop shafts to completely eliminate the CSO regulators and all CSO discharges to Wethersfield Cove. The CSO regulator on Broad Street will be eliminated by installing a 36-inch new combined sewer on Broad Street to a Tunnel regulator that directs wet weather flow to a vortex tunnel drop shafts.

The 30% design proposed to collect the South Branch Park River CSO regulators by three consolidation pipes (27-inch, 42-inch, and 48-inch, pipes that will be constructed by either open excavation or micro-tunneling techniques) and two additional tunnel drop shafts. This LTCP Update report modifies the plan for some of the South Branch Park River CSO regulators – connecting them to the North Tunnel instead. This is discussed in Section 9.

The SSO regulators in West Hartford and Newington will be collected by two new regulator structures (NTS, CTS), which will be located downstream of the existing SSO regulators. The new SSO regulators will be connected to the tunnel by 24-inch and 30-inch consolidation pipes.

The tunnel will also include a tunnel dewatering pump station (currently a 40 mgd facility based on the 30% design) that will discharge flow into the HWPCF and include odor control systems, and other air release, venting, and energy dissipation devices.

The current estimated cost of the South Tunnel including consolidation piping, dewatering pumping station, and other appurtenances is about $500 million. It is anticipated that the tunnel project will be completed by January 2023.

7.3 North Tunnel

7.3.1 General

The North Tunnel is proposed to collect the remaining CSO regulators in the northern portion of the system and convey the flow to the South Tunnel for pumping into the HWPCF. Various tunnel alignments have been considered during the LTCP update to identify the best route to capture CSO discharges and compliment the South Tunnel and are discussed further below.

7.3.2 Tunnel Volume Requirements

The size of the North Tunnel has been modified several times by the elimination of the PRAC from the plan and addition of the South Tunnel. As mentioned earlier, the South Tunnel CSO volume is 41.5 million gallons. The North Tunnel should be sized for the remaining volume of CSOs to the Tunnel Storage System (See Section 1.11 for Tunnel Sizing/Optimization).

HMM and CDM Smith worked together on the sizing and routing of the North Tunnel for this LTCP Update. Several routes were considered in developing tunnel solutions. In general, it is preferred to locate the tunnel along a route where the largest CSO regulators are located to minimize the consolidation piping requirements and to maintain an alignment beneath public right-of-ways, including rivers and roads, to minimize surface and subsurface easement requirements. Other considerations include following a relatively straight path or at least a path that does not include sharp bends. The minimum radius of curvature required is generally 1,000 feet. Sharper turns are allowable, but a construction drop shaft would need to be constructed to make the turn, thereby increasing the cost of the tunnel. Accordingly, a combination of a main tunnel and either spur tunnels or near surface consolidation pipes will likely be the final plan.

The vertical slope of the tunnel should be maintained between a minimum of 0.5 percent and a maximum of 3 percent for constructability reasons. At slope of greater than 3 percent, the tunnel boring machine may have difficulty advancing. It is assumed that the tunnel would be lined with either pre-cast or cast-in-place concrete panels to minimize water infiltration.

7.3.3 Shaft Sites

Another challenge is locating tunnel shaft sites for launching and retrieving the TBM for the main tunnel, any spur tunnels, and drop shafts for flow connections. Shaft locations on vacant or limited-use sites are preferable to avoid relocating buildings and disrupting properties. City-owned or state-owned property is also preferable to private property. Since rock removal is performed from the TBM launch site, it is preferable to have the launch site in commercial/industrial areas where construction impacts may be lessened and where there may be good roads (or railroads) to transport and dispose of the rock and soils excavated for the tunnel and shaft. Spur tunnels are typically created by the construction of a new launch shaft adjacent to the tunnel, which is connected to the main tunnel by an adit (which is typically constructed manually by drill and blast techniques).

7.3.4 Tunnel Alignments

The challenge in locating a tunnel in Hartford is the spatial distribution of the CSO regulators and shaft site locations. Some of the largest CSO regulators are located in the congested downtown area (P-1, P-5, P-16, P-12, and N-25). However, there are also significant CSO regulators located closer to the bordering communities of Windsor (NM-2 through 7), Bloomfield (N-2), and West Hartford (N-14). It is impractical to extend the tunnel to each of these outlying areas. Instead, it may be preferable to consolidate these more distant CSO regulators through near-surface piping connected to a drop shaft located along the tunnel route. Consolidation piping routes were considered after an optimal tunnel arrangement was considered.

Figure 7-2 summarizes some of the general route alternatives that were considered for the main tunnel and some of the proposed spurs to pick up sideline CSO regulators. Final route selection and consolidation pipe locations will be determined in a Basis of Design Report that will include a geotechnical investigation.

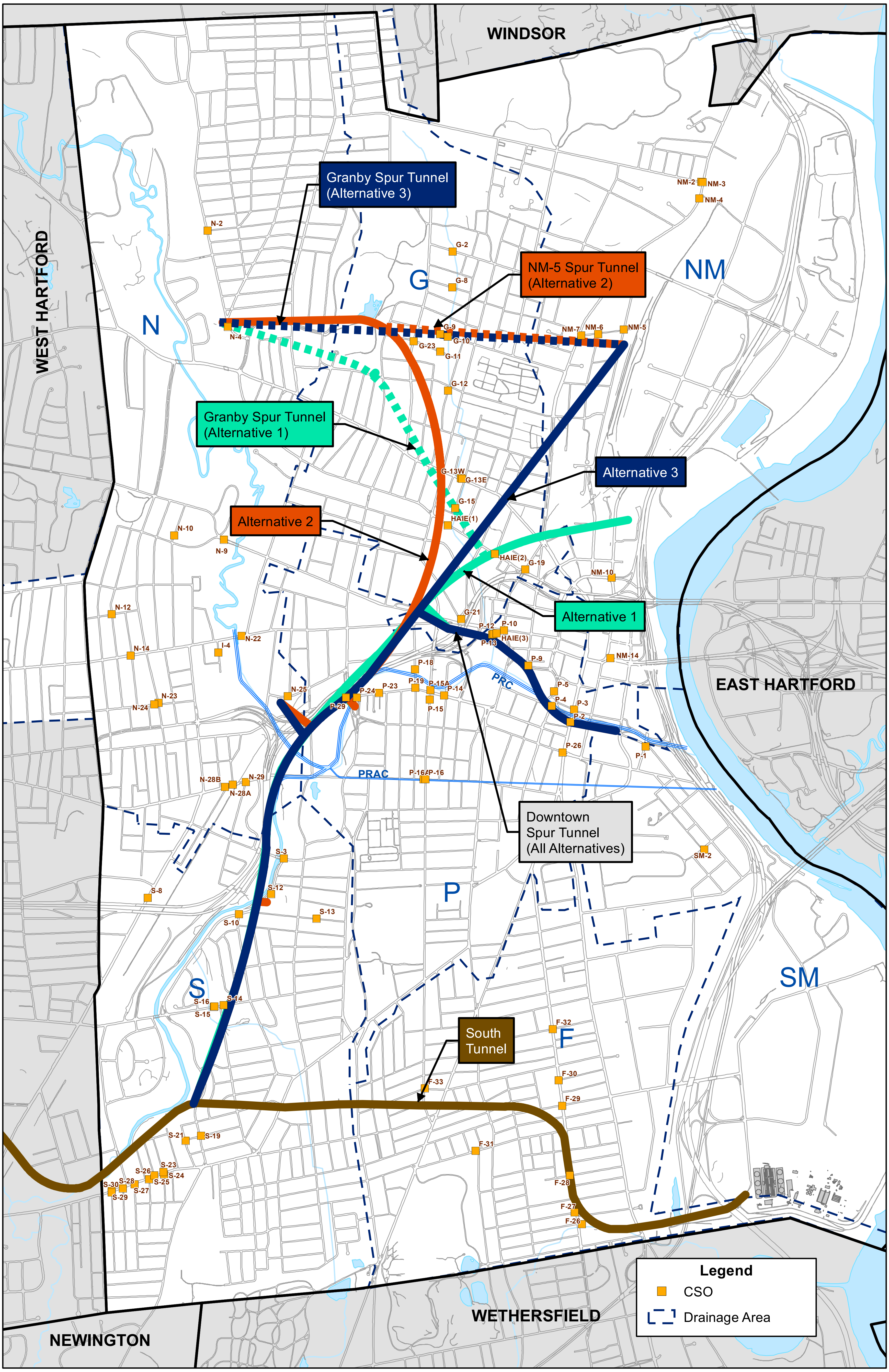
Route Alternative 1

This route (shown in a green color) was the initial mainline preferred tunnel route selected based on the early 2012 study of the feasibility of connecting the North and South Tunnels.

Given the distribution of the largest CSO regulators and limited options for handling downtown Park River Drainage Area CSO regulators by alternate means, it was assumed that a downtown spur tunnel would be routed beneath the Park River through the downtown area using the western shaft as a TBM launch site, and the eastern shaft as a retrieval site. Under Alternative 1, another spur tunnel would be constructed to pick up the large North Branch Park River CSOs (N-2 and N-4).

This spur tunnel would also be available as a connection point at Keney Park to discharge the upper Gully Brook CSO regulators.

A new shaft is also proposed to connect CSO regulator N-25 and provide a point to discharge the Farmington Avenue CSO regulators into the tunnel.



MDC

0 1,150 2,300
Feet

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Hartford, CT
2012 LTCP Update

Figure 7-2
North Tunnel Alternative Routes

Tunnel Route Alternate 2

This route (shown by a red colored line) considered the option of turning the tunnel in an arc to the Keney Park site and then toward N-4. This route was considered to reduce the overall length of tunnels and to reduce the number of shaft locations. In addition, this tunnel alternative avoided new near-surface consolidation pipe in the lower North Meadows area to connect to the terminus of the North Tunnel. The Downtown Spur Tunnel would still be constructed and connected to the main tunnel at the same point. A new tunnel was also proposed to connect the North Meadows CSO regulators (NM-5, NM-6, and NM-7) to the Keney Park shaft. The shaft near N-25 would also be constructed.

Tunnel Route Alternate 3

This route (shown in a dark blue colored line) is ultimately the preferred option based on initial cost estimates of the alternatives. While it is difficult to compare the tunnel route alternatives, because they consolidate different CSO regulators, a general comparison of costs indicated that nearly $50 to $75 million could be saved by Tunnel Route Alternative 3. Under this route, the Downtown Spur Tunnel would be installed along the same route and utilize the same main tunnel connection points. The northern shaft on the North Tunnel near NM-5 would now become the TBM launch site for both the main tunnel and the new spur tunnel to the Granby area. A drop shaft in Keney Park would allow capture of the upstream Gully Brook CSO regulators. The shaft near N-25 would also be constructed.

7.3.5 Tunnel Construction Approach

A general description of the overall tunnel construction approach follows. The connection details of each of the CSO regulators are discussed in Section 9, along with the route and size of any connecting consolidation pipe to meet the CSO control goals.

Main Tunnel

It is expected that Tunnel Route Alternative 3 will be constructed in two stages, using the Loomis Street shaft as a double TBM launch shaft. The first stage would be the construction of the main tunnel. This tunnel would launch from the Loomis Street shaft, be driven south west and retrieved at the Brookfield Street shaft. The second stage would be the construction of the Granby Spur Tunnel. This tunnel would also launch from the Loomis Street Shaft, proceed due west out of the shaft and be retrieved at the Granby Street Shaft. After both tunnels are completed, the bottom of the shaft would be finished to connect them to optimize the hydraulics. The North Tunnel will be connected to the South Tunnel at the Brookfield Street site/shaft by a connecter tunnel. The tunnel depth is expected to be about 150-170 feet deep.

The Loomis Street shaft would be approximately 50 feet in diameter and be constructed in two stages. In the first stage, the shaft would be used for launching the TBMs and facilitating tunnel and spur tunnel construction. After tunnel construction is complete, this shaft would be finished at the base to connect the two tunnels. A small drop structure would be installed on the side of the shaft to receive nearby CSO flows.

The Brookfield Shaft would be approximately 40 feet in diameter and be constructed in two stages. In the first stage, the shaft would be used for receiving, dismantling, and removing the TBM. After tunnel construction is complete, this shaft would be used for connecting the North Tunnel to the South Tunnel through a manually constructed (drill and blast) Adit Tunnel.

The preferred route (colored in dark blue in Figure 7-2) incorporates five offline drop shafts, connecting to the main tunnel via Adit Tunnels. These drop shafts will provide the connection points for the Downtown Spur Tunnel (which receives overflows from the Park River CSO regulators) and a set of near-surface consolidation pipes that will connect the Gully Brook CSOs, the Homestead Avenue Extension Interceptor), the Park Area CSO regulators, the Farmington Area CSO regulators, and the Flatbush Avenue CSO regulators. These consolidation pipes are discussed with other CSO control alternatives in Section 9.

Granby Spur Tunnel

The Granby Spur Tunnel would be launched from Loomis Street double launch shaft. The spur tunnel follows a general west direction and terminates at the corner of Granby Street and Garfield Street.

The Granby Spur Tunnel has one offline drop shaft located in Keney Park. This shaft would be approximately 11 foot in diameter and be constructed as a permanent baffle drop shaft. This drop shaft will convey flows from the Keney Park and Capen Street Conduits (which receives flows from the Gully Brook Interceptor). The tunnel will connect to the North Tunnel so its depth will be around 150 feet.

Additionally, the Granby Spur Tunnel will receive flows from the Granby Street area. These flows will be discharged into the tunnel via the Granby Street Drop Shaft.

The Granby Spur Tunnel will be constructed at the same elevation as the main tunnel so that the entire tunnel system is hydraulically connected and can be utilized as one contiguous tunnel storage system with the South Tunnel. The Granby Spur Tunnel Shaft at Granby and Garfield Streets would be approximately 40 feet in diameter and be constructed in two stages. In the first stage, the shaft would be used for receiving, dismantling, and removing the TBM. After tunnel construction is complete, this shaft would be finished as a permanent baffle drop shaft for CSO inputs.

Downtown Spur Tunnel

The Downtown Spur Tunnel is a deep rock, TBM excavated tunnel designed to capture a number of CSO regulators located in downtown Hartford and convey them to the tunnel. This tunnel will be shallower (about 100 feet deep) than the North Tunnel. These CSO regulators are G-21, P-10, P12, P-13, P-11A, P-9, P-5, P-4, P-2, P26, and P-1 (from west to east). Initially these CSO regulators were to be relieved through a series of conduits that would convey and combine the CSO flows north through the downtown area to a drop shaft located in the Amtrak railroad parking lot. This conduit was assessed, evaluated and refined a number of times. The presence of utilities and sensitive structures indicated the necessity to move the tunnel elevation to a deeper alignment. There are several main advantages to constructing the Downtown Spur Tunnel as a TBM tunnel as opposed to a micro tunnel. First, the TBM tunnel eliminates the need for intermediate jacking and receiving shafts along the length of the alignment. Second, it allows the alignment to be closer to the CSO regulators. Third, major utilities and structure conflicts are eliminated.

The Downtown Spur Tunnel is planned to be constructed fully within bedrock by means of a small diameter TBM. This tunnel will be lined with a single pass segmental concrete liner and have an internal diameter of 10 feet.

The Downtown Spur Tunnel launch shaft would be approximately 35 feet in diameter and be constructed in two stages. In the first stage, the shaft would be used for launching the TBM and facilitating tunnel construction.   After tunnel construction is complete, this shaft would be excavated deeper and finished as a permanent baffle drop shaft for CSO discharges.

The retrieval shaft at Columbus Boulevard would be approximately 30 feet in diameter and be constructed in two stages. In the first stage, the shaft would be used for receiving and dismantling the TBM. After tunnel construction is complete, this shaft would be finished as a permanent drop shaft for CSO discharges.

Section 8

Satellite Treatment and Storage Facilities

8.1 General

Satellite CSO treatment and storage control measures are an alternative to separating the upstream combined sewer system or storing wet weather flow in tunnel systems. Generally, a satellite facility is sited near a CSO regulator to take advantage of the existing regulating structures to divert overflows to the satellite facility and minimize piping and possible pumping requirements. However, this requires available land near the CSO regulator, which is often unavailable in a heavily urbanized city.

For this 2012 LTCP Update report, satellite CSO treatment and storage facilities were considered for general comparative purposes to evaluate the cost-effectiveness of other potential CSO control approaches, especially using the centralized tunnel storage system. This comparison was developed based on the original consolidation site locations (in the 2005 LTCP). The facility costs were updated based facilities sized for the CSO flows and volumes generated for this report and updated construction costs. Due to the large number of Hartford CSO regulators, the 2005 LTCP concluded that it was more practical to construct consolidated CSO treatment or storage facilities versus separate facilities at each CSO regulator.

It is important to note that satellite treatment and storage facilities require above-ground facilities for access to below-grade structures, electrical and odor control equipment, chemical storage/pumping, and sometimes the treatment processes themselves. During the 2005 LTCP, the CAC and the District determined that satellite facilities (with above-ground facilities) would not be readily acceptable to the public as a CSO control strategy and these facilities were ranked lower compared to other alternatives.

8.2 CSO Grouping

For the 2005 LTCP, seven sites were identified as possibilities for the construction of consolidated treatment and storage facilities based on a review of areas of open land, as well as the proximity of each CSO regulator to the open land, to one another and to receiving water bodies. Table 8-1 summarizes the proposed facility locations and the CSO regulators that would contribute flow to each location. Some of the active CSOs in the 2005 LTCP were not specifically connected to the consolidated facilities as these CSOs could be controlled via weir modifications or the other system-wide controls. For this 2012 LTCP Update, an online map search was used to confirm that each of the areas identified in 2005 was still vacant and available to support a potential facility.

It is important to note that the site for N-2 and N-4 can only be used for a storage facility because even treated discharges from a CSO treatment facility would be prohibited as the North Branch Park River is a Class A waterway. A site at G-20 was previously presented in the 2005 LTCP; however, this is no longer required because the District will remove Gully Brook from the system (by 2015) and this CSO regulator (previously, the largest in the system) will be eliminated. For comparison purposes, a site at

Keney Park (near the intersection of Edgewood Street and Capen Street) could be utilized to consolidate many of the remaining northern Gully Brook CSO regulators.

Table 8-1
Proposed Facility Locations for CSO Grouping

Proposed Facility Location	Contributing CSO Regulators
N-4 Vicinity (Storage only) (near intersection of Granby St. & Garfield St.)	N-2, N-4
N-25 vicinity (near intersection of Hawthorn St. & Marshall St.)	N-9, N-10, N-12, N-14, N-22, N-23, N-24, N-25, N-28A, N-28B, N-29
S-16 vicinity (near intersection of Flatbush Ave. & Chandler St.)	All "S" CSO regulators:
Keney Park (near Edgewood Street and Capen Street)	Most "G" CSO regulators: G-2, G-8, G-9, G-10, G-11, G-12
NM-5 vicinity (former Hartford Jai-Alai property)	NM-5, NM-6, NM-7
SM-2 chamber (near intersection of Masseek St. & Huyshope Ave.)	SM-2, P-1, NM-10, NM-14, P-2, P-3, P-4, P-5, P-9, P-10, P-11, P-12, P-13, P-15, P-15A, P-16, P-16A, P-18, P-23, P-24, P-29
F-5 vicinity (South End Playground)	All Franklin CSO regulators

8.3 Satellite Facility Design/Site Considerations

8.3.1 Satellite Treatment

Solids removal and disinfection are typically required for reliable and effective CSO pollutant reduction (or removal). This usually equates with physical-chemical treatment, which is most suitable for highly variable, intermittent influent flows and pollutant concentrations. The satellite treatment technologies considered in the 2005 LTCP (and updated for this report) included: screening, sedimentation, and disinfection; and high rate clarification (HRC; also known as ballasted flocculation) and disinfection. A description of these technologies is provided in the 2005 LTCP. Screening and disinfection was not included as a candidate technology because CTDEEP has indicated that at least a primary level of treatment of CSO discharges would be required to meet the water quality standards at the appropriate control level.

Due to topography and the inverts of the existing pipes, all satellite treatment facilities proposed for the District would require either influent or effluent pumping to discharge the flow into the waterways after treatment. New outfall pipes would also be required for the treatment facilities as the consolidated flows are typically much greater than any existing nearby outfalls to the receiving waters.

Table 8-2 shows the relative site requirements based on CSO flows and volumes for each proposed consolidated treatment or storage facility. Site requirements include space to meet setback standards from abutters and access and parking requirements. The consolidation sites will be used for both treatment and storage options, as described below, although it is likely that the facilities for some of

Table 8-2
Consolidated Facility Size Requirements

Outfall	Screening, Sedimentation, and Disinfection			Storage	
	Peak Flow (mgd)	Tank Area (1) (acres)	Facility Footprint(2) (acres)	Overflow Volume (MG)	Tank Area (3) (acres)
Gully Brook Drainage District					
Keney Park Facility (most G regulators)	66	0.76	0.85	4.0	0.82
North Branch Drainage District					
N-4 Facility (N-2 & N-4 regulators)	Treatment Discharges are prohibited to North Branch Park River			8	1.62
N-25 Facility (all other N regulators)	187	2.15	2.40	11	2.25
North Meadows Drainage District					
NM Facility (NM-2 thru NM-7 regulators)	49	0.56	0.63	3	0.61
South Meadows Drainage District					
P-1	44	0.51	0.57	4	0.84
All other P regulators	306	3.51	3.93	24	4.91
NM-10 & NM-14 regulators	20	0.23	0.26	2	0.31
SM-2 Regulator	50	0.57	0.64	5	1.04
SM-2 Facility (includes above regulators)	420	4.82	5.40	35	7.10
South Branch Drainage District					
S-16 Facility (all S regulators)	90	1.03	1.16	8	1.64
Franklin Avenue Drainage District					
F-5 Facility (not incl. stormlinks F-5 & F-9)	Treatment Discharges are prohibited to Wethersfield Cove			36	7.41

Notes:

(1) Sedimentation tank size based on overflow rate of 2,000 gpd/sq ft

(2) Total facility footprint including allowances for other facility structures including screenings and chlorination buildings and pumpback equipment. Odor control is assumed to be built over the tank.

(3) Based on 15 ft SWD for satellite facilities at CSOs.

Odor control is assumed to be built over the basins. It is assumed that these non-tank facilities will be 17 percent of the CCB area.

It is assumed that non-tank facilities will be 12 percent of the sedimentation tank area.

Chlorine contact basins are not necessary for treatment approach with sedimentation since a minimum of 15 minutes contact time is provided by the sedimentation tanks.

The land area shown represents the expected tank footprint.

Additional land area will be required to meet standards for buffer from abutters.

these options will not fit within the proposed facility locations, given the volume or peak flow that would need to be handled.

Screening, Sedimentation, and Disinfection

These facilities are sized primarily based on the sedimentation basin overflow rate for the peak flow seen in a given design storm. A majority of the total facility footprint area is dedicated to below ground sedimentation tanks. This satellite treatment alternative requires the most land area, since this type of facility is designed to settle suspended solids by gravity. For the purpose of this report, it is assumed that traditional settling tanks will be used.

Additional land area was added to the site assessments to cover other facility structures, such as screenings and chlorination buildings. Since sedimentation tank size requirements are larger than chlorine contact tank requirements, the percentage allocated in the total footprint for non-tank structures is lower for sedimentation facilities than for screening and disinfection facilities. It is assumed that any required odor control facilities would be constructed above the settling tanks. It is expected that influent or effluent pump stations will be required. It is also assumed that dedicated chlorine contact tanks will not be constructed since, in all cases, the sedimentation tanks are larger than the contact tank requirements for a 15-minute contact time.

High Rate Clarification and Chlorine Disinfection

High rate clarification and chlorine disinfection facilities are typically much smaller than other conventional CSO treatment facilities, such as those described above. Actiflo®, a ballasted flocculation process, can have facility footprints 5 to 50 times smaller than conventional clarification systems. However, the manufacturers do not provide guidelines or formulae to calculate tank sizes. Accordingly, for planning purposes, it is assumed that the size of high rate clarification systems for use in Hartford will be smaller than the sizes calculated for screening, sedimentation, and disinfection.

These main facilities are designed to provide an overflow rate from 20 to 70 gallons per minute per square foot for the peak flow generated in a design storm. A space allowance for screening and grit removal is also made for these types of facilities.

8.3.2 Satellite Storage

Satellite storage facilities are designed to capture and hold overflow volumes until capacity is available in the interceptor system, at which time the tanks are dewatered back into the collection system for subsequent treatment at the HWPCF. From a regulatory perspective, storage facilities are often considered more advantageous than satellite treatment facilities, since the captured design volume is eventually conveyed to the HWPCF for higher level treatment, rather than discharged through CSO outfalls following localized solids removal and disinfection.

However, there are some other points to consider when evaluating storage options. Storage has the largest site size requirements among the proposed CSO control options presented in this section.

Pumping is also a consideration. From an operational standpoint, effluent pumping is preferred over influent pumping for storage options, since the pumps only need to run to dewater the tank back to the collection system. Influent pumping may be required to avoid a deep excavation. However, influent pumping is significantly more expensive as the influent pumps must match the high rate of the peak flows of the CSOs versus the lower rate required of dewatering pumps. Influent pumping is required if the invert of the influent pipe is too deep. For this analysis, if the consolidation pipe to the satellite storage facility was deeper than 25 feet, influent pumping (at the peak flow rate) was added to the cost of the facilities. This is because EPA-derived curves for satellite storage are generally for near-surface storage facilities. At an influent depth of 25 feet, the facility may be more than 40-50 feet deep overall where excavation costs (including soil disposal and replacement costs, along with potential rock excavation) may be more than the costs of a larger pumping facility (with smaller overall facility excavation requirements).

Tank area requirements were derived by dividing local overflow volume by an assumed 15-foot side water depth. Storage tanks would be installed below ground. Facility footprints assume additional area for pump-back equipment.

8.3.3 Site Suitability

Preliminary site assessments were conducted for each of the sites identified in Table 8-1 in the 2005 LTCP (with the exception of the Keney Park site). Sites were selected based on available open land, size, proximity to existing CSO regulators, and proximity to receiving water bodies. These site assessments provide information on physical site characteristics, ownership, abutters, zoning, access and traffic, land use, environmental concerns, and historic features. They also show maps of the sites, including some utility information. The Keney Park site requires further investigation but a preliminary review showed that it is available and a storage or treatment facility could be constructed on the site. The N-4 site can only be used for a storage facility as no treated discharges would be allowed to the North Branch Park River.

Based on the site requirements presented in Table 8-2, satellite facilities can be constructed on most of the sites with some exceptions. A general description of the sites and any exceptions to suitability are noted below.

- NM-5 is about 22.5 acres, and includes the former Jai-Alai building, which is now vacant. This parcel is zoned for industrial use and is a flat site.
- The site near CSO regulator N-4 also is vacant, although at the time of the initial site investigation it was being used to temporarily store construction equipment for work being done on Granby Street. This site can only be used for a storage facility (because no treated discharges are allowed along the North Branch Park River). This land is zoned commercial.
- CSO regulator N-25 is also located near a vacant lot, which has an outfall pipe to the Park River Conduit. It is zoned for industrial use, and is not in a residential area. N-25 is about 6.8 acres and is partially vacant. It appears to be the site of a demolished building.
- The city of Hartford Park Department owns a vacant plot near CSO regulator S-16 that was formerly used as a baseball field. An underground storm drain and sanitary sewer pipe are both located adjacent to the lot, and the storm drain eventually discharges to the South Branch Park River. This area is zoned as a low-density residential district.
- The site near SM-2 is currently owned by the city of Hartford, and there is an existing CSO regulator structure with an underground outfall pipe at this site. With the exception of the CSO regulator structure, the lot is vacant and is zoned for public use. This site is 5.74 acres, and is

not large enough to accommodate the 1-year storm for the flow that was proposed to be consolidated to this site.

- The city of Hartford also owns the site near F-5 and it is approximately 8.7 acres. It is currently used as a neighborhood park (South End Playground), and has some open space in the vicinity of the baseball field. It may not be an ideal site for a treatment or storage facility because there are buildings, large underground pipelines (Folly Brook Conduit) traversing the site, and site access restrictions. Additionally, the open space at this site is used as baseball fields and basketball courts. For these reasons, F-5 is no longer being considered.

Accordingly, not all of the consolidation sites may be available and/or can support the right size facility for the District. However, for comparison purposes, the capital costs associated with the consolidated CSO treatment or storage facilities were still updated. If the costs for consolidated storage or treatment facilities are cost-competitive to other CSO control technologies, as discussed further in Section 10, then the District could complete further site investigations to identify potential lots that could be obtained from private property owners through municipal procedures.

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8.4 Facility Costs

Costs for the pumping and storage and treatment facilities, as presented in Table 8-3, were derived using EPA published cost curves, cost data from recent CSO construction projects, and other New England CSO long term control plans. The background for these facility costs is presented in Appendix A. EPA did not have cost curves for high-rate clarification; thus, capital costs for HRC were estimated based on past installations that included screening and disinfection, quotes gathered from HRC vendors for various flow rates, and other CSO facilities planning reports. For consolidated satellite treatment facilities, pumping costs were calculated using peak flow rates. For storage facilities, flow rates were either calculated by assuming that the total storage volume will be pumped out over a period of two days (where the facilities may not be too deep) or assuming full peak flow rates. Consolidation piping was sized based on the peak flow rates and the construction costs to install these pipes were based on recent construction projects within the District. Figure 8-1 shows the locations of the sites and consolidation piping.

All cost data were adjusted to 2012 ENR construction cost indices (CCI) based on an average of the Boston City Base and New York City Base ENRs (13,270 as of October 2012). The capital costs represent construction cost estimates assuming excavation depths of approximately 40 feet on non-contaminated sites. A 25-percent construction contingency was used to develop these construction costs.

The cost estimates do not include costs for full property land acquisition and potential contamination issues associated with the individual sites. Although the potential sites identified in Table 8-1 are not listed as hazardous waste sites by the Toxics Action Center in Hartford, and no information is available on these sites from CTDEEP, it would be necessary to perform further investigations of these industrial areas to confirm that no hazardous material is present.

There do not appear to be many utility conflicts on these sites, except for some of the District's existing sewer pipes, but this would have to be verified since utility mapping generally does not show services on private property. All sites appear to have electrical power lines nearby, located either overhead or underground.

Archeological investigations are also not included in the capital costs, because it is unlikely that they will be required. Initial site investigations confirm that none of these sites are listed on the National Register of Historic Places, although one site (SM-2) abuts historical buildings.

Annual O&M cost estimates associated with the facilities are also presented in Section 10.

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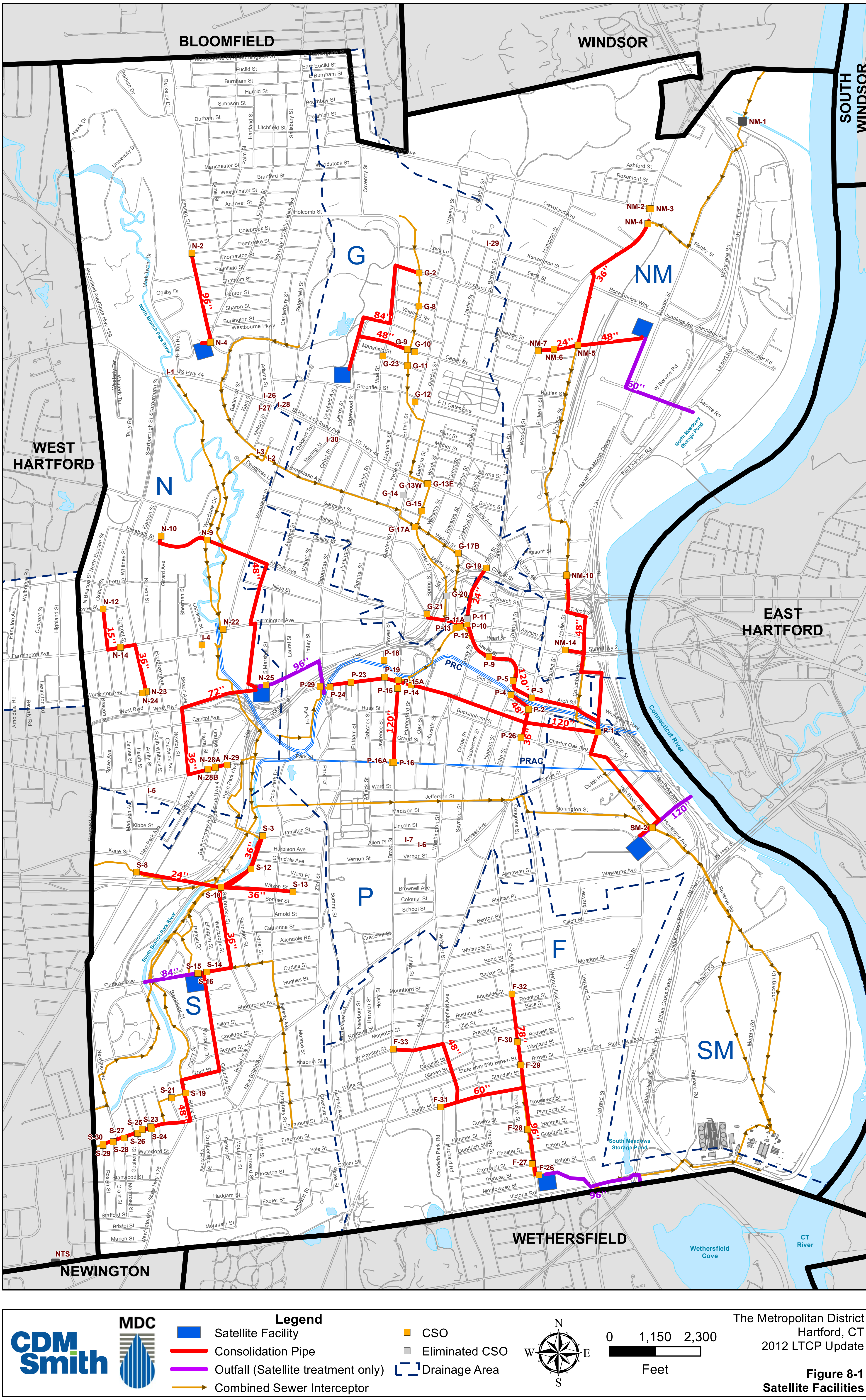
Table 8-3
Summary of Satellite Treatment and Storage Facility Costs

	SATELLITE SCREENING, SEDIMENTATION, & DISINFECTION COSTS		SATELLITE HIGH-RATE CLARIFICATION AND DISINFECTION COSTS		SATELLITE STORAGE COSTS		
Outfall	**Treatment Capacity (mgd)**	**Capital Cost ($M)**	**Treatment Capacity (mgd)**	**Capital Cost ($M)**	**Storage Volume (MG)**	**Pumping Rate (mgd)**	**Capital Cost ($M)**
Gully Brook Drainage Area							
Keney Park Facility (most G regulators)	76	$29	76	$46	4		$47
Consolidation Piping		$27		$27			$27
Pumping Costs		$49		$49		76	$49
Total G-20 Facility Costs		**$105**		**$122**			**$123**
North Branch Drainage Area							
N-4 Facility (N-2 & N-4 regulators)	Treatment Discharges are prohibited to the North Branch Park River				8		$84
Consolidation Piping							$15
Pumping Costs						4	$8
Total N-4 Facility Costs							**$107**
N-25 Facility (all other N regulators)	187	$53	187	$85	11		$109
Consolidation Piping		$73		$73			$73
Pumping Costs		$84		$84		187	$84
Total N-25 Facility Costs		**$210**		**$242**			**$266**
North Meadows Drainage Area							
NM Facility (NM-2 thru NM-7 regulators)	49	$22	49	$35	3		$37
Consolidation Piping		$65		$65			$65
Pumping Costs		$38		$38		49	$38
Total NM Facility Costs		**$124**		**$137**			**$140**
South Meadows Drainage Area							
P-1	44		44		4		$47
All other P regulators	306		306		24		$208
NM-10 & NM-14	20		20		2		$27
SM-2	50		50		5		$57
SM-2 Facility (includes above regulators)	420	$93	420	$145	35		$284
Consolidation Piping		$121		$121			$121
Pumping Costs		$137		$137		420	$137
Total SM-2 Facility Costs		**$351**		**$403**			**$542**
South Branch Drainage Area							
All S regulators	90	$32	90	$52	8		$84
Consolidation Piping		$58		$58			$58
Pumping Costs		$54		$54		90	$54
Total S Facility Costs		**$145**		**$164**			**$196**
Franklin Avenue Drainage Area							
F-5 Facility (not incl. stormlinks F-5 & F-9)	reatment Discharges are prohibited to Wethersfield Cov				36		$291
Consolidation Piping							$77
Pumping Costs						18	$21
Total F-5 Facility Costs							**$389**

Notes:
CSO Flows and Volumes based on 1-year storm event with the exception of the Franklin Avenue
CSOs (F series) and select N CSOs (N2, N4, N9, and N10) that are based on 18-year storm event
All costs include 20% contractors O&P; 25% contingency;
Costs do not include allowance for engineering, consolidation pipe construction, soil conditions, land acquisition, or hazardous waste removal
Costs were calculated by summing peak flows for each regulator, which is conservative
MDC ENR value assumed to be the average between NYC and Boston versus 20-city average = 9,351
MDC ENR Oct 2012 = 13,267



The Metropolitan District
Hartford, CT
2012 LTCP Update

Figure 8-1
Satellite Facilities

8.5 Satellite Facility Summary

Hartford will have 72 active (in design storm) CSO regulators, which makes construction of CSO controls at each individual CSO regulator impractical. In order to provide a cost-effective solution for CSO control, flow consolidation is a better alternative when considering satellite treatment or storage facilities in the District. The consolidation plan required to reduce the number of satellite facilities will likely require pumping into or out of the facility.

Table 8-3 provides a summary of satellite treatment and storage alternatives and costs considered for this report.

As discussed previously, siting of satellite facilities is a critical factor. Space requirements and environmental and community impacts are important considerations, as well as the operations and maintenance requirements for these stand-alone facilities. Satellite storage/treatment may be combined with other CSO control measures to minimize the number of installations and the size requirements for the facilities.

Not all of the sites identified in this analysis can support either a treatment and/or a storage facility for the appropriate design storm. The costs presented in this section are simply derived for comparison with the other CSO control technologies being considered by the District. If satellite treatment or storage alternatives are cost-effective for any group of CSO regulators, and the site cannot support the appropriate sized facility, the District could investigate nearby sites that could work to its advantage.

Table 8-3 presents only capital costs of treatment or storage alternatives for each CSO group. This section was intended to present a general discussion of satellite storage and treatment approaches for comparative purposes based on the original 2005 LTCP program. Section 10 provides a more rigorous discussion of the updated consolidated groupings and life cycle costs (capital and operations and maintenance costs) for CSO control in the District assuming the use of the South Tunnel and, potentially, a new storage facility.

Section 9
Green Infrastructure

9.1 Overview

Green solutions have several benefits that could serve the CSO community and the District well. The main purpose of green solutions is to reduce runoff into the combined sewer system by detaining and infiltrating stormwater. The benefits include dampening peak flows, reducing the amount of grey infrastructure required for CSO reductions, and providing visible improvements for the community. These projects can help build support from the public as well as regulatory agencies. Generally, green solutions applied to sewer systems are intended to reduce inflow from sources connected to the sewer. This is most beneficial in a combined sewer system, such as the District's system in the city of Hartford, because, by design, most private and public inflow is connected to the sewer system.

Although there are many approaches to green infrastructure that have been proven reliable elsewhere for capturing stormwater and infiltrating it into the groundwater, implementing many forms of green infrastructure in Hartford could exacerbate the already high groundwater level. Poor soil conditions in Hartford (clay underlying soil layers) may impact infiltration rates for green infrastructure, which may make this strategy less feasible in the city. To the extent feasible, the following green solutions have been considered for incorporation into the District's LTCP:

- Green roofs
- Permeable pavement
- Bioretention systems, vegetated filter strips, and street planters
- Rain barrels/Cisterns (rainwater harvesting)

9.2 The District's Green Initiatives

To-date, the District has designed and constructed green projects in the Clean Water Project where it was feasible. The District has distributed numerous informational flyers to increase the public's awareness of potential green initiatives that they could implement on their properties to help remove stormwater from the combined sewer system. Figure 9-1 provides an example of a flyer. The flyers encourage homeowner participation through the distribution of rain barrels, and education on disconnecting sump pumps and downspouts from the sewer system.

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REDIRECTING AND REMOVING STORMWATER

While upgrades to the sewer system made through the Clean Water Project have already reduced the discharge of nitrogen into the Connecticut River and reduced overflows, stormwater infiltration continues to be a significant problem and cannot be fully eliminated.

While the District does its part to separate and disconnect systems, build larger tunnels and increase treatment plant size to address capacity, property owners can do their part as well.

It is costly and unnecessary to treat stormwater at our treatment facilities when there are simple and cost effective solutions for removing it. Disconnect direct stormwater connections (i.e. rain leaders, sump pumps) from the sewer system and redirect them to your yard, rain barrels or rain gardens.

Through the Clean Water Project, the largest sewer infrastructure project in the region's history, we are making a very important and necessary investment in improving a system that will leave us with cleaner neighborhoods, rivers and streams and will support current and future generations to come.

Clean Water Project
the choice is clear

We all live downstream

Turning on the tap or flushing the toilet is as simple as turning a knob or pushing a handle. What you don't see is the vast infrastructure of pipe beneath our streets that brings clean water to you and takes wastewater from you. The thousands of miles of water and sewer pipes have worked silently for years, in some cases more than a century, without major interruptions. It is our duty to maintain these systems to ensure they function for current and future generations.

Water pollution control, or wastewater treatment, is one of the most crucial environmental services provided by the MDC. After leaving our homes, schools and businesses, wastewater goes down the drain and travels through more than 1200 miles of sewer infrastructure beneath our streets. Engineered to primarily use gravity to aid in its flow, the wastewater ultimately reaches one of our four treatment facilities (Hartford, East Hartford, Rocky Hill and Windsor) to be processed.

- **THINK BEFORE YOU FLUSH.** Everything you send down the pipe ends up at your local wastewater treatment plant. We are all part of the water cycle. We all live downstream.

Wet Weather Expansion Project

On May 15th, Congressman John Larson was keynote speaker at a groundbreaking ceremony held to mark the beginning of the Hartford Water Pollution Control Facility's (HWPCF) Wet Weather Expansion Project. Three new facilities will be constructed at the HWPCF, which are all a significant part of the overall Clean Water Project. State-of-the-art facility controls for operations and maintenance will be incorporated into the Influent Pump Station, Headworks, and Odor Control facilities.

Once complete, the HWPCF will increase its wet weather capacity from 30 million gallons per day (MGD) to 200 MGD ultimately helping to reduce the number of combined sewer overflows. Additionally, odor control for the entire facility will use a chemical free, biological process.

9.2.1 Green Roofs

By capturing rainwater with rooftop vegetation, the vegetation encourages evaporation, transpiration and water storage in the soil. Through their water-retention properties, green roofs increase the time of concentration in storm events, which decreases the intensity of stormwater peak flows downstream. Green roofs not only provide water retention benefits, but also create aesthetic improvements, and can result in energy-saving benefits as well by reducing the heat-island effect in urban areas. Vegetated roofs can insulate buildings better than regular roofs in the summer and winter, thus reducing energy consumption for heating and cooling.

The Hartford "Green Capitols" was completed around the historic state capitol as a joint collaborative effort of the District, CT DEEP, and State Capitol Facilities to demonstrate the potential use of a number of green infrastructure technologies. The green design elements were installed to demonstrate how these stormwater control technologies can be integrated into the urban landscape. Figure 9-2 provides an overview of the various types of green technologies that were built around the capitol building. The State Capitol encourages the public to tour the grounds and learn more about the low impact development. The project included a green roof installed on a basement roof to allow the public to see it more easily.

9.2.2 Permeable Pavement

Permeable pavement generally is appropriate for sidewalks, parking lots, bike paths, and roadways with low traffic density. These can be installed with an underdrain system if underlying native soils or fill soil has a slow infiltration rate, or to reduce the occurrence of infiltration to the groundwater. The following District projects include permeable pavement as part of the project:

- Hartford "Green Capitols" – The District designed and constructed porous concrete sidewalks and permeable concrete pavers. The Capitol Building Facilities division agreed to own and is maintaining the pavers.

- North Beacon Street Green Demonstration Project – The District designed and constructed two types of pervious concrete pavers within the right-of-way. The city of Hartford approved the pavers, but did not agree to maintain them.
- MDC Headquarters Goes Green – The District designed porous concrete sidewalks and permeable concrete pavers. The city of Hartford has requested the District own and maintain the pavers.

- West Hartford Reservoirs Recreation Parking Access Bridge – The District installed permeable concrete pavers over the bridge access roads in 2009.

While the District may agree to own and maintain the pavers at their headquarter building, they cannot build similar projects within the right-of way in other parts of the city and assume ownership and maintenance. Given the reluctance of the city to take ownership of and maintain green infrastructure in the city's rights-of-ways, there may be limited additional opportunities for permeable pavement projects.

Where Does the Rain Go?

The roads, sidewalks and parking lots that surround Hartford's Capitol support the city's economic vitality. But these "impervious surfaces" and the corresponding absence of green space also impact our environment. When it rains, more "stormwater runoff" winds up in our storm drain system, instead of naturally seeping into the ground. As the runoff flows over the pavement, it picks up pollutants that end up in our rivers, streams and oceans.

"Green" techniques can help divert stormwater runoff from storm drains.

Green or low impact development techniques – such as porous pavements, green roofs, rain gardens and rain harvesting – are cost-effective and environmentally preferable alternatives to conventional drainage techniques. Not only do they reduce the amount of stormwater runoff entering our storm drain system, but they also naturally filter the rain into the earth.

The Hartford Green Capitol project demonstrates the benefits and beauty of green techniques.

The Hartford Green Capitol project provides visitors with the opportunity to see how a green environment can be created utilizing low impact development. Several green infrastructure retrofits have been made in and around the State Capitol grounds, including the installation of rain gardens, walkways and pavements that will allow stormwater to flow through to the ground. A green roof installed on a basement roof will allow the public to see it more easily. A cistern under the Capitol parking lot will collect rainwater from the roof for irrigation.

We measure and maintain the project's effectiveness.

The monitoring program developed by CDM Smith studies the infiltration, durability, and esthetics over time. The rate of permeability of the sidewalks and roadways was measured immediately after construction and then at regular intervals to evaluate the long term rate of flow through the surfaces. The street planters and roof gardens are evaluated for function, maintenance and vegetative cover. The data collected provides us with a quantitative measurement of the effectiveness of sustainable design infrastructure.

Take the Self-Guided Tour.

Hartford is proud of its beautiful Capitol and now we have even more to be proud of – our green infrastructure. We encourage you to tour the capitol grounds, learn more about low impact development, and try some of these techniques in your own community. Together we can all make a difference.

The green capitol project is a demonstration to highlight green infrastructure retrofits and low impact development (LID) projects supported by Department of Energy and Environmental Protection's Watershed Management Program. Green infrastructure and LID can be cost effective, environmentally preferable alternatives to conventional stormwater conveyance and treatment structures.

State of Connecticut
Department of Energy and Environmental Protection
Watershed Management/LID Program
Contact: MaryAnn Nusom Haverstock
(860) 424-3347
maryann.nusomhaverstock@ct.gov

Funding for the Green Capitols Project was provided by the State of Connecticut, Department of Energy and Environmental Protection's Clean Water Fund.
State of Connecticut
Department of Energy and Environmental Protection
Clean Water Fund
Municipal Facilities Section
Contact: Stacy Pappano
(860) 424-3362
stacy.pappano@ct.gov

Additional Information
www.ct.gov/dep

Draft brochure compliments of CDM Smith Inc.

CONNECTICUT ENERGY ENVIRONMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

MDC

CDM Smith

HARTFORD GREEN CAPITOLS PROJECT

State Capitol, Hartford, CT

9.2.3 Bioretention Systems, Vegetated Filter Strips, and Street Planters

Similar to green roofs, bioretention systems such as bio-swales, planters, and vegetated filter strips (green gutters) all have the capability to work in harmony with the Clean Water Project if implemented properly. Most commonly designed to collect runoff and manage it through infiltration, bioretention systems can be designed to drain into the collection system after retaining the water, promoting evapotranspiration, and filtering pollutants from the runoff.

Many communities with bioretention systems involve volunteers in the maintenance. This not only eases the burden on the city, but can also provide a sense of ownership and pride amongst the local citizens. The following District projects include bioretention systems as part of the project:

- Hartford "Green Capitols" – The District designed and constructed multiple rain gardens. The Capitol Building Facilities division agreed to own and is maintaining the gardens.

- MDC Headquarters Goes Green – The District designed multiple rain gardens to take stormwater runoff from the sidewalks and street adjacent to the MDC's headquarters at 555 Main Street in Hartford. The city of Hartford has requested the District to own and maintain the gardens.

- Victoria Road Greening Project – The District has teamed with the local community in Hartford to build a rain garden in the existing island at the intersection of Victoria Road and McMullen Avenue. The District is providing the design and construction of the project, while the local residents have agreed to maintain the island after construction is complete.
- A team of interns from the District's Diversity Internship Program completed the design and installation of a rain garden for the Storrs Mansion on Farmington Avenue in Hartford. The 150 square foot rain garden is filled with 58 native plants that will collect and absorb rain water from the property to reduce the amount that enters the collection system. A similar project was also completed in Wethersfield. Rain Gardens are an excellent way to capture stormwater and reduce what enters the sewer system.

- The Knox Parks Foundation works in partnership with residents, businesses and government to build stronger, greener and more beautiful communities in Greater Hartford. While the District has been completing sewer separation projects for the Clean Water Project, the Knox Foundation has been contracted for tree replacement and landscaping restoration in several project areas through Hartford.

Given the reluctance of the city to take ownership of and maintain green infrastructure in the city's rights-of ways, there may be limited additional opportunities for additional rain garden projects unless neighborhood groups come forward in the future similar to the Victoria Road Greening Project.

9.2.4 Rain Barrels/Cisterns (Rainwater Harvesting)

Rain barrels provide a means to capture runoff from roofs and private property so that it doesn't discharge into the sewer. This approach conserves water since the captured runoff can be used for watering plants on private property, also known as rainwater harvesting. The rain barrels should be emptied between rain events to take advantage of this storage capacity, or be designed to overflow into a rain garden to further any filtration and retention benefits. Cisterns offer more storage volume than rain barrels and can store water for toilet flushing, washing cars, landscape irrigation, or other gray water applications.

In addition to saving the consumers money, rain barrels and cisterns provide a number of important environmental benefits, including reducing the amount of stormwater entering the sewer system during rain storms. By collecting stormwater that would otherwise enter the sewer system and be unnecessarily treated, rain barrels are a smart, low cost, green way to help manage stormwater in the communities.

Figure 9-3 (2 pages) is an example of a brochure prepared by the District and distributed to customers to inform them of the benefit of rain barrels.

The District has undertaken the following initiatives related to rain barrels/cisterns:

- Hartford "Green Capitols" – The District designed and constructed a cistern under the Capitol parking lot that collects rainwater from the roof for irrigation. The Capitol Building Facilities division agreed to own and maintain the cistern.

- In 2012, the District launched a highly successful Rain Barrel Program. Rain barrel demonstration displays were set up in public buildings in each of the eight member towns. The displays were designed to show the many benefits of harvesting rainwater such as saving customers money on their water bill, reducing stormwater runoff, and preserving the environment. The program proved to be a resounding success as the District distributed over 1,300 rain barrels to its customers over thirteen pickup dates.

Clean Water Project
the choice is clear

Rain barrels and the Metropolitan District's "Clean Water Project"

The Clean Water Project is the Metropolitan District's sanitary sewer infrastructure improvement initiative designed to satisfy the mandates of a federal consent decree and state consent order.

When it rains, stormwater enters the sewer system both through direct connections, such as sump pumps and downspouts, as well as through cracks and breaks in the pipes, some of which are more than 100 years old. This allows stormwater to mix with raw sewage, exceeding the pipes' capacity. During major rain storms, this mix of stormwater and raw sewage can then back up into residents' basements, overflow into neighborhood streets and spill out into local rivers and streams.

In response to these serious problems, The Metropolitan District launched the Clean Water Project. Key components of the Clean Water Project include building new sewer systems, removing excess stormwater from the system, and increasing wastewater storage and treatment capacity. The Clean Water Project is not only addressing raw sewage back-ups and overflows in neighborhoods, it is also designed to reduce the sewage flowing into the Connecticut River and the Long Island Sound, consistent with the requirements of the Federal Clean Water Act.

By collecting stormwater that would otherwise enter the sewer system and be unnecessarily treated, rain barrels are a smart, green way to help manage stormwater in our communities.

Where can I get a rain barrel for my house?

Rain barrels are available for purchase at area hardware and home improvement stores.

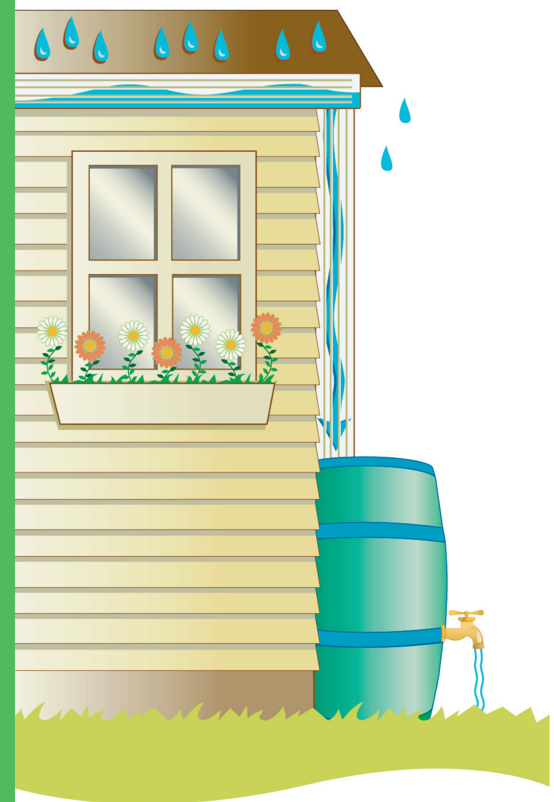
For more information, visit our website at **www.themdc.com**.

About the Metropolitan District

The Metropolitan District (MDC) manages the water and sewer systems for several municipalities in the greater Hartford area. Founded in 1929, the MDC provides its customers with safe, pure drinking water, environmentally protective wastewater collection and treatment and other services that benefit its member towns. For more information about the MDC please visit **www.themdc.com**.

MDC

Rain Barrels



Recycle Water

Save Money

Reduce Pollution

MDC

Clean Water Project
the choice is clear

What does a rain barrel do?

A rain barrel collects and stores rainwater from your roof by diverting runoff from the downspout of your gutter system. Using a rain barrel can help the average homeowner save about 1,300 gallons of water during peak summer months.

What are the benefits of rain barrels?

Rain barrels offer many important benefits, including:

- **Saving money** by reducing the amount of water you use
- Offering a **free source of clean water** for a number of outdoor uses, such as watering plants and gardens, washing cars, etc.
- **Reducing the amount of stormwater that enters the sewer system** during rainstorms, which can help prevent sewage overflows into homes and local waterways
- Providing an **extra source of water** in times of drought
- **Reducing pollution** of local waterways caused by urban runoff

Installation: Installing a rain barrel is a quick and easy process. To start capturing rainwater, all you need is a barrel, diverter or downspout elbow, about an hour of your time and a few tools you probably already own. To get started:

1. Locate a downspout from which to collect rain

2. Place leveled cinder blocks where your rain barrel will sit. The blocks should be tall enough for a watering can to fit below the spigot

3. Determine a location to cut the existing downspout and cut with hacksaw

4. Attach a flexible diverter or downspout elbow from the existing downspout to the top of the rain barrel

5. Place the rain barrel on the center of blocks; you're now ready to harvest rainwater!

Photos: Ward Wilson via Picasa, Creative Commons Attribution

Maintaining your rain barrel: Like most things around your home, your rain barrel needs a little attention to keep working properly. Following these tips will ensure that your rain barrel will provide you many years of reliable service:

Regular Maintenance:
- Empty your rain barrel once a month
- Clean the rain barrel's interior once a year with a nontoxic cleaner & rinse completely
- Clean gutters regularly to minimize debris collected in rain barrel

Seasonal Maintenance:
- Disconnect the downspout & return it to its configuration prior to the barrel's installation
- Remove and store hose
- Drain rain barrel completely to prevent freezing & cracking & store upside-down

9.3 Other District Green Initiatives

As an organization, the District is a steward of the environment. Below are several examples, of green initiatives, outside CSO control.

9.3.1 Hartford Water Pollution Control Facility

Wastewater treatment is energy intensive due to all of the processes and equipment. The new Heat Recovery Facility will provide a system to recover heat (energy) from the incinerator exhaust gas for steam production. The steam will be fed to a steam turbine generator for power production to offset a portion of the power HWPCF purchases from the public utility grid. The new turbine generator has a capacity to produce 1.7 megawatts of power, or approximately 40 percent of the HWPCF's electrical demand. The project has been completed and has been operational since 2013.

9.3.2 Solar Energy Project at Poquonock Water Pollution Control Facility

The District is negotiating a contract with a vendor, to build, own and operate an approximately 249 kW Solar Photovoltaic Facility at the Poquonock Water Pollution Control Facility. The District will purchase electricity generated from the project to supplement the electric power needed at the Poquonock Plant for a 15 year term. The District anticipates a potential cost savings of $400,000+ over the 15 year term of the project. The project was awarded a Zero Emission Renewable Energy Credits (ZRECs) from Connecticut Light & Power.

9.3.3 Watershed Management

The District owns over 31,000 acres of land in Connecticut and Massachusetts, the majority of which is watershed forest land. A watershed forest is the first line of defense for protecting water from degradation and maintaining high quality drinking water. This land acts as a natural filter and buffer to pollutants and protects the integrity of the District's drinking water supply reservoirs. The District's Watershed Management Unit closely monitors and protects this natural area.

9.3.4 Hydroelectric Facilities at Goodwin and Colebrook

The District's Goodwin Hydroelectric Facility is located at the Goodwin Dam and is equipped with two Francis style turbine/generators, each capable of producing 1,695 kilowatts (KW). The Goodwin Facility generates approximately 13,000,000 kilowatt hours of electricity in a typical year, enough to serve about 2,000 homes.

The District's Colebrook Hydroelectric Facility is located at the U.S. Army Corps of Engineers' Colebrook River Dam and Reservoir. While flood control is the primary purpose of the Colebrook River Dam, the reservoir is also used for recreation, maintenance of Farmington River flows, and the generation of hydroelectric power.

The facility is equipped with two sets of 3 Kaplan style submersible turbine/generators, each set capable of producing 1,500 KW. The Colebrook Facility generates approximately 5,000,000 kilowatt hours annually, enough to serve about 1,000 homes.

9.3.5 Hydroelectric Facility at Puddletown Pump Station in New Hartford, CT

The District is in the final stages of selecting a contractor to build and install a Francis style turbine in its Puddletown Facility to generate electric power in the transmission main supplying raw water from Saville Dam to the water treatments plants at West Hartford and Reservoir 6. The system rated size is 210 kW and is expected to generate an Annual Electricity Production (AEP) of 1,475,000 kWh.

9.4 District's Coordination with Hartford's Streetscaping Projects

The city of Hartford has performed and will continue to perform numerous streetscaping projects (i.e. Farmington Avenue, Albany Avenue, Wethersfield Avenue, and the Intermodal Triangle Project). The District has and will continue to assist the city in these projects through any coordination/required utility relocation. These streetscaping projects are prime candidates for incorporating green technologies, such as permeable pavers, porous concrete walkways and street planters. The specific details of each of these projects are unique to the individual project and the city of Hartford should be approached to determine if there any green technologies that have been incorporated into their streetscaping projects. The District would support and assist the city with coordinating the green components; however, given the city's reluctance in owning and maintaining the green infrastructure at the District's headquarters, which is located within the city's right-of-way, the District has not continued to actively pursue low impact development opportunities with the city.

9.5 Conclusion

The District is a proponent of green projects and has $3M reserved in its Clean Water Project budget for green projects, with a willingness to expand that if projects become available. It is important to note that as a sewer and water utility, the District does not intend to take responsibility for the maintenance of green infrastructure projects. This is because the District, as a utility provider, does not own the property within the right-of-way. The District is open to contributing to the planning and construction of green infrastructure projects (that are cost-effective and will provide overall benefit to the Clean Water Project) if the opportunity becomes available; however, another entity must accept ownership and the responsibility for maintaining the new infrastructure.

To date, the District has received resistance from municipalities to assume ownership and maintenance of the green infrastructure, which has made it difficult for the District to incorporate large scale green infrastructure projects. CT DEEP also has grant programs available to assist with the planning, design and construction of a green infrastructure project that could be utilized to fund a more comprehensive green infrastructure demonstration project in the city of Hartford.

Section 10

CSO Control Alternatives Discussion

10.1 Introduction

In Sections 6 through 8, select CSO control technologies (sewer separation, deep rock tunnel storage systems, and satellite treatment and storage) were discussed as potentially applicable CSO control technologies for the District's LTCP Update. In the original 2005 LTCP, the control plan included a new deep rock North Tunnel and use of the existing PRAC as the tunnel storage plan along with targeted combined sewer system separation. Since that time, modifications to the tunnel storage plan have been made through various studies, value planning meetings, and further evaluation, but the primary long-term recommendation is still to store a significant portion of the District's wet weather flow in an extensive tunnel storage system.

For this section, an evaluation was performed for each CSO drainage area in the Hartford system to compare alternative CSO control approaches and estimated implementation costs to the estimated cost to consolidate CSO flow and convey it to the tunnel. Generally, sewer separation is no longer required to address system-wide sewer surcharge issues (see Section 6 for more details). Past surcharge complaints and system problems seem to have been resolved with a comprehensive sewer cleaning and CMOM program and implementation of specific separation projects. Accordingly, sewer separation was only considered as an effective alternative in this report where it would achieve the design control level for CSO discharges (as identified in Section 6).

Satellite storage and treatment facilities are not highly desirable by the District based on past public and CAC input, but were still considered for comparative purposes based on the facility locations and consolidation plan discussed in Section 8.

The evaluation of the CSO regulator control solutions was based generally on the six District drainage areas with a few exceptions as noted below. SM-2, in the South Meadows drainage areas, is resolved via system-wide improvements.

10.2 Summary of the LTCP Alternatives

10.2.1 General

The analysis of CSO control alternatives is based on system conditions simulated in the Future Baseline Conditions Model, as presented in Section 4, which incorporates the completed wet weather capacity improvements at the HWPCF (to 200 mgd), a number of ongoing sewer separation projects, and infiltration/inflow reduction up to 10 percent in the regional communities (via the SSES/SSO program).

The analysis includes capital construction costs for new facilities and system modifications, operations and maintenance (O&M) costs of the various CSO facilities and the potential treatment costs at the HPWCF of any stored flow volume that will be treated after the storm subsides.

In most cases, separation is not effective but in some cases, either 60 percent (public inflow) or 80 percent (public and private inflow) removal can control the CSO discharges according to the model simulations. In many cases, District CSO regulators are impacted by upstream and downstream tributary areas and provide backflow relief from the main interceptor; thus, sewer separation is often not effective when considered individually for each CSO regulator.

There are three types of pipes that are necessary to construct the various alternatives discussed in this section: consolidation pipes, relief pipes, and new combined sewers (as defined in Section 1.3).

The tunnel storage alternatives predominantly utilize consolidation pipes to convey wet weather flow to the tunnel storage system, but in some cases it was cost effective to simply increase existing conveyance capacity through new combined sewers. Flows are either conveyed to the South Tunnel, which is currently under design, or the North Tunnel, which is proposed.

Open excavation and trenchless technologies were considered for all new pipe installations. In many cases, the cost of open excavation of these large diameter pipes exceeded the cost of using a microtunnel machine or similar trenchless approach, especially when considering the density of existing utilities in the street that require relocation and the extended surface disruptions created by open excavations of pipeline.

Overall CSO control improvements will also require ancillary modifications at most of the CSO regulators to ensure that all active CSO regulators are controlled to the design storm conditions. These improvements will consist of CSO regulator modifications (i.e. raising weir elevations, increasing the size of the CSO regulator outlet pipe, or increasing the size of the interceptor connector pipes), new CSO regulators, and tunnel regulators. Some CSO regulators can be addressed solely by regulator modifications while others will likely require new pipes and some modifications. It is important to note the design/construction challenge of modifying the existing CSO regulators to partially discharge only some of the CSO (up to the 1-Year Design Storm) to the tunnel system. In some cases, this controlled partial diversion may require the construction of a second weir and CSO regulator outlet pipe at the CSO regulator. In other cases, an entirely new CSO regulator structure may be needed to implement this proposed partial flow diversion.

10.2.2 Cost Assumptions

The alternatives comparison discussed herein is based on construction costs for the alternative pipe, facility, and tunnel drop shaft and incremental storage layouts. These costs do not include site acquisition (if available) and site development costs (unstable subsurface conditions, rock excavation, soil remediation, and access), engineering and contingencies or other unforeseen or unanticipated conditions. The Engineering News Record (ENR) is based on the average costs between the New York City Index and the Boston City Base Index or 13267 (October 2012).

Capital Costs

Costs for sewer separation projects were based on an allowance of $400,000/acre for 80 percent separation. This allowance was discussed in Section 6.3, primarily based on the costs to-date for sewer separation projects in Hartford, including private I/I removal.

Costs for new piping were based on cost estimates from current District projects and standard means construction costs using conceptual plan and profile drawings. Cost for CSO regulator modifications were incorporated into the analysis as allowances since the final modifications to each CSO regulator must be determined during design.

The cost of incremental tunnel storage was also considered in the analysis. The cost of incremental tunnel storage was estimated to be about $4.5 per gallon, based on the tunnel and ancillary facilities developed for the South Tunnel Basis of Design Report (30 percent design). This should be considered an estimate for comparison purposes and not to be used as the basis for the full cost of the CSO tunnel storage system plan.

Estimated construction costs for the various satellite treatment and storage facilities, as discussed in Section 8, were estimated from curves that are included in Appendix A. These construction cost curves are generally based on the USEPA Combined Sewer Overflow Control Manual (1993) for wet weather controls and were adjusted based on other bid/constructed project costs obtained from similar projects in the country. The USEPA manual does not have cost curves for high-rate clarification (HRC). Capital costs for HRC were estimated based on a review of costs for other installations that included screening and disinfection, quotes gathered from HRC vendors for various flow rates, and other facilities' planning reports. These construction costs have also been adjusted for the Hartford metropolitan area including construction constraints in a heavily urbanized area and the stringent soil replacement requirements for projects in the city.

As discussed in Section 8, for satellite storage facilities, it was assumed that pumping capacity would have to meet peak flow rates if the consolidation pipe was anticipated to be more than 25 feet deep (the cost curves are generally for near-surface satellite storage facilities).

Operations and Maintenance Costs

O&M costs for pumping, disinfection, high-rate clarification, and sedimentation were taken from curves included in Appendix A. These O&M cost curves were based on adjusted O&M cost curves from the above referenced USEPA manual and various data collected from other operating facilities in the country adjusted for Hartford conditions (where practical). HRC costs were estimated based on similar costs for screening and chemical addition facilities. The O&M costs for pumping were based on costs presented in the USEPA Document 430/9-78-009, Innovative and Alternative Technology Assessment Manual, February 1980. The EPA disinfection and HRC curves were from the 1993 USEPA Manual Combined Sewer Overflows Control. Tunnel pump station O&M costs were based on a June 4, 2013 Technical Memorandum prepared by AECOM in association with Black & Veatch, entitled "South Hartford Conveyance and Storage Tunnel -- Life Cycle Cost Comparison: Submersible Pump Station and Dry-Pit Cavern Station". These are representative of the costs that could be experienced with the proposed Hartford facilities based on typical operations and the relative frequency of activation and operation. The O&M cost curves are included in Appendix A.

To estimate the annual O&M cost associated with treating the tunnel flow, the actual 2011 HWPCF expenditures were reviewed. The total HPWCF operating cost was about $11.4 million to treat 24.255 billion gallons (excluding non-flow-dependent costs such as clothing, office supplies, custodial services, etc.). This annual cost results in an annual treated operating cost of about $470 per million gallon of flow treated at the HWPCF. This unit cost was utilized along with the typical annual flows for each CSO regulator group to derive the HWPCF O&M.

Life Cycle Costs

Life cycle costs include all capital costs and a 20-year present worth cost of O&M at a monetary discount rate of 3.25 percent, based on expected low interest rate financing via the state revolving fund program and low inflation.

10.3 Franklin Avenue Area CSO Regulators

Overview

The Franklin area, located in southern Hartford, has eight CSO regulators. The CSO regulators discharge to the Franklin Avenue Drain, which flows into Wethersfield Cove. Seven of the CSO regulators discharge flow during the Wethersfield Cove/North Branch Park River Design Storm. Table 10-1 shows the flows and volumes for these regulators in the design storm.

Table 10-1

Franklin Area CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
F-26	WC/NBPR Design Storm	42	10.9
F-27	WC/NBPR Design Storm	26	4.1
F-28	WC/NBPR Design Storm	7	2.6
F-29	WC/NBPR Design Storm	39	6.1
F-30	WC/NBPR Design Storm	21	4.2
F-31	WC/NBPR Design Storm	0	0.0
F-32	WC/NBPR Design Storm	58	5.4
F-33	WC/NBPR Design Storm	17	2.6
	Total	**210**	**35.9**

Note: The total volume of the Franklin Area CSOs was reduced from the volume reported in the South Tunnel BODR based on additional simulations.

Consolidation Pipes and Tunnel Storage System

The 2012 Franklin Avenue Study dated June 2012 examined the consolidation pipe options to route flow from this area into the South Tunnel from the CSO regulators in this area. During development of the South Tunnel BODR, the South Tunnel route was optimized (along a tunnel route under Franklin Avenue) to minimize the length of consolidation pipe required to collect all of these CSO regulators. The plan consists of a consolidation pipe along Franklin Avenue and a new combined sewer on Preston Street to convey CSO discharges to the tunnel. Figure 10-1 shows the Franklin Avenue area CSO regulators and their connections to the South Tunnel.

A 48-inch new combined sewer is proposed along Preston Street to replace the existing 24 inch sewer from F-33 at the intersection of Broad Street and Preston Street to the proposed tunnel drop shaft near the intersection of Preston Street and Maple Avenue. The new combined sewer allows all dry and wet weather flow to be conveyed to the tunnel regulator at Maple Street, which will eliminate F-33 regulator. The new tunnel regulator will direct dry weather flow to the sewer on Preston Street and excess wet weather flow to the tunnel drop shaft.

The Franklin Avenue consolidation pipe (FACP) collects all of the overflows from F-29, F-30 and F-32 to eliminate these CSOs. The 78-inch consolidation pipe begins at F-32 and flows south to F-30 and F-29. Flow along the FACP enters the CSO tunnel storage system at a tunnel regulator and tunnel drop shaft located by the intersection of South Street and Franklin Avenue.

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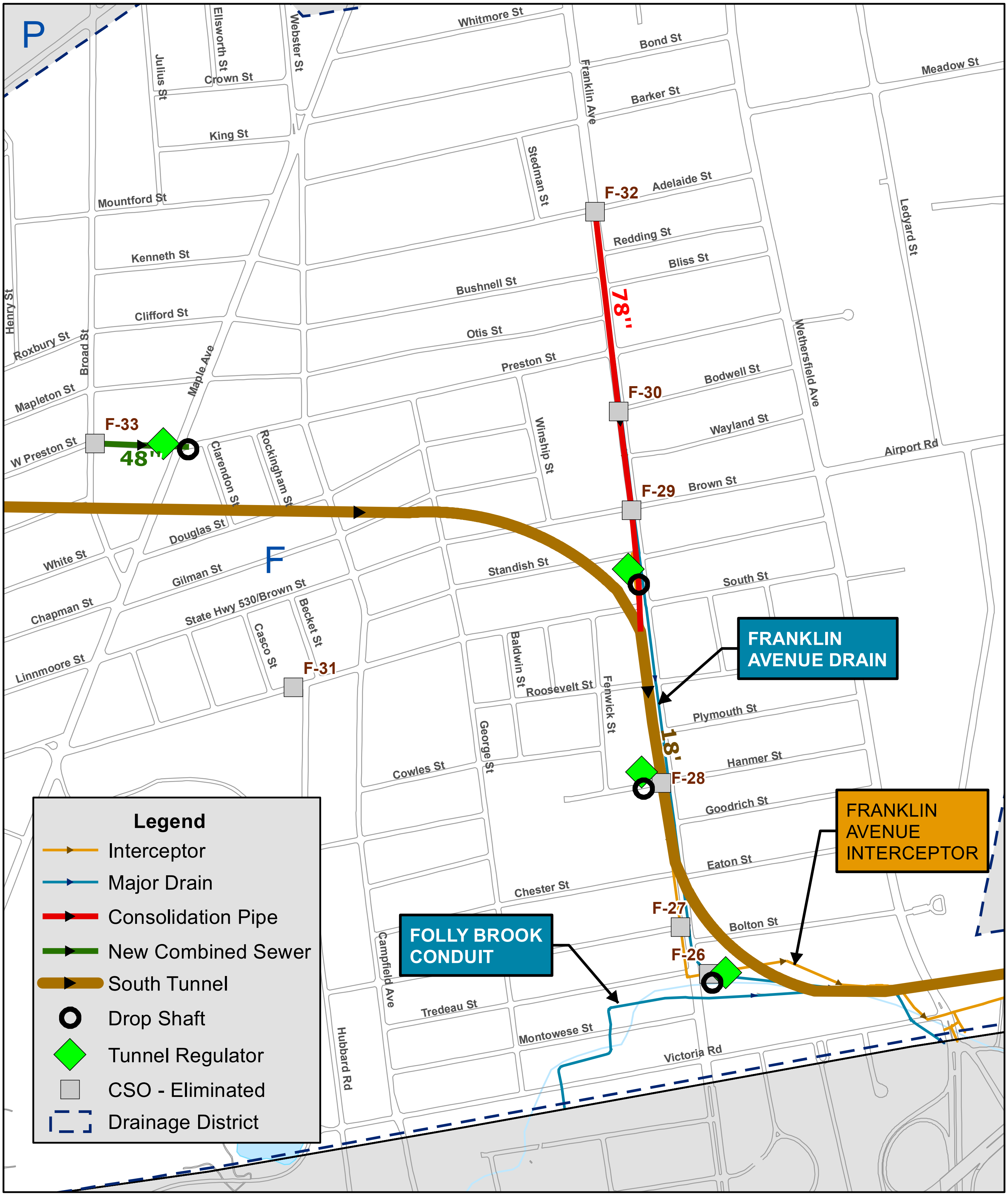

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Figure 10-1
Franklin Area CSOs

Excess wet weather flow at the three remaining CSO regulators (F-28, F-27, and F-26) in the Franklin Avenue area will be directed into the South Tunnel via two tunnel drop shafts located near F-28 and F-26. Thus, all of the existing Franklin Avenue area CSO regulators will be eliminated and replaced with six tunnel regulators along Franklin Avenue at Adelaide Street, Preston Street, Standish Street, Douglas Street, Hanmer Street, and Trudeau Street, and along Maple Avenue at Broad Street and Preston Street.

The estimated construction cost of these consolidation pipes, tunnel regulators, new combined sewer and the five tunnel drop shafts is approximately $29 million. The estimated cost of incremental tunnel storage for this volume is about $162 million; thus the total capital cost of eliminating the Franklin Avenue CSO regulators using the South Tunnel storage system is about $191 million. The life cycle cost of the project is $194 million including operations and maintenance costs.

Sewer Separation

The estimated construction cost for full separation of tributary areas to the Franklin Avenue area CSO regulators is $240 million. However, as discussed in Section 4, sewer separation cannot eliminate discharges from any of the Franklin Avenue CSO regulators up to the WC/NBPR design storm individually or collectively, even with 80 percent inflow removal.

Satellite Treatment or Storage Facilities

As discussed in Section 8, the life cycle cost of a satellite storage facility in the Franklin Avenue area is approximately $359 million. The life cycle cost of a treatment facility is approximately $228 million for primary treatment and disinfection.

Summary

Table 10-2 provides a summary of the life cycle costs of the alternative CSO strategies for the Franklin Avenue Area CSO regulators. The tunnel and consolidation pipe cost of $194 million is significantly less than the cost of a satellite CSO control facility at $359 million for storage or $228 million for treatment. Sewer separation is not effective as a control technology for the Franklin Avenue Area CSO regulators.

Accordingly, the District will include the consolidation pipe and tunnel storage plan for the Franklin Avenue Area CSO regulators as part of the final design of the South Tunnel project.

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Table 10-2
Franklin Avenue CSO Regulators Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$194
Satellite Treatment	$228
Satellite Storage	$359
Sewer Separation[1]	$240

Note: [1] Separation of drainage area will not achieve the required level of control.

10.4 South Branch Park River CSO Regulators

The South Branch Park River drainage area is located in the southwest portion of the city and has 18 CSO regulators that discharge flow during the 1-Year Design Storm. Some of these CSO regulators have already been incorporated into the South Tunnel 30% design project drawings.

Fourteen CSO regulators control flow into or along the Old South Branch Interceptor (OSBI). Three CSO regulators control flow along the Cemetery Brook Branch Interceptor. These are discussed below in three sub-groups – Southern South Branch, Middle South Branch, and Northern South Branch CSO regulators.

Eight CSO regulators (S-23, S-24, S-25, S-26, S-27, S-28, S-29, and S-30) regulate flow along New Britain Avenue and direct wet weather overflows to a local drain that discharges into the South Branch Park River between Newfield Avenue and the West Hartford border. S-19 and S-21, located on Arlington Street, overflow to drains that discharge to the South Branch Park River (downstream of the New Britain Avenue CSO regulators outfall). These are considered together and referred to as the Southern South Branch Park River CSO regulators.

The three CSO regulators along the Cemetery Brook Branch Interceptor (S-14, S-15, and S-16) are discussed as the Middle South Branch Park River CSOs and the remaining four CSO regulators (S-8, S-10, S-12 and S-13) are referred to as the Northern South Branch Park River CSOs.

10.4.1 Southern South Branch of the Park River CSOs

Overview

Table 10-3 shows the characteristics of the ten Southern South Branch CSO regulators (around New Britain Avenue).

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Table 10-3
Southern South Branch Park River CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
S-19	1-Year Design Storm	8	0.4
S-21	1-Year Design Storm	7	0.4
S-23	1-Year Design Storm	5	0.2
S-24	1-Year Design Storm	0.6	<0.1
S-25	1-Year Design Storm	2	0.1
S-26	1-Year Design Storm	5	0.4
S-27	1-Year Design Storm	8	1.1
S-28	1-Year Design Storm	1	<0.1
S-29	1-Year Design Storm	4	0.3
S-30	1-Year Design Storm	2	0.1
	Total	**43**	**3.0**

Consolidation Pipes and Tunnel Storage System

These CSO regulators are already incorporated into the South Tunnel 30% design documents, as shown in Figure 10-2. A new 24-inch drain will be installed along New Britain Avenue from Nepaug Street to Roslyn Street that will allow the existing drain (24-inch to 45-inch) on New Britain Avenue to become a consolidation pipe to convey CSO discharges from S-23, S-24, S-25, S-26, S-27, and S-28 to a new tunnel regulator at Roslyn Street. At Roslyn Street, 1-Year Design Storm CSO flows from these regulators and from the S-29 and S-30 CSO regulators will be directed into a new 36-inch consolidation pipe (New Britain Avenue Consolidation Pipe) on New Britain Avenue. The new consolidation pipe will start at Roslyn Street and end at the tunnel drop shaft at Hillcrest Avenue in West Hartford.

A separate consolidation pipe (Arlington Consolidation Pipe) conveys the 1-Year Design Storm CSO flow from S-21 and S-19 to a tunnel drop shaft at Brookfield Street. The proposed 36-inch consolidation pipe starts at S-21 and flows east to S-19, and then flows north up Stone Street and Brookfield Street to a new tunnel drop shaft along the South Tunnel.

The total cost of the consolidation piping, tunnel regulators, and connecting tunnel drop shafts is approximately $14 million. The cost of the incremental storage in the South Tunnel for this CSO volume of 3 MG is approximately $14 million. Thus, the total capital cost of the tunnel storage system for the Southern South Branch Park River CSO regulators is approximately $28 million. The life cycle cost of the project is $29 million including operations and maintenance costs.

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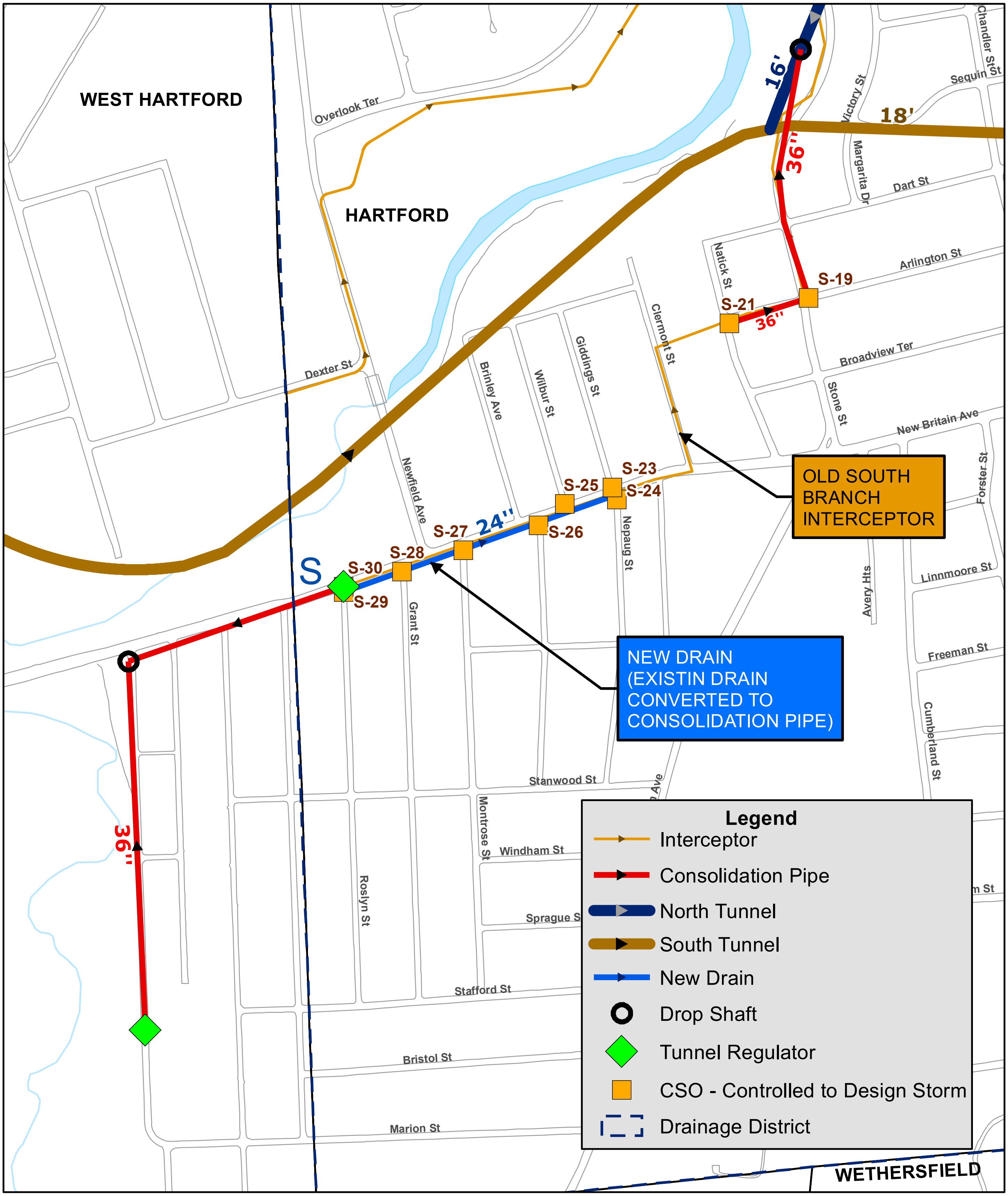

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Figure 10-2
Southern South Branch Park River CSOs

Sewer Separation

The total cost of sewer separation of the Southern South Branch Park River area is approximately $80 million. With the exception of CSO regulator S-25, sewer separation of the upstream basins to the CSO regulators in this subgroup would not meet the control level of a 1-Year Design Storm.

Sewer separation of S-25 could potentially control CSOs to the 1-Year Design Storm with an estimated cost of $2 million. However, this CSO regulator is already connected to the common overflow pipe, along New Britain Avenue (which is used to convey flow from all of the CSO regulators S-19 through S-30). The cost to incorporate the flow for S-25 into the tunnel (via the new consolidation pipe for the whole group of CSO regulators) is minimal (approximately 3 percent of the total flow along the consolidation pipe, which is about $1.4 million, including the incremental cost of storage for S-25 flow).

Satellite Treatment or Storage Facilities

In Section 8, the least expensive satellite treatment option for the Southern South Branch Park River CSO regulators is identified as primary treatment with a life-cycle cost of approximately $98 million. A satellite storage facility for these regulators has a life-cycle cost of approximately $101 million, making satellite treatment the less expensive satellite facility option.

Summary

Table 10-4 summarizes the general costs and CSO control approaches for the Southern South Branch Park River CSO regulators. Consolidation of the flows from the Southern South Branch Park River CSO regulators into the South Tunnel is less expensive (at approximately $29 million) than satellite treatment or storage facilities at $98 million and $101 million, respectively. Sewer separation of all of the CSO regulators will not achieve the CSO control objectives for a 1-Year Design Storm. Sewer separation of CSO S-25 could meet the control goal but the incremental cost of directing these CSO regulators into the tunnel is less expensive than the cost for separation.

The consolidation pipe and tunnel storage plan for the Southern South Branch Park River CSO regulators is the least cost alternative and the District will include this plan as part of the final design of the current South Tunnel project.

Table 10-4

Southern South Branch Park River CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$29
Satellite Treatment	$98
Satellite Storage	$101
Sewer Separation[1]	$80

Note: [1] Separation of drainage area will not achieve the required level of control.

10.4.2 Middle South Branch of the Park River CSOs

Overview

S-14, S-15, and S-16 are the Middle South Branch Park River CSO regulators and regulate the Cemetery Brook Branch Interceptor and overflow to the Cemetery Brook Conduit, which discharges to the South Branch Park River. Table 10-5 shows the CSO regulator characteristics.

Table 10-5
Middle South Branch of the Park River CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
S-14	1-Year Design Storm	2	0.1
S-15	1-Year Design Storm	8	1.9
S-16	1-Year Design Storm	15	2.0
	Total	**25**	**4.0**

Consolidation Pipes and Tunnel Storage System

The South Tunnel BODR included consolidation of the flow from these three CSO regulators into the South Tunnel via a 48-inch consolidation pipe to a tunnel drop shaft located by the intersection of Flatbush Avenue and Westbrook Street. The cost of this consolidation pipe was approximately $12 million.

In the proposed North Tunnel alignment, the North Tunnel will now pass directly adjacent to this group of CSO regulators as shown in Figure 10-3. SWMM modeling indicated that a tunnel drop shaft at S-14 can control the CSO regulator group to the 1-Year Design Storm. Adequate wet weather flow could be diverted into the tunnel, via a tunnel drop shaft, at S-14 to control overflows to the 1-Year Design Storm at the downstream S-15 and S-16 CSO regulators (with minor modifications to these CSO regulators). The cost of the tunnel drop shaft near Westbrook Street (to the North Tunnel) and CSO regulator modifications is estimated to be $6 million. Accordingly, connecting these CSO regulators directly to the North Tunnel is less expensive than a connection to the South Tunnel. Figure 10-3 shows the suggested consolidation pipes for these CSO regulators.

The estimated cost of the incremental storage volume for these CSO regulators in the North Tunnel is approximately $18 million. Thus, the total capital cost for the tunnel and consolidation pipe plan is $24 million. The life cycle cost of this alternative is $26 million including operations and maintenance costs.

Sewer Separation

The cost to separate the entire drainage area (430 acres) is about $172 million but would not control discharges at these CSO regulators as these CSO regulators provide relief for the Cemetery Brook Branch Interceptor. Model simulations indicate that 60 percent separation of S-14 (291 acres) could theoretically achieve the 1-Year Design Control level at this CSO at a cost of $93 million. However, the separation cost for S-14 significantly exceeds the incremental cost of tunnel storage for this CSO regulator.

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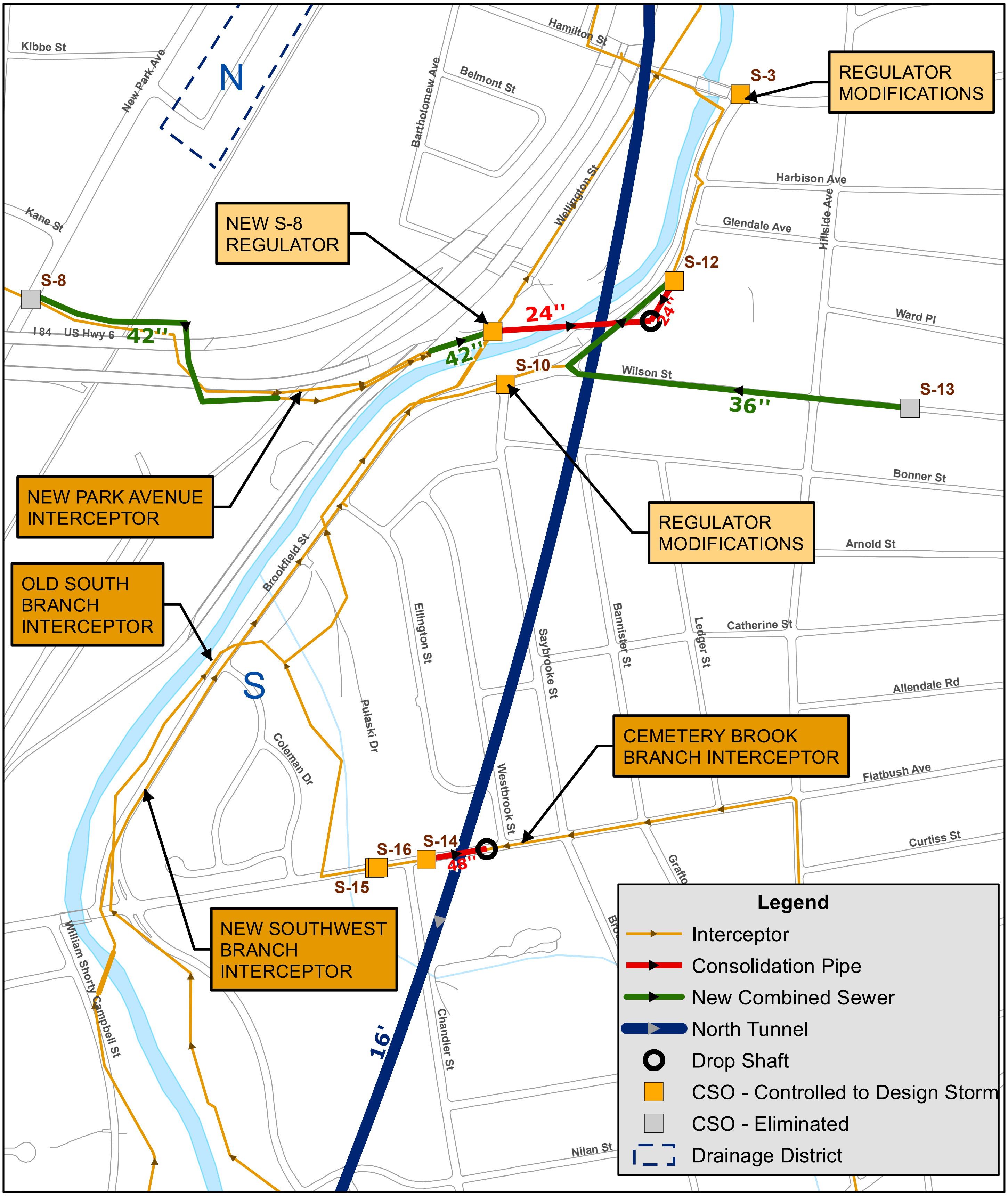

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Figure 10-3
Middle and Northern South Branch Park River CSOs

Satellite Treatment and Storage Facilities

The least expensive satellite treatment option for the Middle South Branch Park River CSO regulators was identified as primary treatment with a life-cycle cost of approximately $54 million. A satellite storage facility for these regulators has a life-cycle cost of approximately $56 million, making satellite treatment the less expensive satellite facility option.

Summary

Table 10-6 summarizes the general costs and CSO control approaches for the Middle South Branch Park River CSO regulators.

The cost to consolidate and control flow from these three CSO regulators and direct that flow into the North Tunnel is about $26 million (including the cost of incremental tunnel storage volume) and includes construction of a local tunnel drop shaft near S-14 and some minimal consolidation pipe and CSO regulator modifications. The cost for full separation of these areas is $172 million. Partial sewer separation of the tributary area upstream of these CSO regulators could achieve control but the cost of partial sewer separation would exceed $26 million for the tunnel. Likewise, construction of a satellite treatment or a storage facility would exceed the tunnel storage cost. Accordingly, the District will consolidate and control flow from these three CSO regulators and direct that flow into the North Tunnel is the least cost control alternative.

Table 10-6

Middle South Branch North Park River CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$26
Satellite Treatment	$54
Satellite Storage	$56
Sewer Separation[1]	$172

Note: [1] Separation of drainage area will not achieve the required level of control.

10.4.3 Northern South Branch Park River CSO Regulators

Overview

Table 10-7 shows the CSO regulator characteristics. S-3, S-10, and S-12 regulate flow from local sub-catchment areas into the Old South Branch Interceptor and discharge CSO directly into the South Branch Park River. S-13 regulates the local sewer flow on Wilson Street into the Old South Branch Interceptor and directs CSO to a local drain that eventually flows to the South Branch Park River. S-10 is inactive during the 1-Year Design Storm.

S-8 regulates a combined sewer area in Hartford, west of New Park Avenue, and receives some flow from West Hartford. However, this regulator discharges into Kane Brook, which is a Class A waterway. Therefore, the S-8 regulator must be relocated to direct excess wet weather flow into the South Branch Park River, as discussed below.

Table 10-7
Northern South Branch of the Park River CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
S-3	1-Year Design Storm	2	0.1
S-8	1-Year Design Storm	7	0.4
S-10	1-Year Design Storm	0	0.0
S-12	1-Year Design Storm	5	0.2
S-13	1-Year Design Storm	8	0.3
	Total	**22**	**1.0**

Consolidation Pipes and Tunnel Storage System

A tunnel drop shaft is proposed for these CSO regulators near S-12 as shown in Figure 10-3 (previous figure). Hydraulic modeling indicated that this tunnel drop shaft location could also be used to address surcharge along the Old South Branch Interceptor (OSBI). District Operations identified surcharge along the OSBI to be a continuing problem. The S-12 regulator could be modified to reduce excess flow into the interceptor, which is causing the surcharge. The ability to discharge excess wet weather flow from these area CSO regulators into the tunnel could relieve the OSBI of these extreme surcharge conditions without constructing a new parallel relief sewer. The area CSO regulators could be connected to the tunnel drop shaft by consolidation pipes.

The proposed improvements include a new combined sewer (36-inch) from S-13 to the CSO regulator S-12. For this CSO regulator, a smaller diameter sewer (24 inches) could be constructed to convey only the CSO from this area, but a 36-inch pipe would eliminate S-13, conveying all flow downstream towards the Old South Branch Interceptor and then north to the S-12 CSO regulator. The District elected to proceed with a larger pipe to eliminate the CSO regulator. An alternative was considered to construct another tunnel drop shaft at Wilson Street but this would be more expensive than constructing 500 feet of new combined sewer along Brookfield Street to make the tunnel connection at S-12. In addition, SWMM model simulations showed that a discharge from S-13 into the Old South Branch Interceptor at Wilson Street may create a significant local surcharge in the interceptor.

The SWMM modeling also indicated that CSO regulator S-10, which was previously inactive during the 1-Year Design Storm, had some minor discharges during the 1-Year Design Storm under the consolidation pipe plan. Most of this new CSO discharge is likely a function of modeling sensitivity and is easily controlled with CSO regulator modifications.

A short 24-inch consolidation pipe connects S-12 to the tunnel drop shaft. S-3 could be controlled by CSO regulator modifications (and diversion of some offsetting wet weather flow at S-12 to allow for capacity in the OSBI for S-3).

For S-8, system improvements must be implemented to relocate the discharge out of Kane Brook. A new 42-inch pipe will likely be needed to convey all of the flow upstream of S-8 to a location near the South Branch Park River. The middle segment of this new pipe is currently under construction as part of the CT Department of Transportation Fastrak Busway Improvements Project. Accordingly, the District will eventually have to install new connecting pipe upstream and downstream of the Busway pipe to complete the relocation plan. The LTCP work will include the installation of approximately 1,400 feet of new 42-inch combined sewer, which will convey all flow from the existing S-8 CSO regulator to the 42-inch diameter Busway combined sewer and another 300 feet of new 42-inch pipe downstream of the Busway pipe will need to be installed to replace the existing 30-inch pipe downstream of the Busway pipe. This new 42-inch combined sewer will connect to a new CSO regulator that will discharge excess CSO flow into the South Branch Park River, a Class B waterbody. A future consolidation pipe will convey the 1-Year Design Storm CSO flow into a tunnel drop shaft south of S-12. Storms greater than the 1-Year Design Storm will result in CSO discharges from S-8 to the South Branch Park River. This plan eliminates the existing S-8 CSO discharge into to Kane Brook, a Class A Waterbody.

The estimated construction cost of the consolidation conduits, new combined sewers, and regulator modifications is $19 million. The estimated cost for incremental storage in the tunnel is approximately $5 million. Thus, the total capital cost of the tunnel storage plan is approximately $24 million. The operations and maintenance cost for the improvements in this area are not significant so the total life-cycle cost of this project is $24 million.

Sewer Separation

Sewer separation of the upstream drainage areas to these CSO regulators was considered. The total cost of sewer separation is approximately $108 million.

Sewer separation of the S-12 combined sewer area could achieve the design control level and would be approximately $8 million. As discussed above, the tunnel drop shaft near S-12 is the best location for the area CSO regulators and to provide surcharge relief to the OSBI. The cost to separate S-12 exceeds the cost for the short reach of 24-inch consolidation pipe to the proposed tunnel drop shaft (life cycle cost of $1.4 million including the cost of incremental storage).

Model simulations in Section 6 also indicated that sewer separation of the upstream area of S-13 at a cost of $20 million could control CSO discharges from this regulator to the 1 Year Design Control level. However, the proposed 36-inch combined sewer will eliminate the CSO regulator entirely at a cost of $5.5 million.

Satellite Treatment and Storage Facilities

In Section 8, the least expensive satellite treatment option for the North South Branch Park River CSO regulators was identified as primary treatment with a total life-cycle cost of approximately $69 million. A satellite storage facility for these regulators is approximately $60 million, making satellite storage the less expensive satellite facility option.

Summary

Table 10-8 summarizes the general costs and CSO control approaches for the Northern South Branch Park River CSO regulators.

Based on the discussions above, the District will proceed with the proposed consolidation pipes and tunnel storage system plan, with a tunnel drop shaft near S-12, as the suggested system improvements to control the CSO regulators in this group, especially considering the added benefits of OSBI surcharge relief. The life cycle costs of sewer separation and satellite CSO control facilities are more costly than the life cycle cost of consolidation pipes and tunnel storage system plan as shown in Table 10-8.

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Table 10-8

Northern South Branch Park River CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$24
Satellite Treatment	$69
Satellite Storage	$60
Sewer Separation[1]	$108

Note: [1] Separation of drainage area will not achieve the required level of control.

10.5 Park River Area CSO Regulators

The Park River drainage area is located in central Hartford and includes 23 CSO regulators (two have been eliminated – G-20 and P-11) that must be controlled to the 1-Year Design Storm. The CSO regulators in the area control flow from local areas upstream of the Park River Interceptor (PRI) and direct wet weather overflows to either the PRC, which flows into the Connecticut River, or the Park River Auxiliary Conduit (PRAC). The Park River area was examined as two different groups of CSO regulators – one upstream of the intersection of the PRI and PRC near Capitol Avenue and one downstream of that intersection in the downtown area.

Also, given their proximity to the consolidation pipes/tunnels in this area, the downstream connection of the Homestead Avenue Interceptor Extension (P-11A), G-19 and G-21 were included in the downtown group. SM-2 is also included in this group as SM-2 will eventually be controlled by system-wide improvements, most notably those completed for the Park River area.

10.5.1 Downtown Park River Area CSO Regulators

Overview

Table 10-9 summarizes the flows and volumes for the downtown Park River area CSO regulators. CSO regulator P-3 has no CSO discharges during the 1-Year Design Storm.

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Table 10-9
Downtown Park River Area CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
P-1	1-Year Design Storm	44	4.2
P-2	1-Year Design Storm	16	0.7
P-3	1-Year Design Storm	0	0.0
P-4	1-Year Design Storm	6	0.3
P-5	1-Year Design Storm	24	3.3
P-9	1-Year Design Storm	19	1.6
P-10	1-Year Design Storm	16	1.4
P-11	Eliminated		
P-11A	1-Year Design Storm	42	3.0
P-12	1-Year Design Storm	69	8.3
P-13	1-Year Design Storm	24	1.3
P-26	1-Year Design Storm	20	0.9
G-19	1-Year Design Storm	1.4	<0.1
G-20	Eliminated		
G-21	1-Year Design Storm	7.6	0.4
SM-2	1-Year Design Storm	51	5.1
	Total	**340**	**30.5**

Consolidation Pipes and Tunnel Storage System

Figure 10-4 shows the proposed Downtown Spur Tunnel (as discussed in Section 7) that will consolidate the flow from these CSO regulators into the North Tunnel. The proposed plan consists of a 10-foot diameter spur tunnel (Downtown Spur Tunnel) that starts near the P-1 CSO regulator (at Columbus Boulevard) and flows west to a connection at the North Tunnel near the intersection of Farmington Avenue and Broad Street.

The actual construction of the Downtown Spur Tunnel will likely begin at a TBM launch shaft located at the intersection of Farmington Avenue and Broad Street. From this launch shaft, the tunnel would be driven east, in bedrock towards the first batch of the downtown CSO regulators (P-10, P-12, P-13, and P-11A), that are located near the intersection of Asylum Street and Ford Street. From here the TBM tunnel alignment turns slightly south passing P-9 and P-5. Near P-5, the alignment passes under the Park River Conduit before turning southeast and aligning along Sheldon Street. The alignment proceeds towards P-4 and P-2 along Sheldon Street and then east along Sheldon Street to a TBM reception shaft located in a parking lot at the intersection of Sheldon Street and Columbus Boulevard. The North Tunnel BODR should consider whether it is possible to extend the tunnel from this intersection to the location of CSO regulator P-1 to minimize any connecting consolidation pipes.

The Downtown Spur Tunnel is approximately 6,600 feet long and includes six tunnel drop shafts. CSO regulators P-1, P-2, P-4, P-5, P-9, P-26, and G-21 connect to the tunnel drop shafts by consolidation pipes ranging from 24 inches to 96 inches in diameter. The future North Tunnel BODR should consider the cost of additional tunnel drop shafts adjacent to the tunnel to minimize consolidation pipes.

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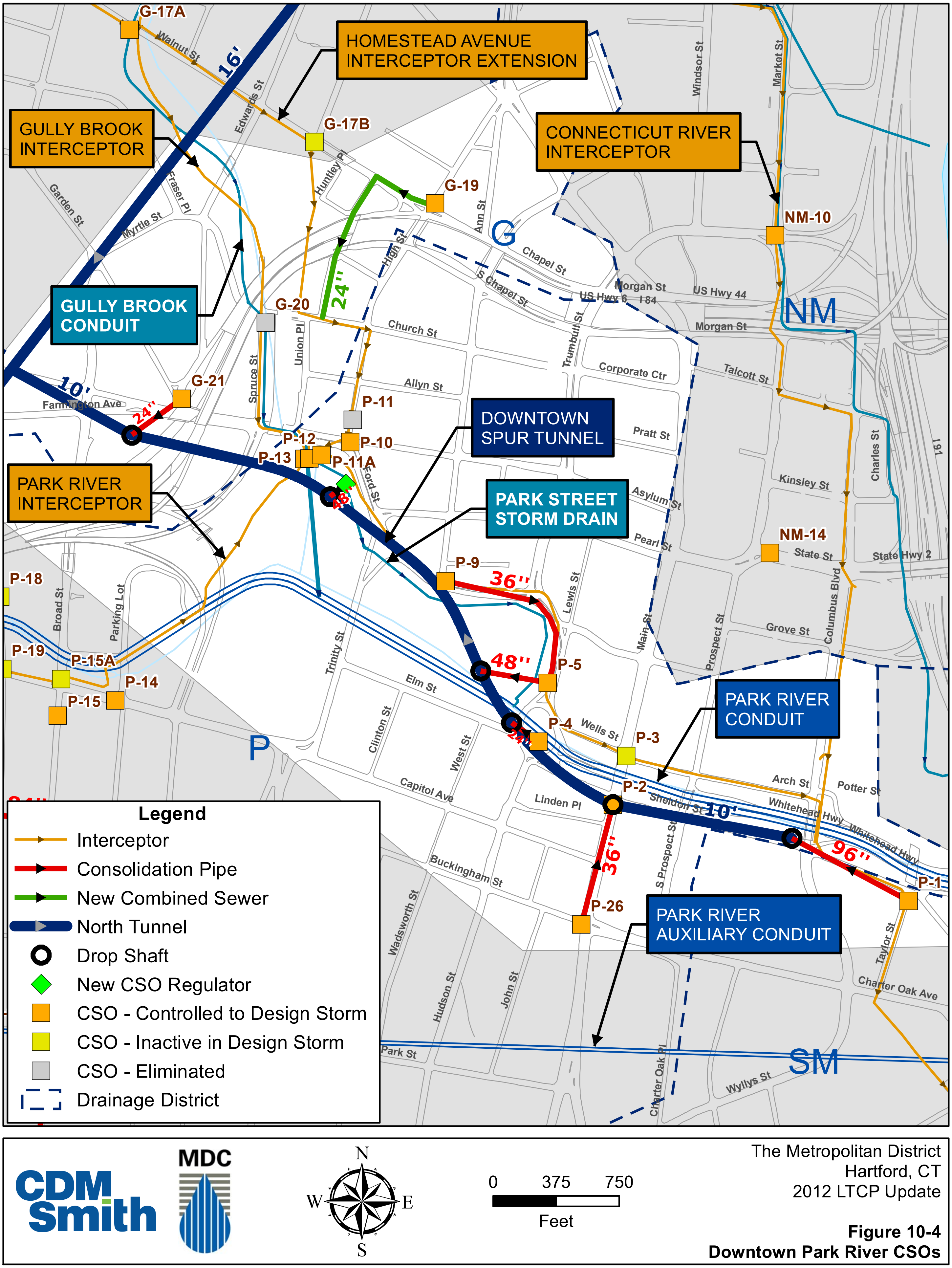

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Figure 10-4
Downtown Park River CSOs

CSO regulators P-12, P-13, and P-11A discharge CSO to the Park River Storm Drain (PRSD) and P-10 discharges CSO to a local drain that connects to the PRSD. The construction of new individual consolidation pipe connections to some of these structures would be challenging and would require pipe to be run in multiple routes in Bushnell Park. To minimize the consolidation pipes needed to address these CSO regulators, the LTCP Update proposes the construction of a new CSO regulator directly on the PRSD, which will allow the CSO flow from all four CSO regulators to be discharged to the tunnel. The 1-Year Design Storm wet weather flow from the PRSD will be conveyed to the Downtown Spur Tunnel via a 48-inch consolidation pipe and a tunnel drop shaft located by the intersection of Ford Street and Trinity Street. Excess flow (greater than the 1-Year Design Storm) will continue downstream along the PRSD.

Due to its proximity of the Downtown Spur Tunnel, G-21 will be directly connected to the spur tunnel shaft at Farmington Avenue. The recommended improvement for G-21 is to modify the CSO regulator and install a larger CSO regulator outlet pipe (24-inch diameter) to control the CSO regulator to the 1-Year Design Storm. The recommendation for G-19 is to install a new combined sewer to connect to the HAIE to control this CSO regulator.

The total cost of the Downtown Spur Tunnel, tunnel drop shafts, tunnel regulators, consolidation pipes, new combined sewers, and CSO regulator modifications is approximately $57 million. The cost of incremental tunnel storage in the North Tunnel is approximately $137 million. Accordingly, the total capital cost of the tunnel storage plan for these CSO regulators is $194 million. The life cycle cost of this tunnel storage plan is approximately $204 million including operation and maintenance costs.

Sewer Separation

If sewer separation was considered as a control alternative for these CSO regulators, the entire main branch of the Park River area would have to be separated at a cost of approximately $440 million and there would be additional separation costs for the tributary area upstream of P-11A, G-19 and G-21. Separation of the Downtown Park River Area accounts for $270 million of the $440 million for the Park River Drainage Area.

Based on SWMM modeling as presented in Section 6, separation of some individual CSO regulators in this area could potentially control discharges to the 1-Year Design Storm including for P-2, P-4, and G-19.

P-2 and P-4 could potentially be separated for a total cost of about $32 million and $14 million, respectively, to control the CSO regulators to a 1-Year Design Storm. By comparison, the life cycle cost of the consolidation pipe plan for P-2 and P-4 is about $3 million each. If the cost for the tunnel drop shaft required at P-2 (to the Downtown Spur Tunnel) were considered, the cost for each would be about $10 million, which is still less than the cost for separation. Thus, for these CSO regulators, the tunnel storage system is the less expensive option.

The tributary areas to CSO G-19 could also be separated to achieve the design event control. However, the cost of sewer separation of this area is about $6 million versus the cost of the new combined sewer of $2.1 million (including incremental storage in the tunnel system).

Satellite Treatment and Storage Facilities

In Section 8, the least expensive satellite treatment option for the Downtown Park River Area CSO regulators (including NM-10 and NM-14) was identified as primary treatment with an estimated life-cycle cost of $366 million. A satellite storage facility for these regulators is approximately $466 million, making satellite treatment the less expensive satellite facility option.

Summary

The life cycle cost for the Downtown Spur Tunnel CSO consolidation plan is approximately $204 million (including incremental tunnel storage costs). The cost to separate the Downtown Park River Area is approximately $270 million. The cost of satellite facilities is approximately $366 and $466 million for treatment and storage, respectively. Accordingly, the District is proceeding with the tunnel storage plan based on costs and the least disruptive approach for the downtown area.

Table 10-10 summarizes the general costs and CSO control approaches for the Downtown Park River CSO regulators.

Table 10-10

Downtown Park River CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$204
Satellite Treatment	$336
Satellite Storage	$466
Sewer Separation[1]	$270

Note: [1] Separation of the drainage area will not achieve the required level of control.

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10.5.2 Upstream Park River Area CSO Regulators

Overview

Table 10-11 summarizes the flows and volumes for the upstream Park River area CSO regulators. There are four CSO regulators in this group that do not have discharges during the 1-Year Design Storm.

Table 10-11
Upstream Park River Area CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
P-14	1-Year Design Storm	7	0.2
P-15	1-Year Design Storm	31	1.7
P-15A	1-Year Design Storm	0	0.0
P-16	1-Year Design Storm	38	2.5
P-16A	1-Year Design Storm	8	0.3
P-18	1-Year Design Storm	0	0.0
P-19	1-Year Design Storm	0	0.0
P-23	1-Year Design Storm	7	0.2
P-24	1-Year Design Storm	21	1.5
P-29	1-Year Design Storm	0	0.0
	Total	**112**	**6.4**

Consolidation Pipes and Tunnel Storage System

Figure 10-5 shows the proposed consolidation pipes for flow from these CSO regulators to discharge them into the North Tunnel via a tunnel drop shaft at Capitol Avenue.

The proposed plan is to install a consolidation pipe from the tunnel drop shaft along Russ Street up to Broad Street and then along Broad Street to collect flows from the Broad Street Sewer, which currently overflows into the PRAC via P-16 and P-16A. The consolidation pipe from the tunnel drop shaft at Russ Street and Park Terrace will be 84-inch diameter pipe along Russ Street and will be micro-tunneled. A 48-inch consolidation pipe is proposed along Broad Street up to the Ward Street intersection, which will also be installed via micro-tunnel techniques.

P-16 and P-16A are located in an intersection that has dense utilities and development, which makes work in the intersection, especially at the depth required for the consolidation pipe, very challenging. Accordingly, the plan is to divert adequate flow from the Broad Street combined sewer at Ward Street and at Russ Street to control flow in the area such that the downstream P-16, P-16A, and P-15, are controlled to the 1-Year Design Storm. The 84-inch pipe along Russ Street is required to convey the flow from both new CSO regulators. This plan will also control P-23 to the 1-Year Design Storm by lowering the head along the PRI and avoiding backflow through this CSO regulator.

P-24 will be connected to the Russ Street consolidation pipe and/or the tunnel shaft.

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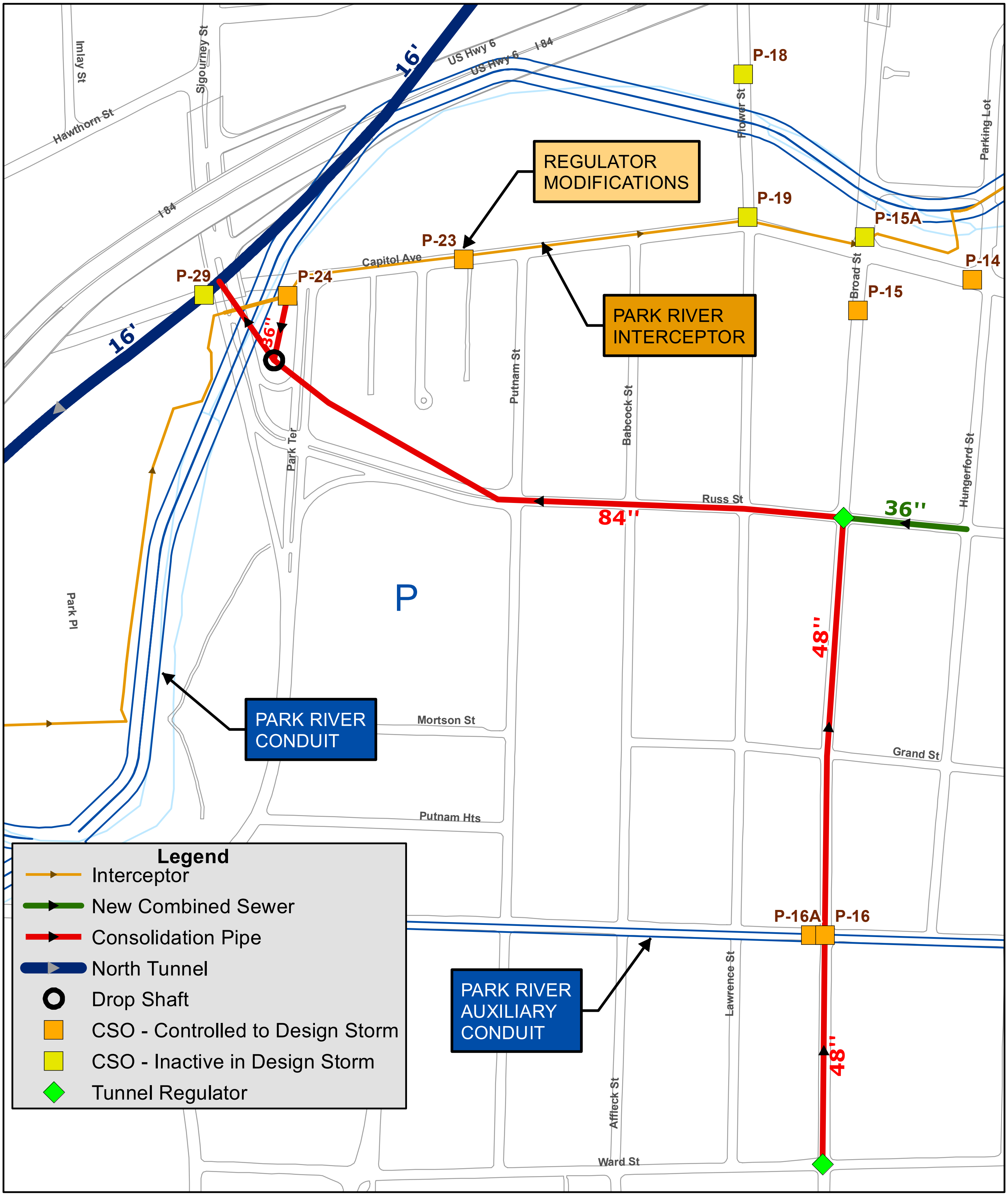

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Figure 10-5
Upstream Park River CSOs

A 36-inch new combined sewer on Russ Street from Hungerford Street to Broad Street will control overflows at CSO regulator P-14 up to the 1-Year Design Storm. P-14 is located at the intersection of Capitol Avenue and Hungerford Street. The new combined sewer will direct a significant portion of the P-14 drainage area to the tunnel regulator at Broad Street. The tunnel regulator will direct wet weather flow upstream of P-14 to the North Tunnel via the 84-inch consolidation pipe on Russ Street.

The total cost of the Upstream Park River Area CSO consolidation pipes and tunnel storage system plan is approximately $25 million. The cost of incremental tunnel storage in the North Tunnel for these CSO regulators is $29 million. Thus, the total capital cost to control these CSO regulators using the tunnel storage system is about $54 million. The life cycle cost of the project is approximately $55 million including operations and maintenance costs.

Sewer Separation

Sewer separation of these CSO regulators was considered in Section 6. As noted above, the total cost of sewer separation of the entire tributary area for the Park River Area CSO regulators is approximately $440 million and would not meet the control objective. Separation of the Upstream Park River Area accounts for $170 million of the $440 million for the entire Park River Area. Sewer separation is not cost-effective system-wide for this group of CSO regulators.

Separation of individual CSO regulators was also considered and could be effective for P-14 ($19 million) and P-16A ($17 million). The incremental cost for the upstream Park Area CSO regulators consolidated pipe and tunnel storage plan for P-16A is about $4 million, which is significantly less than the sewer separation cost for the upstream area of P-16A. In addition, the 48-inch pipe along Broad Street must be constructed for P-16 regardless of what is done to control P-16A.

The cost of the 36-inch combined sewer along Russ Street from Hungerford Street to divert excess flow from the P-14 area (including incremental tunnel storage) is about $2 million, which is significantly less than the cost of separation of this combined sewer area.

Satellite Treatment and Storage Facilities

In Section 8, the least expensive satellite treatment option for the Upstream Park River Area CSO regulators was determined to be primary treatment with an estimated life-cycle cost of $181 million. A satellite storage facility for these regulators has a life-cycle cost of approximately $189 million, making satellite treatment the less expensive satellite facility option.

Summary

Table 10-12 summarizes the general costs and CSO control approaches for the Upstream Park River CSO regulators.

The life cycle cost for the including the Upstream Park River CSO regulators in the tunnel storage system is approximately $55 million. The cost to separate the area is approximately $170 million. The cost of satellite facilities is approximately $181 million and $189 million for treatment and storage, respectively. Accordingly, the consolidation pipe and tunnel storage plan is the least cost alternative.

Table 10-12

Upstream Park River CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$55
Satellite Treatment	$181
Satellite Storage	$189
Sewer Separation[2]	$170

Note: 1. Separation of the drainage area will not achieve the required level of control

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10.6 North Meadows CSO Regulators

The North Meadows drainage area is located in the northeast portion of the city and contains 8 CSO regulators (Table 10-13) that are all active during the 1-Year Design Storm. The area's major infrastructure includes two combined interceptors and three drains. The Northeast Interceptor (NEI) and the Connecticut River Interceptor (CRI) convey the combined flow from the North Meadows area to the South Meadows Area, and eventually to the HWPCF. The NEI begins downstream of the Fishfry Pump Station and flows south. At the intersection of Windsor Street and Sanford Street, the NEI flows into the CRI and continues south.

Table 10-13
North Meadows CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
NM-2	1-Year Design Storm	2	0.1
NM-3	1-Year Design Storm	1.4	<0.1
NM-4	1-Year Design Storm	7	0.3
NM-5	1-Year Design Storm	27	1.4
NM-6	1-Year Design Storm	5	0.2
NM-7	1-Year Design Storm	6	0.2
NM-10	1-Year Design Storm	20	1.5
NM-14	1-Year Design Storm	0.6	<0.1
	Total	**69**	**3.7**

The Tower Brook Conduit (TBC) is the northern most drain and starts by the intersection of Tower Avenue and Barbour Street and flows to the North Meadows Storage Pond before being pumped into the Connecticut River. The Northeast Drain (NED) starts at approximately the downstream point of the TBC and flows south before discharging to the Connecticut River by Pequot Street. The Eastside Drain (ESD) begins approximately at the downstream point of the NED and continues south into the South Meadows drainage area before discharging into the Connecticut River.

NM-2, NM-3, and NM-4 regulate flow from the Tower Avenue area upstream of the NEI. The regulators direct wet weather overflows to the TBC. NM-5 is located directly on the downstream end of the NEI and conveys wet weather overflows to both the Tower Brook Conduit and the Northeast Drain. NM-6 and NM-7 regulate local sewers on Sanford Street and Bellevue Street and overflow to a local drain that flows to the Northeast Drain. NM-10 is located on the CRI at the intersection of Trumbull Street and Market Street and overflows to the Eastside Drain. NM-14 regulates flow on State Street upstream of the CRI and directs overflow to a local drain which flows to the Eastside Drain.

The CSO regulators in the North Meadows area were broken into two groups – Northern North Meadows CSO regulators and Southern North Meadows CSO regulators.

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Consolidation Pipes and Tunnel Storage System

Figure 10-6 shows the proposed consolidation pipe plan for the North Meadows Area. CSO from NM-2 and NM-3 combine with CSO from NM-4 and share a common outfall pipe from NM-4 to the Tower Brook Conduit. To address these three CSO regulators, approximately 3,800 feet of new 36-inch consolidation pipe from the NM-4 outfall pipe to NM-5 would convey CSO up to and including the 1-Year Design Storm from NM-2, NM-3, and NM-4 south on Main Street and then south on Windsor Avenue to NM-5.

CSO Regulators NM-5, NM-6, and NM-7 are located adjacent to the proposed Loomis Street North Tunnel drop shaft. It is recommended that a new combined sewer be installed to eliminate NM-6 and NM-7 along Sanford Street and convey this flow to the interceptor near NM-5, where the CSO discharges can be conveyed to the tunnel drop shaft. Figure 10-7 shows the suggested piping improvements.

The District is currently completing a conceptual design of these improvements and evaluating pipe routes and the best alternative to address NM-2, NM-3, NM-4, NM-5, NM-6, and NM-7 as one complete package.

The cost of the new combined sewer, consolidation pipes, and tunnel drop shaft to address NM-2 through NM-7 is approximately $24 million. The incremental storage cost is approximately $10 million.

CSO regulators NM-10 and NM-14 are located in downtown Hartford along the CRI on Market Street at the Trumbull Street and State Street intersections, respectively. SWMM modeling showed that NM-10 and NM-14 should be controlled by limiting the flow discharged by NM-5 into the Northeast Interceptor to provide more capacity for the downstream CSO regulators. The NM-10 and NM-14 CSO regulators would then be modified to discharge more flow into CRI to achieve the 1 Year Design Control level. In addition, the District should remove sediment within the interceptor downstream of NM-5 to NM-14 to increase storage and conveyance capacity. The estimated cost of the improvements to address NM-10 and NM-14 is about $5 million. The cost of incremental tunnel storage for these two CSOs is $7 million.

The total capital costs for the tunnel storage alternative for the North Meadows CSO regulators is approximately $29 million. The incremental tunnel storage cost is approximately $17 million. Thus, the total capital cost is approximately $46 million. The life cycle cost for the project is approximately $50 million including operations and maintenance costs.

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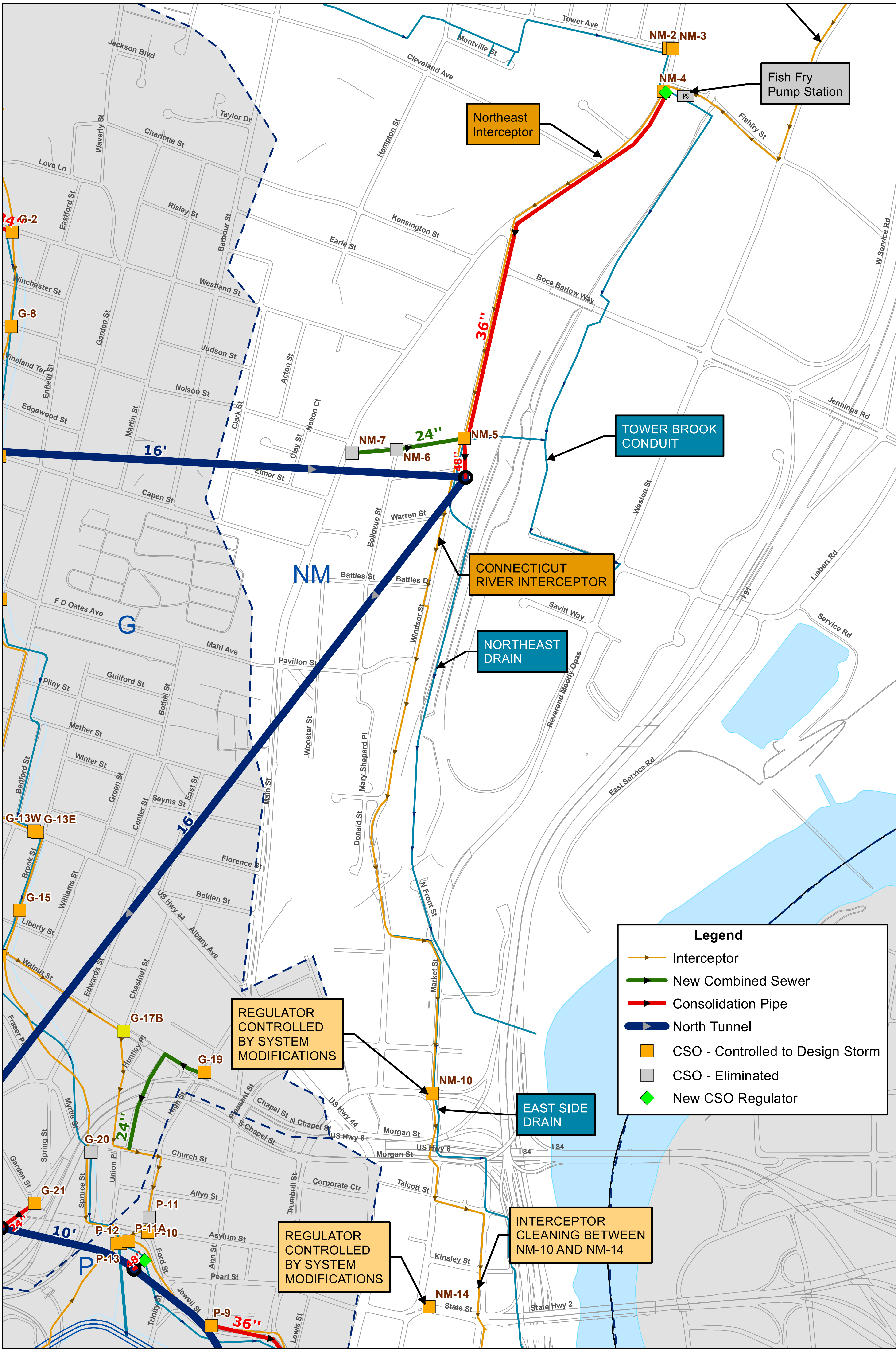

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Figure 10-6
North Meadows CSOs

Sewer Separation

The upstream CSO tributary areas for NM-2, NM-3, and NM-4 are already separated.

Total separation of the tributary area to NM-5, NM-6, and NM-7 cost approximately $120 million and would not achieve the CSO control goals. Section 6 identified that individual sewer separation of NM-7 and NM-14 could control CSOs to the 1-Year Design Storm at a cost of about $14 million and $2 million, respectively. The cost for the new combined sewer to convey NM-7 flows to NM-5 to eliminate NM-7 is significantly less expensive than full separation of the area. The proposed plan for NM-14 is to modify the regulator to discharge more flow into the CRI. This recommendation is less expensive than the separation plan of $2 million.

Satellite Treatment and Storage Facilities

In Section 8, the least expensive satellite treatment option for the North Meadows Area CSO regulators was determined to be primary treatment with an estimated life-cycle cost of $103 million. A satellite storage facility for these regulators has a life-cycle cost of approximately $54 million, making satellite treatment the less expensive satellite facility option.

Summary

Table 10-14 summarizes the general costs and CSO control approaches for the North Meadows CSO regulators.

The life cycle cost of consolidation pipes and the tunnel storage system plan is approximately $50 million. Satellite storage to address the entire North Meadows area would cost approximately $54 million and satellite treatment would cost approximately $103 million. Sewer separation would cost $120 million and would not control CSOs to the 1-Year Design Storm.

Accordingly, using the North Tunnel to address the North Meadows CSO regulators is the most cost effective option.

Table 10-14

North Meadows CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$50
Satellite Treatment	$103
Satellite Storage	$54
Sewer Separation[1]	$120

Note: [1] A portion is already separated and further separation would not control to the 1-Year Design Storm.

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10.7 Gully Brook Area CSO Regulators

The Gully Brook drainage area is located in north central Hartford and is divided by two major north-to-south flowing pipes: the Gully Brook Interceptor (GBI) and the Gully Brook Conduit (GBC). The GBI is 24 inches at its upstream end in the northern part of the Gully Brook drainage area and 48 inches at its downstream connection to the Park River Interceptor. The GBC flows parallel to the GBI and is 84 inches at its upstream end and is dual 84-inch pipes at its downstream connection to the PRC. G-20, previously the largest CSO in the system, will be eliminated when the East Side Sewer Separation (Upper Albany 1) project is finished. G-14 was eliminated in 2013 with the completion of the Burton Street Sewer Separation.

Table 10-15 shows the ten remaining CSO regulators in the Gully Brook area that contribute CSO to the GBC. Seven of these CSO regulators discharge flow during the 1-Year Design Storm. G-2 and G-13W are directly located on the interceptor, while the others regulate local sewers just upstream of their connection with the GBI. This grouping also includes the two new CSO regulators along the HAIE: G-17A and G-17B; only G-17A discharges flow during a 1-Year Design Storm.

Table 10-15
Gully Brook CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
G-2	1-Year Design Storm	48	2.4
G-8	1-Year Design Storm	6	0.3
G-9	1-Year Design Storm	8	0.3
G-10	1-Year Design Storm	4	0.2
G-11	1-Year Design Storm	6	0.3
G-12	1-Year Design Storm	3	0.1
G-15	1-Year Design Storm	0	0.0
G-13E	1-Year Design Storm	0	0.0
G-13W	1-Year Design Storm	1.4	<0.1
G-23	1-Year Design Storm	0	0.0
G-17A	1-Year Design Storm	6.9	0.1
G-17B	1-Year Design Storm	0	0.0
	Total	**83.3**	**3.7**

Two of the most southern Gully Brook CSO regulators (G-19 and G-21) were addressed in the Park River Area because of their proximity to the other Park River CSO regulators.

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Consolidation Pipes and Tunnel Storage System

Figure 10-7 shows the proposed consolidation pipes for the upstream Gully Brook drainage area that will utilize a tunnel drop shaft in Keney Park. The tunnel drop shaft is connected to a new Granby Spur tunnel from the Loomis Street area near NM-5 to Granby Street. The tunnel plan is discussed in Section 7.

The consolidation pipes convey flow from the largest upstream Gully Brook area CSO regulators – G-2, G-9, and G-10 – into the Granby Spur Tunnel at the Keney Park shaft. SWMM modeling shows that if adequate wet weather flow is diverted from these three CSO regulators away from the GBI during wet weather events less than or equal to the 1-Year Design Storm, then CSO from G-8, G-11, and G-12 can be captured by the GBI up to the 1-Year Design Storm (with modifications to these three CSO regulators). Figure 10-8 shows the 84-inch microtunneled pipe to convey flow from G-2 west on Westland Street, south on Vine Street, and west/south on Edgewood Street to a tunnel drop shaft located in Keney Park. A 48-inch consolidation pipe conveys flow from CSO regulators G-9 and G-10 to the tunnel drop shaft.

SWMM modeling also indicated that several of the southern Gully Brook CSO regulators, which were previously inactive during the 1-Year Design Storm (G-13E and G-15), had some minor discharges during the 1-Year Design Storm under the consolidation pipe plan. Most of this new CSO discharge is likely a function of modeling sensitivity and is easily controlled with CSO regulator modifications and some GBI cleaning (approximately 3,000 feet). Accordingly, for all of the remaining Gully Brook CSO regulators (G-13E, G-13W, G-15 and P-11A), CSO regulator modifications will be required, along with the diversion of G-2, G-9, and G-10 into the tunnel to control all of the Gully Brook CSO regulators.

The cost of the consolidation pipes for the northern Gully Brook CSO regulators to connect this flow to the tunnel drop shaft at Keney Park, GBI cleaning, and the CSO regulator modifications to all of the CSO regulators in this area is $28 million. The incremental cost of the tunnel storage is approximately $17 million. Thus, the total capital cost is approximately $45 million. The life cycle cost of the consolidation pipes and tunnel storage system plan for the Gully Brook CSO regulators is approximately $46 million including operations and maintenance costs.

Sewer Separation

The cost of separating the tributary area to these Gully Brook CSO regulators is approximately $320 million and would not achieve the control objective. Section 6 also indicated that sewer separation of any of the individual upstream basins to the Gully Brook CSO regulators would not achieve the 1-Year Design Storm control level. Thus, sewer separation is not a viable alternative for the Gully Brook area CSO regulators.

Satellite Treatment or Storage Facilities

In Section 8, satellite storage and treatment was also considered for this area; however, there is no suitable location for an outfall for a satellite treatment facility, making satellite storage the only viable satellite alternative option. Similar consolidation pipes would be required if a satellite facility was installed in Keney Park instead of the spur tunnel and tunnel drop shaft. The estimated cost of a satellite storage facility for the upper Gully Brook CSO regulators (not including G-13W and P-11A) is approximately $123 million. Accordingly, the consolidation pipe and tunnel storage system plan is less expensive.

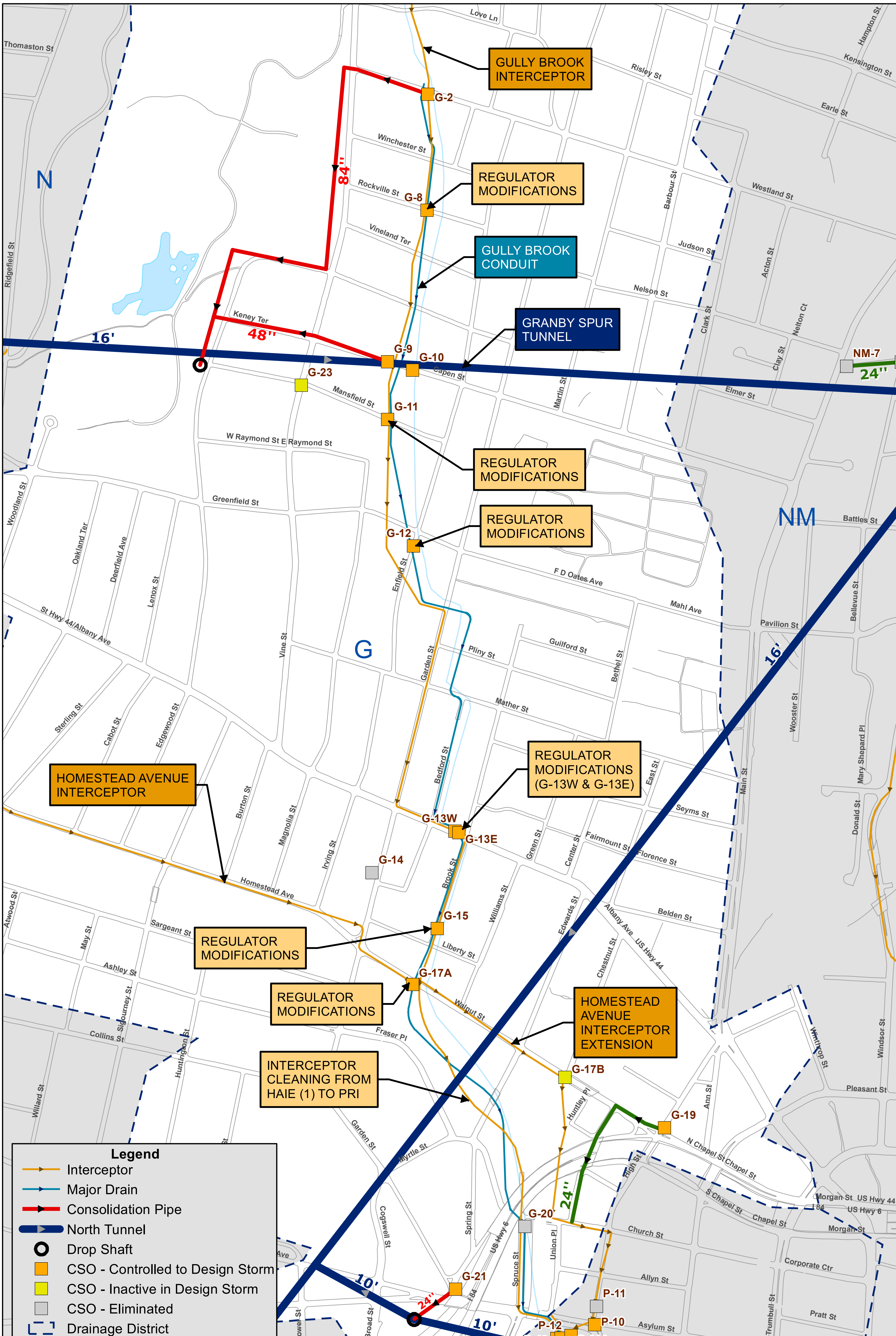

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Figure 10-7
Gully Brook CSOs

Summary

Table 10-16 summarizes the general costs and CSO control approaches for the Gully Brook CSO regulators.

The proposed consolidation pipe and tunnel storage plan for the Gully Brook CSO regulators using the Granby Spur Tunnel is the least cost alternative at $46 million (including incremental tunnel storage volume costs). The cost of sewer separation at $320 million and satellite storage at $123 exceeds the cost of using the Granby Spur Tunnel.

Table 10-16

Gully Brook CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$46
Satellite Treatment	NA
Satellite Storage	$123
Sewer Separation[1]	$320

Note: [1] Separation of drainage area will not achieve the required level of control.

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10.8 North Branch Park River CSO Regulators

The North Branch Park River drainage area is located in the northwest portion of the city and has 14 CSO regulators, 13 of which discharge flow during the 1-Year Design Storm.

Two CSO regulators (N-2 and N-4) are located in the Granby neighborhood area and discharge to the open North Branch Park River and must be eliminated. The Wethersfield Cove/North Branch Park River Design Storm provides the basis for the alternatives analysis; Section 11 furthers the analysis to include complete elimination.

Nine CSO regulators are in the Farmington Avenue area. Two of these nine Farmington area CSO regulators (N-9 and N-10) are located adjacent to each other and discharge into the open North Branch Park River (at Asylum Avenue) and must be eliminated. The WC/NBPR Design Storm provides the basis for the alternatives analysis; Section 11 furthers the analysis to include complete elimination. The remaining seven CSO regulators discharge to the North Branch Park River conduit and must be controlled to the 1-Year Design Storm; however, I-4 is inactive during the 1-Year Design Storm.

Three CSO regulators (N-28A, N28B, and N-29) are located along Park Street and must be controlled to the 1-Year Design Storm and are examined a separate area.

10.8.1 Granby Area CSO Regulators

The Granby Area is in the northwest portion of the city in the North Branch Park River drainage area. The area has two active CSO regulators: N-2 located at the intersection of Granby Street and Pembroke Street and N-4 located at the intersection of Granby Street and Garfield Street.

Table 10-17 summarizes the overflow rates and volumes for each regulator. N-2 and N-4 discharge to the North Branch Park River (a Class A waterway) and must be eliminated.

Table 10-17
Granby Area CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
N-2	WC/NBPR Design Storm	157	8.2
N-4	WC/NBPR Design Storm	58	2.7
	Total	**215**	**10.9**

CSO Regulators N-2 and N-4 regulate flow into the Granby Street sewer that connects to the Homestead Avenue Interceptor (HAI). It is important to note that during the WC/NBPR Design Storm, the HAI surcharges and is relieved at CSO regulator N-4.

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Consolidation Pipes and Tunnel Storage System

Figure 10-8 shows the proposed consolidation pipes for the Granby area. The Granby Spur Tunnel (discussed in more detail in Section 7) ends with a tunnel drop shaft near N-4, east of the intersection of Garfield Street and Granby Street. Flows from CSO regulator N-2 cannot be conveyed by the existing system, so a 96-inch consolidation pipe is proposed (running parallel to the rail road tracks), which will be constructed by micro-tunneling. The existing CSO regulator at N-2 will be converted to a tunnel regulator to direct CSO from the east to the tunnel and a new tunnel regulator on Granby Street at the intersection of Pembroke Street will be constructed to direct CSO from the combined sewer system north of N-2 to the tunnel. These two tunnel regulators associated with N-2 flow will utilize the existing CSO outfall to convey flow to the 96-inch consolidation pipe (if feasible). The Granby Spur Tunnel drop shaft near N-4 will receive all wet weather flow up to and including the WC/NBPR Design Storm from N-2 and N-4. The proposed alignment for the consolidation pipe requires the District to obtain an easement west of Granby Street, along the railroad tracks.

The cost of the incremental tunnel storage is approximately $49 million. The cost of the N-2 consolidation pipe and the N-4 connections to the tunnel drop shaft near N-4 is about $11 million. Thus, the total capital cost of this alternative is approximately $60 million. The annual operation and maintenance is insignificant, making the total life cycle cost of this alternative approximately $60 million.

An alternative was considered to install micro-tunneled consolidation pipes from N-4 to Keney Park but this approach was more expensive than the extension of the Granby Spur Tunnel from Keney Park to N-4.

In addition, the cost to extend the Granby Spur Tunnel beyond N-4 to N-2 (versus the proposed approach to microtunnel a consolidation pipe between the two CSO regulators) was also considered. If the Granby portion of the tunnel was extended after Keney Park, the cost would be about $3.5 million more than the cost of the tunnel to N-4 and the micro tunnel consolidation pipe to N-2. This incremental increase is within 7 percent of the total project cost ($49 million for the extension of the Granby Spur Tunnel to the Granby CSO regulators) and, thus, was considered equivalent at this conceptual design level.

The construction impacts of each alternative are very similar and it is hard to distinguish whether either alternative is a better option at this time. The N-4 tunnel site is adjacent to N-4 and a potential N-2 site is adjacent to the Annie Fisher Montessori Magnet School on school playing fields. Comparatively, the N-4 site is smaller and closer to residences but may be located in a better spot for construction vehicle access. The N-4 site is also predominately owned by the District. Meanwhile, the N-2 site has more room for construction but its location on the playing fields and adjacent to the school would have greater impacts to the school and students. Construction vehicle access may also be a concern since the vehicles will likely share the same road as buses and parents, creating some traffic challenges. There are other options to use temporary roads along the rail line and/or nearby railroad sidings (for spoils removal) but this requires further analysis.

The District will consider these two alternatives more thoroughly to select the appropriate alternative based on costs and local impacts in the future North Tunnel BODR.

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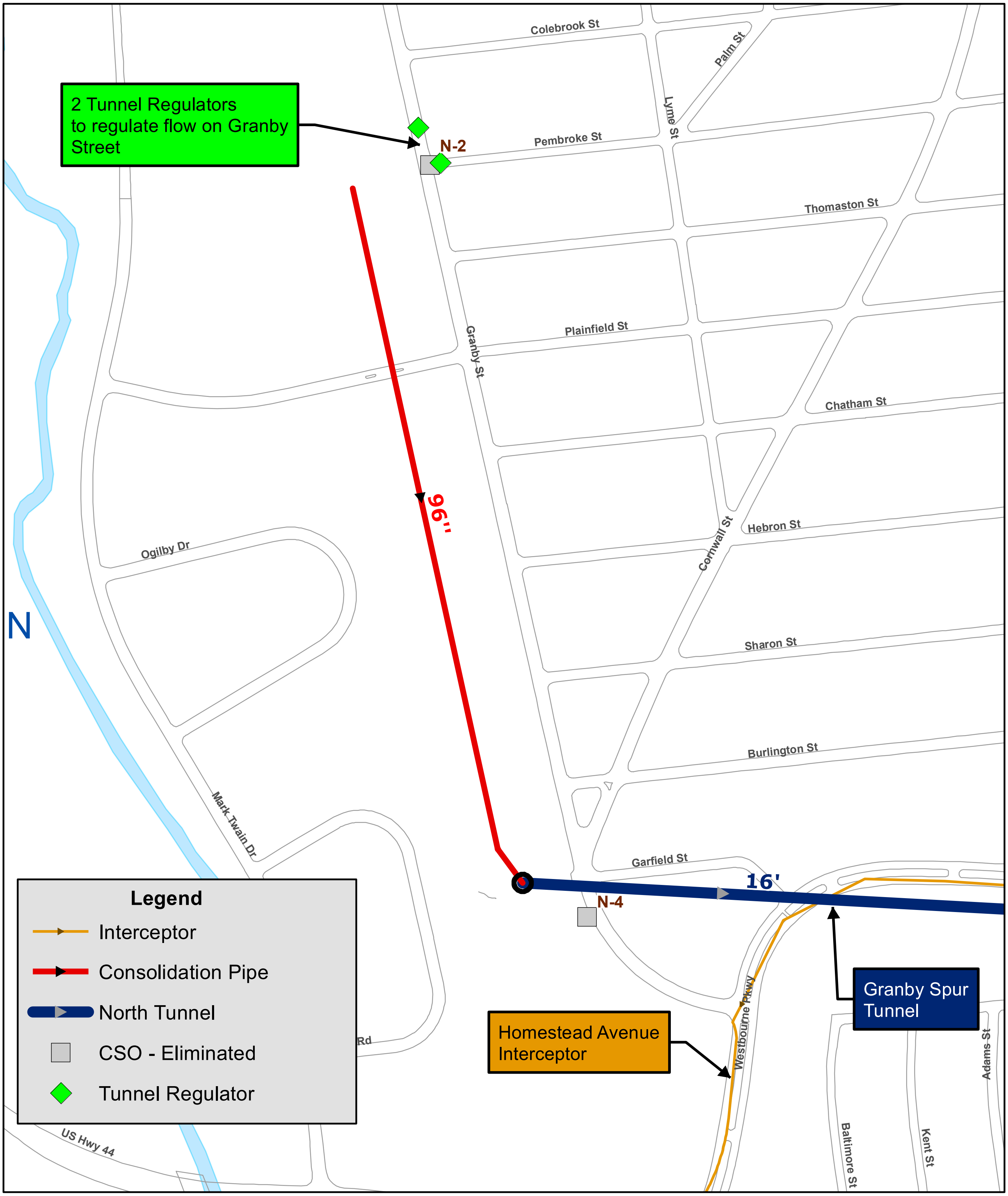

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Figure 10-8
Granby CSOs

Sewer Separation

Section 6 indicated that complete sewer separation of the tributary area upstream of N-2 and N-4 regulators (at a total cost of $170 million) would not control these CSO regulators to the WC/NBPR Design Storm.

Satellite Treatment and Storage Facilities

Satellite treatment of these CSO flows is not an alternative as no treated discharges of flow are allowed into the North Branch Park River. In Section 8, it was determined that satellite storage facilities for these two CSO regulators have a capital cost of about $129 million and a life cycle cost of about $133 million. Accordingly, the consolidation pipes and tunnel storage system plan is less costly than constructing a satellite storage facility.

Summary

Table 10-18 summarizes the general costs and CSO control approaches for the Granby CSO regulators.

The consolidation pipes and tunnel storage system plan for the Granby CSO regulators, N-2 and N-4, is the least cost option at $60 million. Sewer separation of the upstream would cost $170 million and will not control these CSO regulators to the WC/NBPR Design Storm and a satellite CSO storage facility at $133 million is more expensive than the tunnel plan.

The North Tunnel BODR should consider the possibility of extending the Granby Spur tunnel up to a location along the new N-2 outfall pipe to eliminate the need for the 96-inch consolidation pipe parallel to the railroad tracks.

Table 10-18

Granby CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$60
Satellite Treatment	N/A
Satellite Storage	$133
Sewer Separation[2]	$170

Note: [1] Separation of drainage area will not achieve the required level of control.

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10.8.2 Farmington Area CSO Regulators

The Farmington area is located in west central Hartford and the eastern portion of West Hartford. There are nine CSO regulators (Table 10-19) in this area; eight regulators (all but I-4) are active during their respective design storm. CSO regulators N-9 and N-10 overflow to drains that discharge to the day-lighted portion of the North Branch Park River and, therefore, are evaluated using the WC/NBPR Design Storm and will be eliminated. The remaining CSO regulators must be controlled to the 1-Year Design Storm.

CSO regulators N-12, N-14, N-23, and N-24 regulate flow upstream of the New North Branch Interceptor (NNBI) and discharge overflow to the Tremont Street Drain, a major drain system starting in West Hartford that flows into Hartford and eventually to the Park River Conduit (PRC). The drain is 36-inches at its upstream end and 104-inches at the connection to the PRC. N-22 and N-25 discharge CSO directly to the PRC.

Table 10-19
Farmington Area CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
N-9	WC/NBPR Design Storm	17	2.1
N-10	WC/NBPR Design Storm	24	0.6
N-12	1-Year Design Storm	4	0.3
N-14	1-Year Design Storm	32	0.9
N-22	1-Year Design Storm	7	0.4
N-23	1-Year Design Storm	7	0.6
N-24	1-Year Design Storm	15	0.8
N-25	1-Year Design Storm	45	2.3
I-4	1-Year Design Storm	0	0.0
Total		**151**	**8.0**

Consolidation Pipes and Tunnel Storage System Plan

Figure 10-9 shows the plan for the Farmington Area CSO regulators to connect and discharge flow to the North Tunnel. CSO regulators N-9 and N-10 are a significant distance away from the proposed tunnel drop shaft near CSO N-25, as shown on Figure 10-9, which posed a challenge for consolidation.

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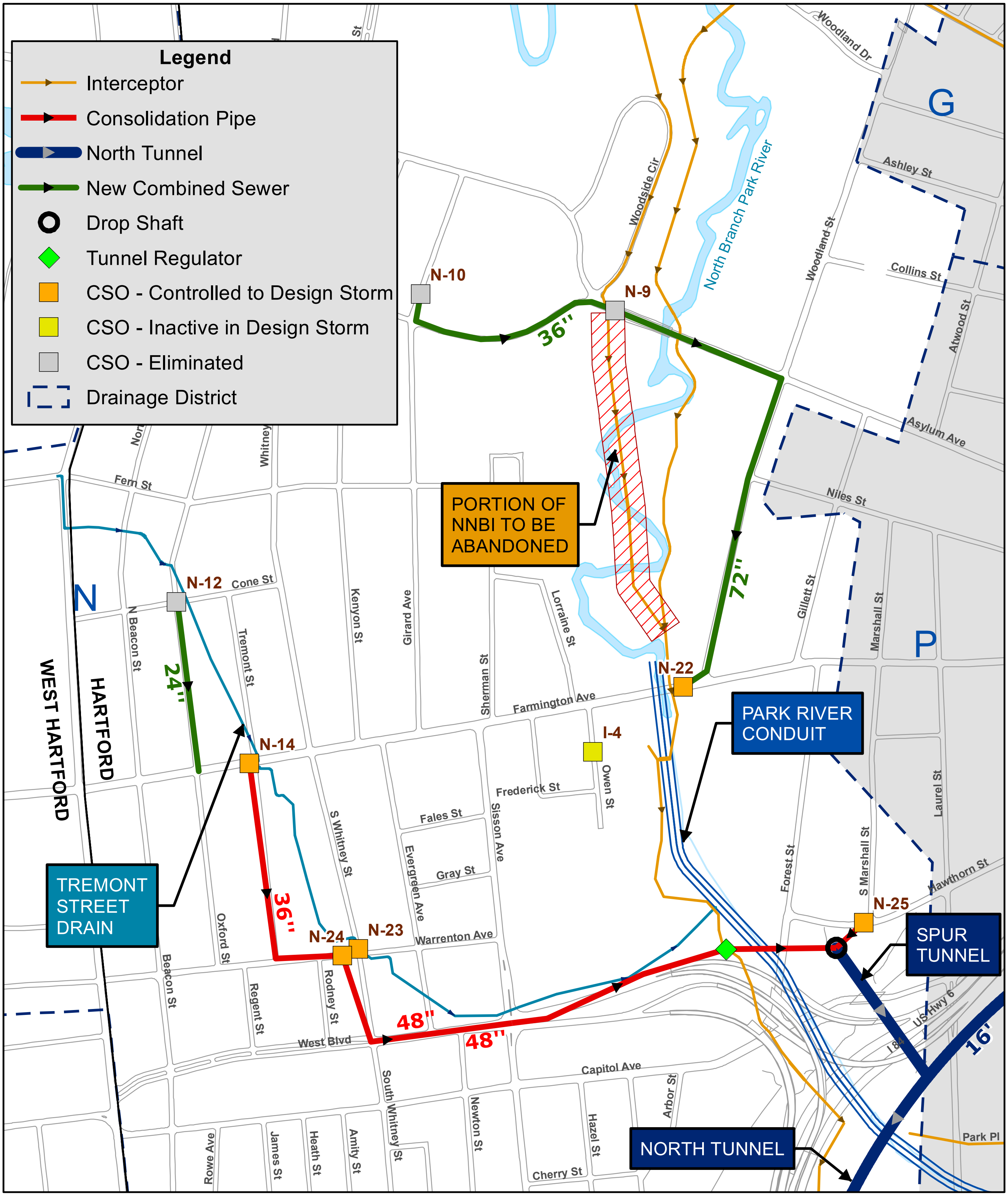

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Figure 10-9
Farmington CSOs

One other issue for this area is the existing maintenance problems along the New North Branch Interceptor (NNBI) reported by the District. Section 2 discusses the problems along this pipe reach, from Asylum Street to Farmington Street. The pipe is often surcharged and is a continuous maintenance problem (due to access issues to maintain the three siphons in this reach of pipe). One solution to address both the CSO and interceptor maintenance issue is to install a new combined sewer pipe from CSO N-10 to CSO N-22 to eliminate CSO regulators N-9 and N-10 and to provide adequate capacity to eliminate the maintenance-prone portion of the NNBI. This could be achieved by a 36-inch and 72-inch new combined sewer pipe downstream to the lower portion of the NNBI (south of Farmington Avenue). The proposed piping plan requires one siphon to cross the Park River (easily accessible from the road), but this approach is an improvement over the current alignment that has three siphons along the existing NNBI from Asylum Avenue to Farmington Avenue (and relatively inaccessible). The cost of the new combined sewer pipes from CSO N-10 (36-inch and 72-inch diameters) is about $19 million, including the cost to reconstruct the N-22 CSO regulator. The cost for the incremental tunnel storage from N-9, N-10, and N-22 is approximately $14 million.

SWMM model simulations were performed to evaluate this new combined sewer and its impact to the NNBI, a 54-inch diameter pipe, and the adjacent CSO regulator N-22. The new combined sewer pipe would be directly connected to the NNBI at Farmington and the N-22 CSO regulator would be used to discharge excess flow during storm events to the PRC. Simulations showed that if a new NNBI Relief Structure (discharging to the tunnel system) was constructed along the pipe near West Boulevard, the system hydraulic gradeline along NNBI could be modified such that the flow from the N-9/N-10 new combined sewer pipe and the N-22 CSO discharge would be conveyed downstream without any surcharge along the NNBI. Under this plan, there would be no CSO discharges to the daylighted portion of the North Branch Park River and the N-22 CSO regulator discharge to PRC would be controlled to the 1-Year Design Storm. The new NNBI tunnel regulator would be connected to the tunnel drop shaft near CSO regulator N-25. The cost of the NNBI tunnel regulator is about $8 million, including the tunnel overflow pipe cost to the tunnel drop shaft near N-25. The cost of incremental storage in the tunnel for this solution was about $11 million (the storage volume required for N-9 and N-10 is approximately 2.4 MG for a 1-Year Design Storm since these CSO regulators will no longer discharge to the North Branch Park River). Thus, the total capital cost of a new combined sewer to eliminate CSO regulators N-9 and N-10 and control N-22 is about $38 million, including the cost of incremental tunnel storage.

Several consolidation pipe alternatives were also considered to convey these two CSO regulators (N-9 and N-10) to the tunnel. One alternative was to construct a new tunnel spur for the CSO discharges from the North Tunnel from a site near Walnut and Chestnut Streets over to a site along the North Branch Park River and Asylum Street (east of the river). This spur tunnel would be a 10-foot diameter tunnel, extending about 6,000 feet from the North Tunnel to the site near N-9, with a construction cost of about $60 million. (A spur tunnel was less costly than a microtunneled pipe from N-9 to the tunnel.) The spur tunnel option was significantly more than the $38 million cost for the new combined sewer pipe and this option was not considered further.

Other alternatives for CSO regulators N-9 and N-10 considered installation of consolidation pipes (36-inches and 48-inch in diameter) along city streets between CSO N-9 and CSO N-25 to get CSO discharges to the tunnel. However, these alternatives require more extensive construction along Farmington Avenue, which already poses a challenge due to a significant number of underground utilities. In addition, the cost of constructing a consolidation pipe to the tunnel for CSO regulators N-9 and N-10 was only about $8 million less than the 72-inch new combined sewer pipe but the consolidation pipe will not address the long-standing interceptor maintenance problem along the NNBI (and allow the District to permanently remove the section of this interceptor pipe from Asylum Street to Farmington Avenue from service). Accordingly, the new combined sewer pipe along Asylum Street and Woodland Road was the better option to address both CSO discharges and long-term maintenance problems associated with NNBI.

For CSO N-12, SWMM model simulations indicated that a 24-inch new combined sewer pipe along Oxford Street would convey all flow reaching this CSO regulator down to the Farmington Avenue combined sewer with minimal additional surcharge. Accordingly, the new combined sewer would eliminate CSO N-12. The capital cost of this new pipe is approximately $1.7 million. The incremental tunnel storage for N-12 is approximately $1.4 million.

For CSO regulators N-14, N-23 and N-24, a 36-inch and 48-inch consolidation pipe is proposed that will start from N-14 and convey flow south along Tremont Street and Warrenton Avenue to N-23/N-24, and then south along South Whitney Street. These consolidation pipes will likely be constructed by open-cut excavation. From South Whitney Street, a 48-inch microtunneled pipe will convey flow from N-14/N-23/N-24 and the new NNBI tunnel regulator (via a connection shaft to the microtunnel near West Boulevard), east under the PRC to the tunnel drop shaft near N-25. The capital cost of this consolidation pipe plan, including all regulator modifications, structures, and incremental tunnel storage, is about $55 million.

The CSO regulator outlet pipe for N-25 would be directly connected to the tunnel shaft due to its proximity.

The total capital cost of the consolidation pipes and tunnel storage system plan for the Farmington Area CSO regulators, including the cost of CSO N-25 and incremental storage for all of the CSO regulators is about $91 million. Including operations and maintenance, the life-cycle cost is approximately $92 million.

Table 10-20 presents a summary of the consolidation pipes alternatives for the Farmington Avenue area CSO regulators.

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Table 10-20
Piping Options for Farmington Area CSO Regulators

Regulators	Consolidation Pipes Options	Cost	Status
Regulators N-9 and N-10			
Option A	Combined sewer, 36-in and 72-in diameter, 4,500 ft to N-22.	$38 M	Selected option (LTCP Fig. 10-9).
Option B	Tunnel spur, 6,000-ft long, 10-ft diameter.	$50 M	Rejected due to higher cost.
Option C	Modify Option A by reducing the 72-in pipe conveyance pipe for N-9 and N-10 to 36-in & 48-in pipes to N-25.	$30 M	Rejected. Major disadvantages include Farmington Ave construction, and not addressing NNBI maintenance issues.
Regulator N-12			
	Combined sewer, 24-in, in Oxford Street.	$3.1 M	Selected option (LTCP Fig. 10-9).
Regulators N-14, N-23 and N-24			
	Consolidation pipe, 36-in & 48-in, to new Tunnel shaft at N-25.	$37 M	Selected option (LTCP Fig. 10-9).
Regulator N-25			
	Direct connection to Tunnel shaft, due to proximity.	$0.9 M	Selected option (LTCP Fig. 10-9).

Sewer Separation

Sewer separation of the CSO regulators N-9 and N-10 would cost $115 million but would not control discharges to the WC/NBPR Design Storm. Separation of the remaining Farmington Area CSO regulator basins would cost $280 million, which is significantly more than the tunnel storage/consolidation pipe plan.

SWMM simulations showed that only sewer separation in the CSO N-22 basin would individually control any of these CSO regulators. The cost of sewer separation of the N-22 area is about $11 million. In comparison, the cost of the new N-22 CSO regulator and incremental cost of tunnel storage is about $6 million; accordingly, the consolidation pipe plan (and tunnel storage) for CSO N-22 is less costly than sewer separation

As discussed in Section 4, Farmington 7.1 and 7.2, which were upstream of N-24, were only partially separated as the separated flow recombines downstream outside of the project area. The project provided benefit and relief to residents in the project area that used to be prone to surcharging and sewer backups. To completely separate Farmington 7.1 and 7.2, approximately 2,300 feet of 48-inch drain pipe would be required along Warrenton Avenue, which would cost approximately $6 million. The project would not replace any other recommended infrastructure and would just be an additional expenditure to the Clean Water Program with minimal CSO benefit. For that reason, the District will not move forward with the Warrenton Avenue Drain.

Satellite Treatment or Storage Facility

In Section 8, the least expensive satellite treatment option for the Farmington Area CSO regulators was determined to be primary treatment at approximately $202 million. A satellite storage facility for these regulators is approximately $144 million, making satellite treatment the less expensive satellite facility option.

Summary

Table 10-21 summarizes the general costs and CSO control approaches for the Farmington Area CSO regulators.

The plan for CSO regulators N-9, N-10 and N-22, which consists of about 4,500 feet of a new 36-inch and 72-inch diameter new combined sewer pipe and the NNBI tunnel regulator, represents a better and less costly solution for these three CSO regulators in comparison to a satellite storage facility (CSO regulators N-9 and N-10) and sewer separation of CSO N-22. It may also be possible to construct the 72-inch new combined sewer early in the project phasing (without construction of the NNBI tunnel regulator and connection to the North Tunnel). Expediting this project may be an early water quality benefit to the North Branch Park River while addressing the existing system maintenance issues.

The new combined sewer for N-12 and the consolidation pipe for CSO regulators N-14, N-23, N-24, and N-25 into the North Tunnel shaft near CSO N-25 is a better, and less costly, alternative than sewer separation or a satellite treatment or storage facility for these same CSO regulators.

Table 10-21

Farmington Area CSO Regulators
Summary of CSO Control Approaches

CSO Control Approach	Life Cycle Cost ($M)
Tunnel Storage	$92
Satellite Treatment[1]	$202
Satellite Storage[1]	$144
Sewer Separation[2]	$395

Note: [1] Separation of drainage area will not achieve the required level of control.

10.8.3 Park Street CSO Regulators

There are three CSO regulators along Park Street, in the North Branch Park River drainage area, that were grouped together because of an ongoing integration effort with a Department of Transportation (DOT) Fastrack Corridor/Busway Improvements project, which was the subject of a separate preliminary design project. Table 10-22 shows the flows from these CSO regulators. Figure 10-10 shows the suggested improvements that were developed as part of this preliminary design.

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Table 10-22
Park Street CSO Regulators

CSO Regulator	Design Storm	Peak Flow (mgd)	Volume (MG)
N-28A	1-Year Design Storm	10	0.6
N-28B	1-Year Design Storm	20	0.9
N-29	1-Year Design Storm	7	0.6
	Total	**37**	**2.1**

The preliminary design considered several alternatives for control of these CSO regulators including sewer separation and consolidation and direct connection of the flow to the North Tunnel with a tunnel drop shaft near Pope John Paul Park. The more detailed analysis identified opportunities to partially separate the area using some existing drainage pipe – an opportunity that is not available in most of the other CSO areas. The recommendation was to construct a 24- and 36-inch new combined sewer pipe between the three CSO regulators to convey more flow downstream to the interceptor. In addition, a new 36-inch drainage pipe is proposed along Park Street to collect drainage from some of the existing separated drain pipes along the side streets to divert this separated drainage flow away from the Park Street combined sewer. The life cycle cost of Park Street area improvements is approximately $15 million.

The overall work required to address the Park Street CSO regulators for this alternative includes sewer replacement to install larger downstream conveyance on Park Street from I-84 to Francis; partial sewer separation on Park Street from Amity Street to Francis Avenue; consolidation of the N-28A and N-28B CSO regulators by installing a new CSO regulator downstream; the redirection of the Bartholomew Avenue combined sewer away from the existing N-29 regulator to the Old South Branch Interceptor at cross country location between Pope Park Highway and Route I-84; and downstream interceptor relief to the North Tunnel.

A second, and also still viable alternative, includes consolidating the Park Street CSO regulators to the tunnel with an estimated total construction cost of approximately $26 million. The consolidation pipe alternative includes additional costs for incremental tunnel storage volume. A comparison of the alternatives is included in Table 10-23.

Subsequent to submitting the Draft 2012 LTCP Update, the preferred sewer separation project has been delayed to allow construction of the DOT Fastrack Corridor/Busway Improvements project to proceed without complications related to schedule and coordination issues. Therefore, there will no longer be a cost sharing of the project with the DOT. The $15 million partial sewer separation project along Park Street discussed above is recommended at this time and the project will be re-initiated approximately 3 to 5 years after the CT Fastrack project is complete.

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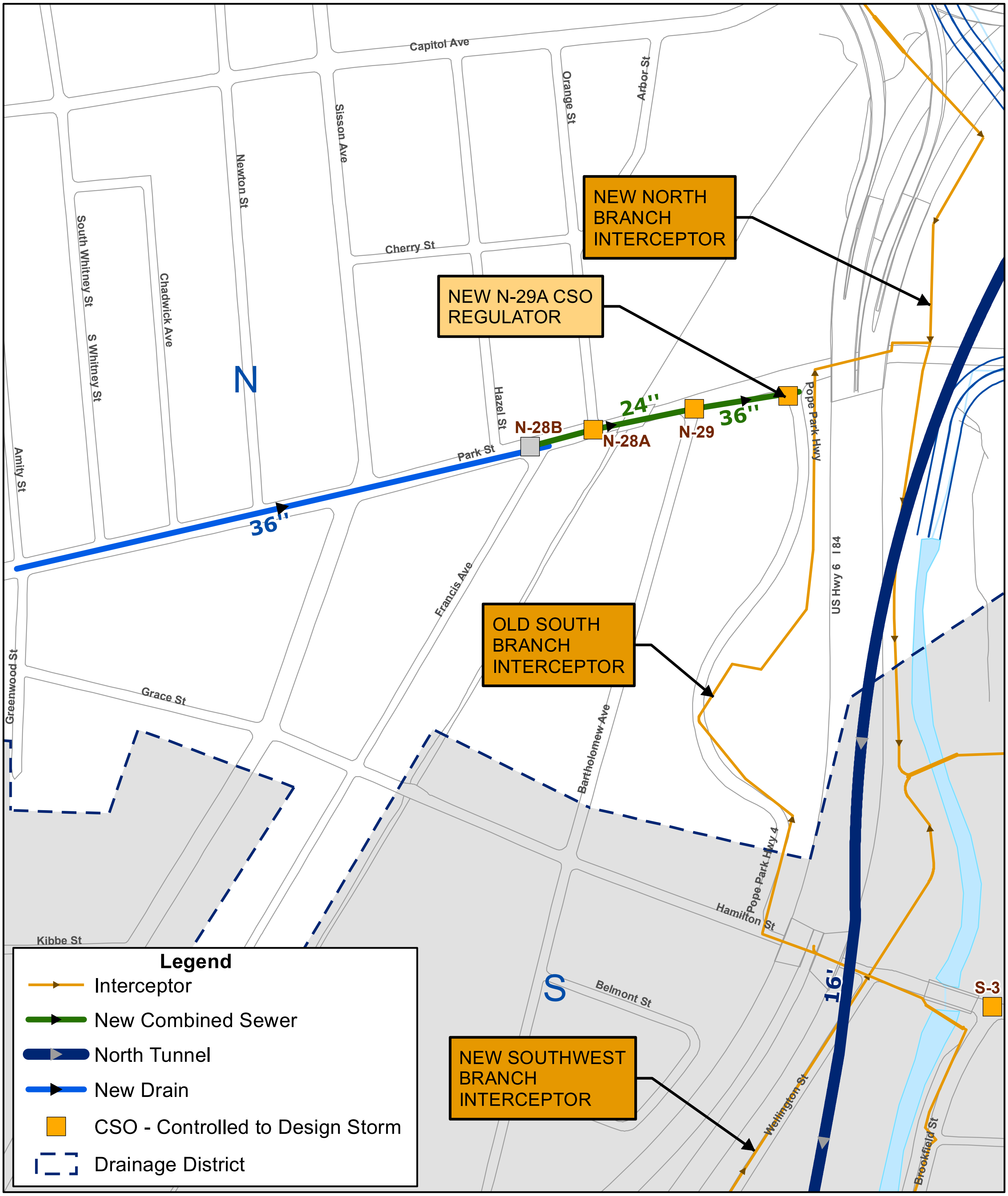

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Figure 10-10
Park Street CSOs

Table 10-23
Comparison of the Park Street CSO Mitigation Alternatives

Consideration	Alternative 1 Open Cut Sewer Replacement and Partial Sewer Separation	Alternative 2 Consolidation Conduit to Tunnel
Estimated Construction Costs	~$15M	~$26M
Replaces existing sewer infrastructure	Yes – New sewer from Pope Park Highway to Amity.	No – No existing sewer infrastructure would be replaced.
Improves hydraulics from Francis to Amity	Yes – New sewer and drain will provide improvements.	No – No improvements would be made from Francis to Amity on Park Street.
Removes drainage from separated streets (Sisson, S. Whitney, Amity & Greenwood)	Yes	No – This separated flow would be conveyed through existing interceptor system and/or North tunnel.
Potential coordination with water main replacement	Yes	Yes
North Tunnel considerations	No increase to flow and volume to tunnel.	Increases flow and volume to tunnel. Requires odor control facility and siting.
O&M considerations	No increase over current O&M.	Requires O&M of consolidation pipe, Tunnel drop shaft, and odor control facility.

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10.11 North Tunnel and Granby Spur Tunnel Storage Optimization and Sizing

In Section 7, the overall system requirements for tunnel storage system were discussed. The total tunnel storage system volume had increased to 123.9 million gallons (from 49) based on the modifications and evolution of the 2005 LTCP including the following:

- New requirements of SSO reduction (17 million gallons);
- The elimination of the PRAC for tunnel storage and the addition of the South Tunnel;
- The change in CSO control goals for the North Branch Park River CSO regulators (change from 1-Year Design Storm to WC/NBPR Design Storm);
- No further sewer separation (reduction of 2,760 acres of proposed separation to about 700 acres of actual separation system-wide);
- Additional storage required for the Franklin Avenue CSO regulators;
- Lower assumption of the I/I reduction in the member communities (25 percent to 10 percent); and
- Updates to the SWMM model in 2009/2011 (resulting in refined CSO flows and volumes).

The overall system storage requirement is a theoretical requirement assuming that all three storm events – the two CSO design storms (1-Year Design Storm and WC/NBPR Design Storm) and the SSO Design Storm – occur coincidentally. However, the SSO Design Storm is a low intensity long duration event. Wet weather flow generated by the member communities during the SSO Design Storm occurs for days after the storm event but doesn't peak until almost a day after the event. This occurs because the SSO flow is related to infiltration and inflow (i.e., sump pumps and foundation drains) that have a lag time after the storm.

In addition, this overall system storage requirement assumes that the tunnel will not be dewatered until after the storm event. However, the HWPCF is currently being upgraded to provide wet weather treatment to a total peak flow of 200 mgd. SWMM model simulations show that the existing interceptor system (CRI, CCRI, and FAI) will only convey a peak of about 165 mgd during storm events. Accordingly, the South Tunnel (and North Tunnel/Granby Spur Tunnel) and the HWPCF can be used as an integrated conveyance and treatment system during the storm event to minimize the volume of wet weather storage that has to be constructed in the District.

Table 10-24 shows the tunnel storage requirements for the system, the South Tunnel, and the North Tunnel/Granby Spur Tunnel based on the approach discussed above using the tunnel system for conveyance and the HWPCF for treatment during the storm event. These tunnel storage volumes were simulated during each design storm (CSO and SSO), to ensure that the optimized tunnel storage volume would meet the CSO and SSO control objectives. Under dynamic storm event conditions, maximizing conveyance and treatment capacity, the total tunnel storage requirement is about 87 million gallons.

Table 10-24
Tunnel Storage Optimization

	2012 LTCP Update	
	Coincidental Events[3]	Optimized System
North Tunnel (and Granby Spur Tunnel)		
1-Year Design Storm CSO Regulators	56.7 MG	
WC/NBPR Design Storm CSO Regulators	10.8 MG	
Total	67.5 MG	45.5MG
South Tunnel		
1-Year Design Storm CSO Regulators	*3.1*[1]	
WC/NBPR Design Storm CSO Regulators	*35.9*[1]	
SSO Design Storm	*17.4*	
Subtotal	*56.4*	41.5[2]
Total Tunnel Volume Required	**123.9**	**87**
LTCP Assumptions		
HWPCF Capacity	200 mgd (interceptors convey 165 mgd)	200 mgd (maximized by tunnel pump station)
Separation in flood prone areas	Separation of only select contracts	
Franklin Area	Separation of contracts 5 & 13 36 MG Interceptor Relief	
Granby Area (N-2/N-4)	Separation of Contracts 2, 5	Separation of Contracts 2, 5
	WC/NBPR Design Storm (8 MG)	
CSO Regulators N-9/N-10	Included in NNBI Relief	
I/I Reduction in SSO Communities	10%	10%
Relief Pipes in SSO Communities	Yes	Yes
Interceptor Relief	CRI/NNBI/OSBI/FAI	

Note:

(1) The tunnel volume required for the Franklin Avenue CSO regulators (WC/NBPR Design Storm) and the South Branch CSO regulators (1-Year Design Storm) have changed slightly due to additional modeling and SWMM updates and the elimination of S-12, S-13, and S-14 from the South Tunnel over to the North Tunnel.

(2) Actual volume of the South Tunnel.

(3) Not realistic.

Assuming that the South Tunnel will remain at its current design storage volume of 41.5 MG, then the North Tunnel would be designed for a storage volume of about 45.5 million gallons – based on the current length of the North Tunnel and adjoining Granby Spur Tunnel of approximately 30,600 feet, the diameter of these tunnels will be 16 feet.

The South Tunnel system is currently being designed (at 30 percent design) with influent control gates at many of the consolidation pipe connections (at the vortex drop connections) to the main tunnel. The North Tunnel, Granby Spur Tunnel, and Downtown Spur Tunnel should be constructed with similar control gates so that a balanced system operation can be implemented. This is important to be able to divert excess flow at each CSO regulator (greater than the 1-Year Design Storm) away from the tunnel and to the existing waterway. Each consolidation pipe should be designed with a high outlet relief (i.e. a new CSO regulator that discharges to an appropriate waterway or stormwater conduit) so that if system operation of the control gates becomes problematic during more significant storms (greater than 1-Year Design Storm) the system has an alternative relief point(s). The tunnel FDE will need to perform a more detailed analysis of the operation of the tunnel under normal and surcharged (large storm) events to determine the arrangement of tunnel control features to protect the tunnel infrastructure and meet the wet weather control objectives. (Note: consolidation pipes that service N-2, N-4, and all Franklin Avenue area CSO regulators will not have relief points, as CSO discharges to the Wethersfield Cove and North Branch Park River will be eliminated.)

This report recommends an 18 foot diameter for the South Tunnel. The plan was developed assuming that the South Tunnel would proceed to final design at this diameter. An 18-foot diameter South Tunnel includes a 48% reserve capacity, and therefore, eliminates any future scenarios that might require a larger diameter South Tunnel. The 16-foot North Tunnel adequately meets the control requirements. The range of North Tunnel diameters that would work with the 18-foot South Tunnel, as well as the potential to lower the Downtown Tunnel to include the volume in the tunnel storage system, has the flexibility to increase the total tunnel storage system volume by over 25%. Similar to the South Tunnel design approach to-date, the North Tunnel project requires a BODR and preliminary (approximately 30 percent) design to provide sufficient analysis of tunnel operation under normal and surcharged (large storm) events to determine the best location, length, diameter and volume of the tunnel. It is anticipated that the BODR phase will commence in 2014 and the more refined tunnel alignment and volume will be presented in the next LTCP Update, which is planned to be submitted by December 31, 2017.

Section 11

Complete Elimination System Alternatives

11.1 Introduction

Section 10 evaluated alternatives to achieve CSO reduction at the CSO regulators to meet a specific level of control. Alternatives in Section 10 were evaluated to control almost all of the CSO regulators to the 1-Year Design Storm, with the exception of those that discharge to the North Branch Park River or Wethersfield Cove (and S-8, which will be relocated to avoid a discharge to Kane Brook).

The Consent Order requires elimination of CSO discharge to these sensitive, open surface water bodies. To address control levels for these water bodies, the analysis in Section 10 used the Wethersfield Cove/North Branch Park River Design Storm to compare alternatives for these unique CSO regulators (that discharge to the North Branch Park River and Wethersfield Cove). This design storm was selected during the 2004 Wethersfield Cove Study as a basis for analysis of alternatives to eliminate CSO discharges into Wethersfield Cove. However, based on a review of the Draft 2012 LTCP Update, CT DEEP determined the selection of this storm event was inappropriate for the goal of complete CSO elimination and that this approach did not comply with the Consent Order.

Accordingly, the historical precipitation record was examined to determine if there were more significant storms than the previously defined WC/NBPR Design Storm that could create system problems. Based on this analysis, the storm event that approximated a reasonable worst case precipitation event was adopted. System alternatives to eliminate these CSO regulators (that discharge to the North Branch Park River and Wethersfield Cove) to be physically sealed (by brick and mortar) were reexamined.

CSO regulators that discharge to the North Branch Park River and Wethersfield Cove are F-26, F-27, F-28, F-29, F-30, F-32, F-33, N-2, N-4, N-9 and N-10. Section 10 recommended addressing N-9 and N-10 via the installation of a new combined sewer with a larger diameter that would convey all of the wet weather flow from these two CSO regulators without the need for tunnel storage. Accordingly, this proposed system improvement will eliminates CSO discharges from N-9 and N-10 into the North Branch Park River. Thus, these two CSO regulators did not require further evaluation.

The analysis discussed in this section only further investigates how complete elimination affects the plan for CSO regulators from Section 10 that had storage solutions sized to the WC/NBPR Design Storm (i.e., CSO regulators connected to the tunnel system).

11.2 Evaluation Criteria

The goal for complete CSO discharge elimination to the North Branch Park River and Wethersfield Cove analysis was to identify the most cost-effective solution to meet the Consent Order elimination requirements while not creating worse hydraulic conditions (surcharge) in the collection system under reasonable extreme storm events. Historic precipitation data from 1920 to the present provided the basis to identify the extreme storms to be considered. Approximately 5,000 rain events with greater than 0.1 inches of precipitation occurred over the 94-year period. Hydrologic and hydraulic modeling predicted that the proposed 87 MG tunnel from Section 10.11 completely captures

CSO discharges from the Franklin Avenue (Wethersfield Cove) and Granby Street (North Branch Park River) areas in all but three of the events.

These extreme storms are the following:

1. Great New England Hurricane (1938);
2. Hurricane Diane (1955); and
3. Tropical Storm Tammy (2005).

The two hurricanes (1938 and 1955) were devastating storms that caused significant damage within Connecticut and resulted in considerable loss of life. Building, operating, and maintaining capacity in the public's sewer and storm drainage infrastructure to completely manage such events would be technically and financially irresponsible. Therefore, the complete elimination alternatives analysis excluded these two storms. Tropical Storm Tammy provided the basis for the complete elimination alternatives analysis as an extreme storm.

The evaluation compared the predicted hydraulic grade lines (HGLs) during the extreme storm under collection system conditions prior to the Clean Water Project (2006) to the HGLs resulting from the proposed complete CSO elimination alternatives in the Franklin Avenue and Granby Street areas.

11.3 Alternatives

Three (3) alternatives were investigated to achieve the goal of physically sealing the CSO regulators that discharge to the North Branch Park River and Wethersfield Cove:

1. 87 MG Tunnel (optimized tunnel size from Section 10)
2. 78 MG Tunnel with Pump Station to Connecticut River
3. 55 MG Tunnel with Complete Separation of Franklin Avenue and Granby Street Areas

The first step in the analysis was to use the hydraulic model to evaluate each alternative to determine if it was technically feasible to meet the evaluation criteria discussed above. The second step was to examine the additional costs associated with complete elimination of these CSO regulators to the respective receiving waters.

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11.3.1 Alternative 1 – 87 MG Tunnel

Overview

Alternative 1 consisted of the 87 MG tunnel storage system from Section 10.11 along with physically sealing the CSO regulators that discharge to the North Branch Park River and Wethersfield Cove. Simulations of Tropical Storm Tammy showed this alternative is a viable option because, even though the entire storm is not captured in the tunnel, the resulting HGLs in the local combined sewer system were not worse than conditions prior to the Clean Water Project. The recommendations that allow for this approach are summarized below. Figure 11-1 provides a plan of Alternative 1.

The following three aspects of Alternative 1 explain how existing conditions were improved.

1. Lowering the Elevation of Regulator Outlet Pipe

The new tunnel regulator outlet pipes in the Franklin Avenue and Granby Street areas will be at a lower elevation than the existing CSO regulator outlet pipes. Existing conditions force the sewer to surcharge before overflowing into the drainage system. With this alternative, the tunnel regulator outlet pipes in each area will be set a lower elevation, to provide relief at a lower hydraulic grade line. This will significantly reduce the surcharge in the combined sewer system.

2. Larger Regulator Outlet Pipes

Alternative 1 includes tunnel regulator outlet pipes that are larger than existing CSO regulator outlet pipes. The existing CSO regulators on Franklin Avenue and Granby Street rely on small diameter CSO regulator outlet pipes to convey the CSO to the drainage system. The larger diameter tunnel regulator outlet pipes included in this alternative will provide additional conveyance capacity to move overflow out of the sewer system.

3. Additional Conveyance Capacity

Under existing conditions, the total conveyance of sewer and stormwater piping downstream of the CSO regulators on Franklin Avenue and Granby Street are limited by the size of the existing infrastructure, which is incapable of conveying flows from extreme storms, such as Tropical Storm Tammy, and thus restricts the sewer system's ability to relieve itself. With this alternative, the sewer system relieves itself to a new tunnel, which significantly increases the hydraulic conveyance capacity as compared to existing conditions. This will improve hydraulic conditions in the local sewer system and drainage system.

Summary

Alternative 1 meets the technical criterion of not creating worse hydraulic conditions and has a negligible cost associated with complete elimination as it does not include any additional infrastructure, and therefore is the recommended plan. Table 11-1 details the above discussed hydraulic improvements on Franklin Street based on the South Tunnel 30% Design. The same concepts will be included in the North Tunnel design. Because the 87 MG tunnel met the technical criterion, the evaluation of a larger diameter tunnel was not necessary; however, the potential for a larger tunnel and the flexibility of storage volume in the recommended plan is discussed in Section 12.

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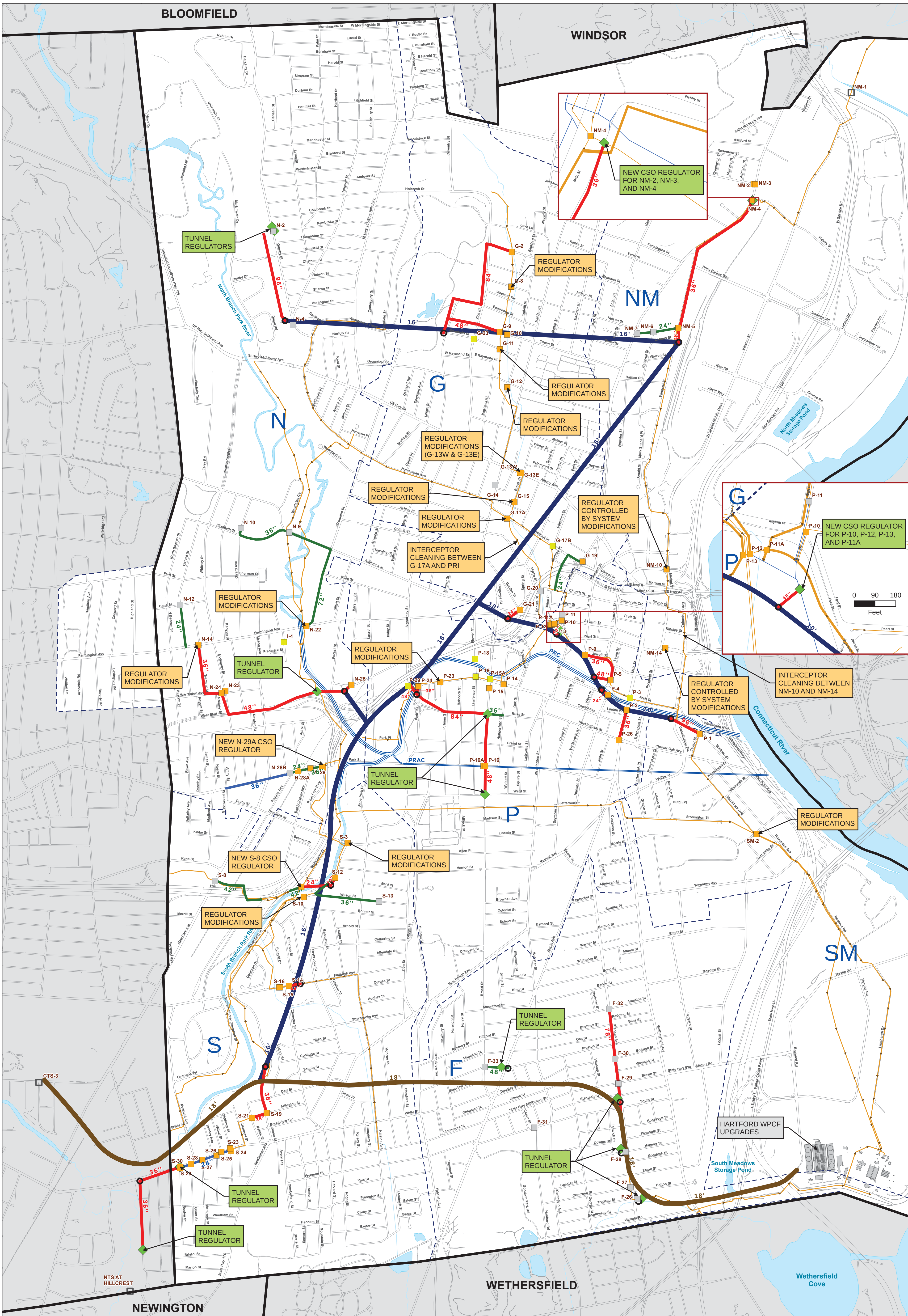

Legend

- NorthTunnel
- South Tunnel
- Consolidation Pipe
- New Combined Sewer
- New Drain
- Existing Interceptor
- Drop Shaft
- New Structure
- Drainage Area

Regulators

- CSO - Controlled to Design Storm
- CSO - Inactive in Design Storm
- CSO - Eliminated (Brick and Mortar)
- SSO

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Feet

The Metropolitan District
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Figure 11-1
Complete Elimination Alternative 1

Table 11-1
Hydraulic Comparison of CSO Regulators to Tunnel Regulators on Franklin Avenue

Location	Existing CSO Regulator Outlet Pipe Elevation *(ft, NAVD 88)*	Proposed Tunnel Regulator Outlet Pipe Elevation *(ft, NAVD 88)*	Existing CSO Regulator Outlet Pipe Size *(in)*	Proposed Tunnel Regulator Outlet Pipe Size *(in)*
Adelaide St[1]	36.6	31.6	48	66
Brown St/Standish St[2]	30.4	26.7	24	48
Hanmer St[3]	27.5	24.1	12	48
Tredeau St[4]	28.0	23.6	24	48

1. Existing CSO regulator F-32
2. Existing CSO regulator F-29 is at Brown St; new tunnel regulator will be at Standish St
3. Existing CSO regulator F-28
4. Existing CSO regulator F-26

11.3.2 Alternative 2 – 78 MG Tunnel with a Dewatering Pump Station to the Connecticut River

Overview

Alternative 2 considered a tunnel sized to capture CSOs up to the 1-year design storm for the entire combined sewer system. This alternative included physically sealing the Franklin Avenue and Granby Street area CSOs and directing all wet weather flow into the tunnel system. For storm events greater than the 1-year design storm, wet weather flow from the Franklin Avenue and Granby Street areas exceeding the 1-year storm storage capacity of the tunnel discharges into the Connecticut River via a new pump station, tunnel/force main, and CSO outfall. The dewatering pump station converts the tunnel from a storage tunnel into a partial conveyance tunnel for storms with an ARI greater than 1-year.

The minimum volume of the tunnel to capture the 1-year design storm is approximately 60 MG. However, the tunnel system needs to be sized to convey the peak flows from Franklin Avenue and Granby Street areas in all storms greater than 1-year. The South Tunnel final design engineer (FDE) evaluated surge in a technical memorandum dated February 17, 2014 and determined that small diameter tunnels would result in hydraulic surge issues when capturing/conveying intense rain events. To avoid surge associated with small diameter tunnels, this alternative assumes the South and North Tunnels are 16-foot in diameter; thus, the total tunnel volume is approximately 78 MG. If this alternative is determined to be financially superior, detailed hydraulic analysis would be required to determine the optimal tunnel diameters to capture and convey the large storm events from the Franklin Avenue and Granby Street areas.

See Figure 11-2 for the system improvements required under Alternative 2.

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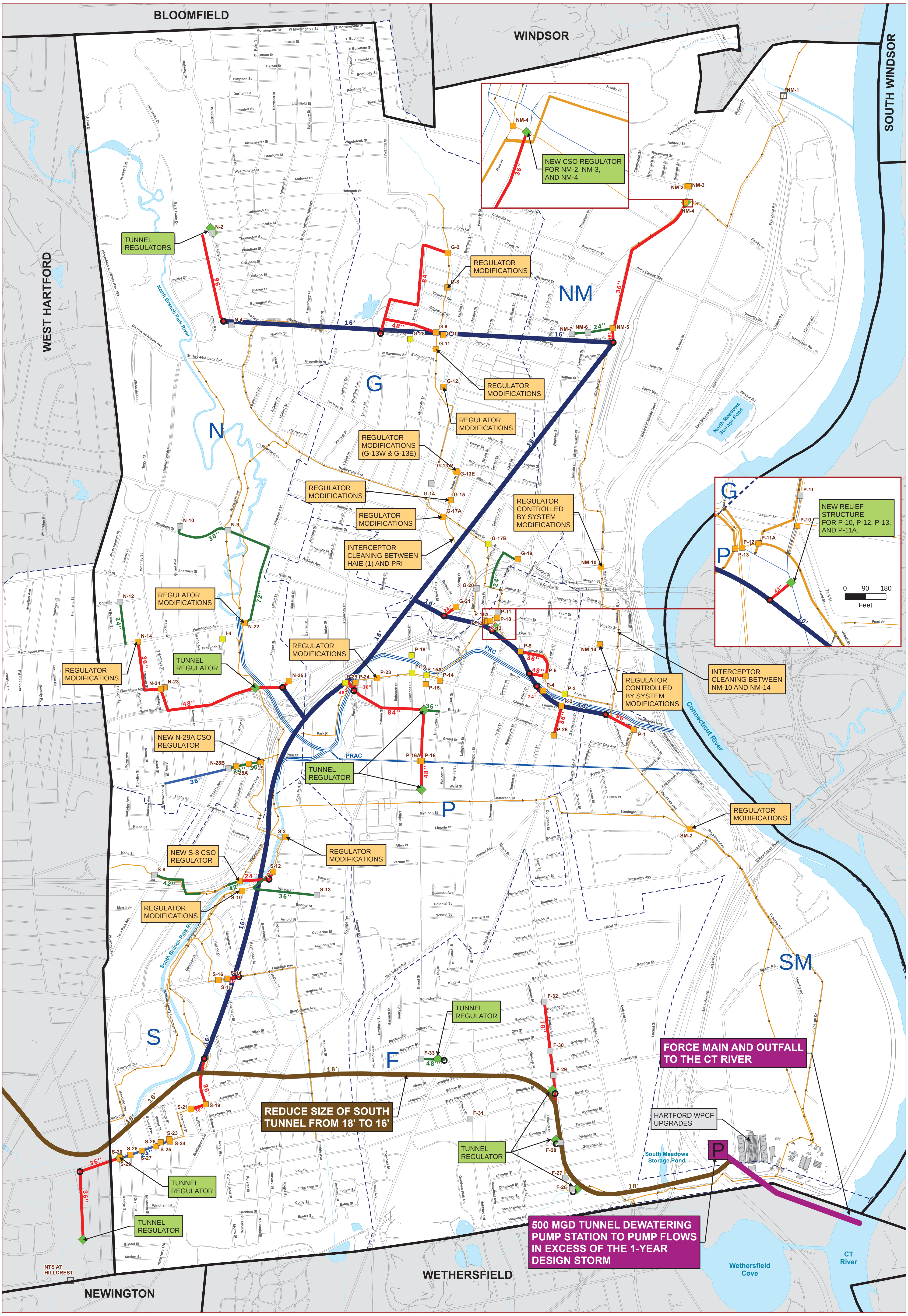

Legend

- North Tunnel
- South Tunnel
- Consolidation Pipe
- New Combined Sewer
- New Drain
- Existing Interceptor
- Drop Shaft
- New Structure
- Drainage Area

Regulators

- CSO - Controlled to Design Storm
- CSO - Inactive in Design Storm
- CSO - Eliminated (Brick and Mortar)
- SSO

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Feet

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Hartford, CT
2012 LTCP Update

Figure 11-2
Complete Elimination Alternative 2

Dewatering Pump Station

The largest peak flow from the Franklin Avenue and Granby Street areas in the period evaluated (1920 to present) requires an approximately 500 MGD pump station to relieve the tunnel of flows in excess of 1-year. The estimated construction cost for the pump station, excluding engineering and contingency, is approximately $170M. The EPA Cost Curves in Appendix A and the South Tunnel design cost estimate, which takes into account the additional construction costs for construction a pump station in conjunction with a deep rock tunnel, provided the basis for the cost estimate.

Tunnel and Force Main

Alternative 2 requires a tunnel/force main from the new pump station (at the downstream end of the tunnel system) to the HWPCF. The tunnel would likely be installed with a tunnel boring machine and would require construction under two highways and the U.S. Army Corp of Engineers flood protection dike. The estimated cost for the tunnel and force main, excluding engineering and contingency, is approximately $50M. The South Tunnel design cost estimate provided the basis for the cost estimate.

Tunnel Volume Reduction

Alternative 2 includes reducing the tunnel volume from 87 MG to 78 MG for a total volume reduction of approximately 9 MG. Using the incremental storage cost from Section 10 ($4.5/gal, excluding engineering and contingency), Alternative 2 includes a $40.5 million decrease in tunnel storage costs.

Summary

Alternative 2 meets the technical criteria of not creating worse hydraulic conditions; however, it requires an additional $179 million in construction costs to achieve complete elimination. Table 11-2 summarizes the additional complete elimination costs discussed above.

Table 11-2

Complete Elimination Alternative 2 Additional Construction Costs

Item	Construction Cost
Dewatering Pump Station	$170M
Tunnel/Force Main	$50M
Reduction in Tunnel Size	($41M)
Total:	**$179M**

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11.3.3 Alternative 3 – 55 MG Tunnel with Complete Separation of Franklin Avenue and Granby Street Areas

Overview

Alternative 3 considered removing the Franklin Avenue and Granby Street areas from the tunnel system and completely separating the areas upstream of all CSOs that discharge to Wethersfield Cove and the North Branch Park River as an approach to completely eliminate the structural overflows in each area. Alternative 3 includes physically sealing the CSO regulators after separating the upstream areas.

See Figure 11-3 for the system improvements required under Alternative 3.

Additional Sewer Separation

The combined area upstream of the CSOs that discharge to the North Branch Park River is approximately 420 acres, excluding areas in current separation construction projects. Using the $400,000/acre cost calculated in Section 6, the estimated total remaining separation cost for the Granby Street area CSOs is approximately $170 million. The combined area upstream of the CSOs that discharge to Wethersfield Cove is approximately 600 acres, excluding areas in current separation construction projects. The total estimated separation cost for the Franklin Avenue area CSOs is approximately $240M.

Tunnel Volume Reduction and Removal of Consolidation Conduits

Separating the Franklin Avenue and Granby Street areas and removing them from the tunnel system reduces the minimum required tunnel system to approximately 50 MG. However, to achieve an acceptable tunnel sizes, Alternative 3 assumed a 14-foot diameter North and South Tunnel, which results in approximately 55 MG in storage volume (note: the North Tunnel length is shorter as it does not extend out to the Granby Street CSOs). Therefore, Alternative 3 includes reducing the tunnel volume from 87 MG to approximately 55 MG for a total volume reduction of approximately 32 MG. At $4.5 per gallon, this results in a $144 million decrease in construction cost.

Removing the Granby Street and Franklin Avenue CSO regulators from the tunnel system also results in the removal of the associated consolidation conduits. Removing the Granby Street consolidation conduit for N-2 provides an $11 million credit and removing the Franklin Avenue area consolidation conduits provides a $29 million credit.

Summary

In total, Alternative 3 costs an additional $226 million (see Table 11-3); however, it is not guaranteed to meet the complete elimination criteria. The difficulties (as discussed in Section 6) associated with removing all public and private infiltration and inflow (I/I) may result in not enough stormwater being removed from the sewer system. This has the potential to cause increased surcharging during some storm events.

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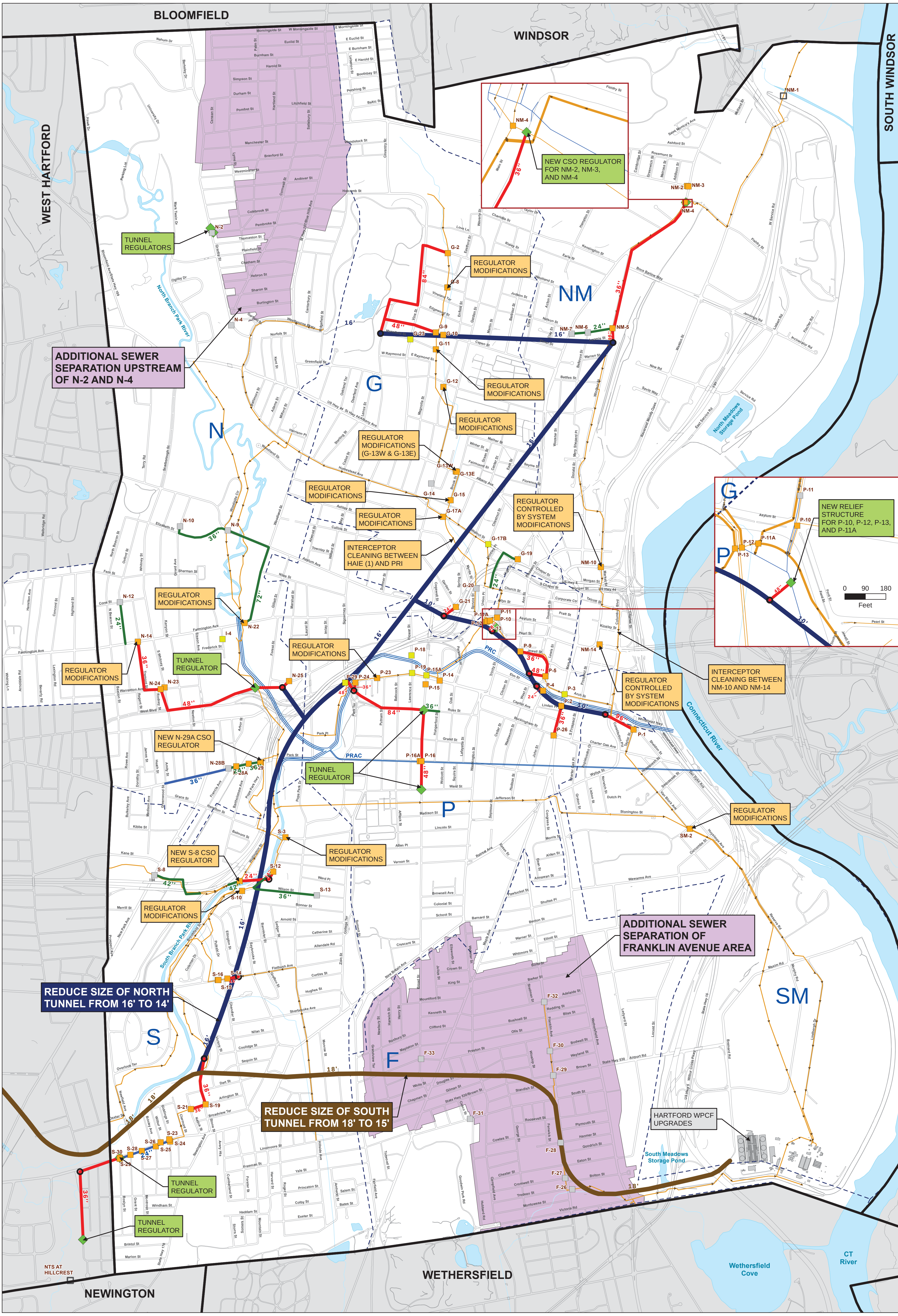

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Legend
- North Tunnel
- South Tunnel
- Consolidation Pipe
- New Combined Sewer
- New Drain
- Existing Interceptor
- Drop Shaft
- New Structure
- Drainage Area

Regulators
- CSO - Controlled to Design Storm
- CSO - Inactive in Design Storm
- CSO - Eliminated (Brick and Mortar)
- SSO

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Feet

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Figure 11-3
Complete Elimination Alternative 3

Table 11-3
Complete Elimination Alternative 3 Additional Costs

Item	Construction Cost
Separation of Granby Street Area	$170M
Separation of Franklin Avenue Area	$240M
Elimination of Granby Consolidation Conduit	($11M)
Elimination of Franklin Consolidation Conduit	($29M)
Reduction in Tunnel Size	($144M)
Total:	**$226M**

11.4 Summary and Recommended Complete Elimination Alternative

Based on the above alternatives analysis, the 87 MG tunnel in Section 10 accommodates complete elimination (i.e., brick and mortar) of the CSO regulators that discharge to the North Branch Park River and Wethersfield Cove. The plan improves hydraulic conditions in the collection system for most storms and does not worsen hydraulic conditions in reasonable extreme events in the Granby Street and Franklin Avenue areas. Using Tropical Storm Tammy, Figures 11-4 and 11-5 illustrate this hydraulic condition for Granby Street and Franklin Avenue, respectively. Each figure is a time series of the HGL elevation for three points along the respective street. The figures include the elevation of the crown of the pipe to show surcharging, 6-feet below the manhole rim to show times when there is a risk of sewer backups, and the rim elevation to identify the potential for street flooding. At all points in Granby Street, the 87 MG tunnel with complete elimination of the overflows to the North Branch Park River improves the hydraulic conditions as compared to conditions prior to the Clean Water Project. At all points on Franklin Avenue, the 87 MG tunnel with complete elimination of the overflows to Wethersfield Cove does not make hydraulic conditions worse as compared to conditions prior to the Clean Water Project (i.e., there is no additional risk of private property sewer backups).

In summary, Section 10 utilized an extreme representative historic storm for the purposes of comparing the costs of control alternatives. This section furthered that analysis by determining if the optimized tunnel from Section 10 can achieve the Consent Order requirements for complete elimination. An analysis of historical precipitation data and hydraulic simulations confirmed the 87 MG tunnel can accommodate physically closing the CSO regulators without creating worse hydraulic conditions in all historic storms excluding two major hurricanes since 1920.

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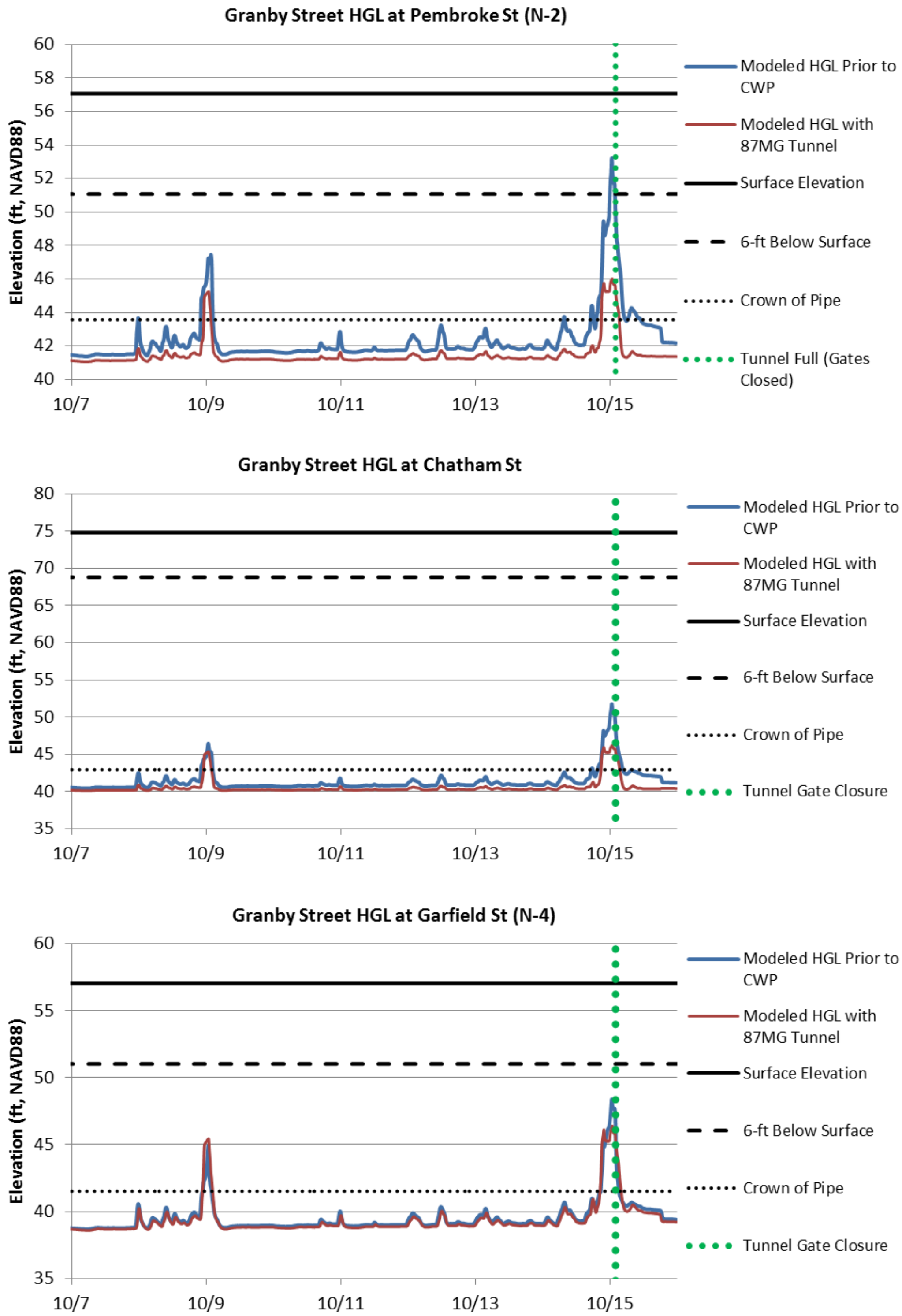

Figure 11-4: Time series of modeled hydraulic grade line elevations on Granby Street at Pembroke Street (top), Chatham Street (middle), and Garfield Street (bottom) during Tropical Storm Tammy in 2005.

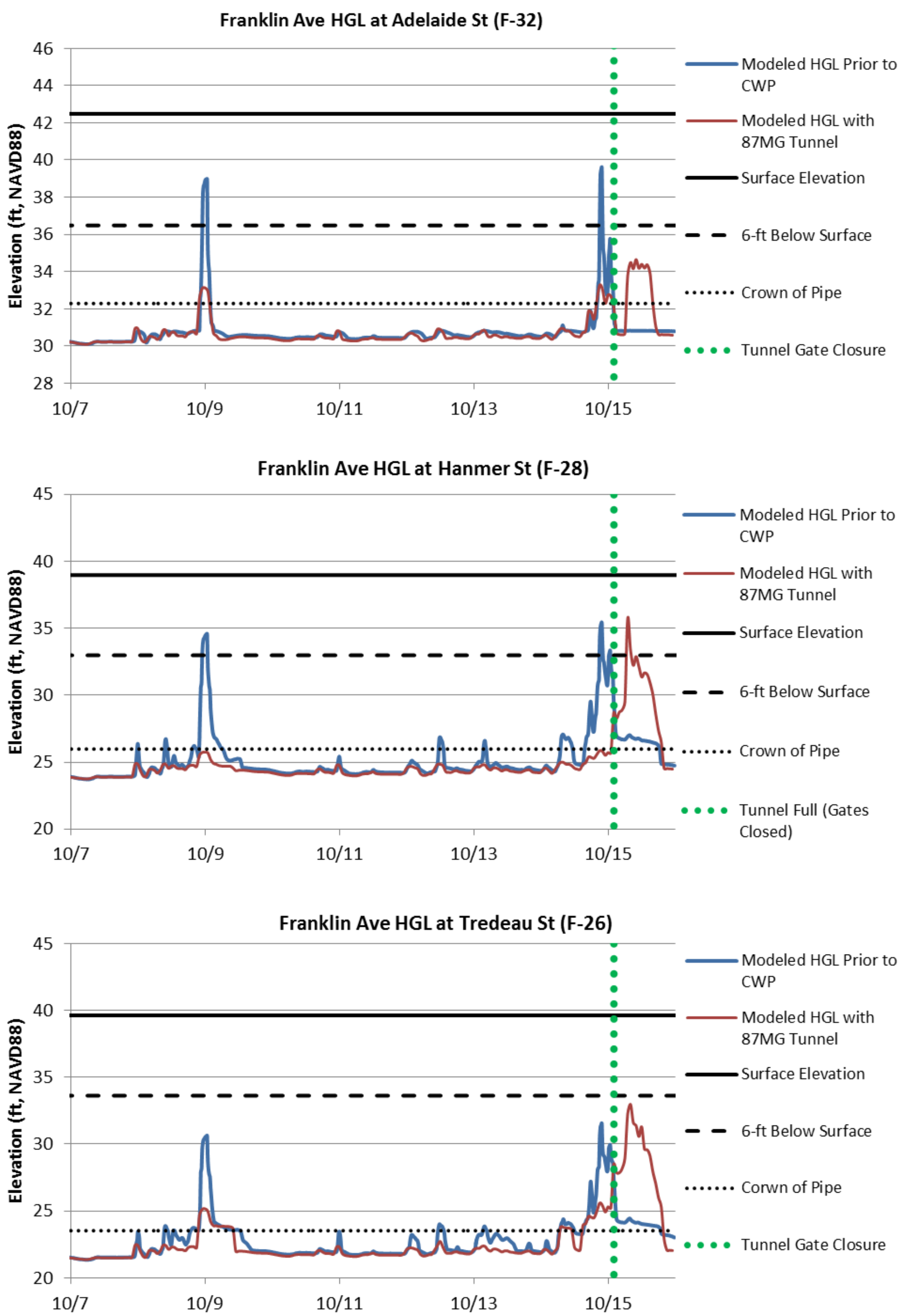

Figure 11-5: Time series of modeled hydraulic grade line elevations on Franklin Avenue at Adelaide Street (top), Hanmer Street (middle), and Tredeau Street (bottom) during Tropical Storm Tammy in 2005.

Section 12

Recommended Plan

12.1 Background

The Recommended Plan was developed based on the alternatives screening, development, and evaluation presented in Sections 6 through 11. The analysis relied on CSO characteristics generated by the 2009/2011 updated SWMM model and incorporated the current/ongoing District combined sewer system and HWPCF improvements (projects that will be completed or near completion by 2015).

The goal of the LTCP was also integrated with the goals of the ongoing SSO and CMOM programs, all of which are being driven by separate regulatory administrative and consent orders. The goal of the CSO control plan was to capture CSO regulator discharges resulting from wet weather events up to and including the 1-Year Design Storm for most of the overall service area. However, the existing CSO regulators that discharge to Wethersfield Cove and the North Branch Park River (CSO regulators in the Franklin Avenue area and N-2, N-4, N-9 and N-10) will be eliminated to meet the objectives of the Wethersfield Cove Study, State water quality classifications, and Consent Order requirements.

The recommended plan and the updated CWP costs and implementation schedule are discussed in this section.

12.2 Summary of Control Alternatives

Section 10 evaluated CSO control alternatives for individual groups of CSO regulators based on the drainage systems in Hartford. Table 12-1 summarizes the capital, operation and maintenance, and total life cycle costs for system-wide implementation of the control alternatives - sewer separation, satellite treatment, satellite storage, and tunnel storage - in each CSO area as discussed in Section 10. Table 12-2 further summarizes these costs with engineering (20 percent) and contingency (25 percent) by drainage area.

As shown in the tables, the least cost alternative for all CSO groupings and for system-wide implementation is utilizing tunnel storage.

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Table 12-1

Detailed Net Present Value of Control Alternatives (All $ in Millions)[1]

CSO Group	Design Storm Flow (MGD)	Design Storm Vol. (MG)	Typical Year Flow (MGD)	Typical Year Vol. (MG)	Sewer Separation Total Cost [2]
Franklin Avenue	210	35.9	198	72	$240
Southern South Branch Park River	43	3.0	48	34	$80
Middle South Branch Park River	25	4.0	28	48	$172
Northern South Branch Park River	22	1.0	28	3	$108
Downtown Park River	340	30.5	451	291	$270
Upstream Park River	112	6.4	137	42	$170
North Meadows	69	3.7	96	101	$120
Gully Brook	83	3.7	99	16	$320
Granby	215	10.9	71	5	$170
Farmington	151	8.0	133	27	$395
Park Street	37	2.1	47	12	$35
NET PRESENT VALUE					Total: $2,080
TOTAL PROJECT LIFE CYCLE COST WITH ENGINEERING AND CONTINGENCY (20% and 25% ON CAPITAL COSTS)					**$3,100**

CSO Group	Primary Treatment and Disinfection: Pumping [3]	Treatment [4]	Cons. Pipe [5]	Total Capital Cost	Annual O&M [6]	Total Life Cycle Cost [7]
Franklin Avenue	$90	$69	$38	$197	$2.14	$228
Southern South Branch Park River / Middle South Branch Park River / Northern South Branch Park River	$54	$38	$46	$138	$1.37	$158
Downtown Park River / Upstream Park River	$147	$108	$100	$355	$5.04	$428
North Meadows	$37	$34	$18	$89	$0.93	$103
Gully Brook	$52	$31	$22	$104	$1.32	$123
Granby	$91	$59	$10	$160	$1.06	$176
Farmington / Park Street	$84	$64	$50	$197	$2.00	$227
NET PRESENT VALUE					Total:	$1,442
TOTAL PROJECT LIFE CYCLE COST WITH ENGINEERING AND CONTINGENCY (20% and 25% ON CAPITAL COSTS)	**$2,100**					

CSO Group	High Rate Clarification and Disinfection: Pumping [3]	Treatment [8]	Cons. Pipe [5]	Total Capital Cost	Annual O&M [9]	Total Life Cycle Cost [7]
Franklin Avenue	$90	$103	$38	$231	$4.72	$299
Southern South Branch Park River / Middle South Branch Park River / Northern South Branch Park River	$54	$57	$46	$157	$3.14	$203
Downtown Park River / Upstream Park River	$147	$164	$100	$411	$10.00	$556
North Meadows	$37	$47	$18	$102	$2.19	$134
Gully Brook	$52	$49	$22	$123	$3.04	$167
Granby	$91	$93	$10	$195	$2.48	$230
Farmington / Park Street	$84	$95	$50	$229	$4.45	$293
NET PRESENT VALUE					Total:	$1,882
TOTAL PROJECT LIFE CYCLE COST WITH ENGINEERING AND CONTINGENCY (20% and 25% ON CAPITAL COSTS)	**$2,600**					

CSO Group	Satellite Storage: Pumping [3]	Storage [10]	Cons. Pipe [5]	Total Capital Cost	Annual O&M [11]	Annual O&M HWPCF [12]	Total Life Cycle Cost [7]
Franklin Avenue	$21	$290	$38	$349	$0.64	$0.03	$359
Southern South Branch Park River / Middle South Branch Park River / Northern South Branch Park River	$54	$84	$46	$184	$0.36	$0.04	$190
Downtown Park River / Upstream Park River	$147	$307	$100	$554	$1.94	$0.18	$584
North Meadows	$4	$29	$18	$50	$0.22	$0.02	$54
Gully Brook	$52	$44	$22	$118	$0.34	$0.01	$123
Granby	$10	$108	$10	$129	$0.26	$0.00	$133
Farmington / Park Street	$10	$102	$50	$161	$0.59	$0.02	$170
NET PRESENT VALUE						Total:	$1,612
TOTAL PROJECT LIFE CYCLE COST WITH ENGINEERING AND CONTINGENCY (20% and 25% ON CAPITAL COSTS)	**$2,400**						

CSO Group	Tunnel Storage: Tunnel Storage [13]	New Pipe & Tunnel Features [14]	Total Capital Cost	Annual O&M Tunnel System [15]	Annual O&M HWPCF [12]	Total Life Cycle Cost [7]
Franklin Avenue	$162	$29	$191	$0.14	$0.03	$194
Southern South Branch Park River	$14	$14	$28	$0.07	$0.02	$29
Middle South Branch Park River	$18	$6	$24	$0.09	$0.02	$26
Northern South Branch Park River	$5	$19	$24	$0.01	$0.002	$24
Downtown Park River	$137	$57	$194	$0.56	$0.14	$204
Upstream Park River	$29	$25	$54	$0.08	$0.02	$55
North Meadows	$17	$29	$46	$0.20	$0.05	$50
Gully Brook	$17	$28	$45	$0.03	$0.01	$46
Granby	$49	$11	$60	$0.01	$0.002	$60
Farmington	$36	$55	$91	$0.05	$0.01	$92
Park Street	$9	$6	$15	$0.02	$0.01	$15
NET PRESENT VALUE					Total:	$795
TOTAL PROJECT LIFE CYCLE COST WITH ENGINEERING AND CONTINGENCY (20% and 25% ON CAPITAL COSTS)	**$1,200**					

Notes:

1. This table was developed to show the probable costs for the use of a single technology/strategy approach (i.e., all primary treatment, high-rate clarification, etc.) system-wide to reduce CSO discharges in the District system for comparative purposes. Typically, the least cost technology/approach is selected for each CSO regulator individually or for consolidated groups of CSO regulators. In the District system, a least cost technology selection approach would favor the use of a tunnel storage system. It is important to note that the table was developed as a preliminary comparative tool to address questions raised by various parties. In some cases, the technology approach is not feasible (for example, the discharge of treated CSO flow into the North Branch Park River from a N2/N4 consolidated treatment facility) or practical (for example, there is no place for discharge from the Gully Brook CSO consolidated facility unless a new outfall was constructed to the Connecticut River or Park River Conduit).Text in RED indicates alternatives that are not feasible or practical. Accordingly, with the exception of the of the Satellite Storage or Tunnel Storage approaches, the system-wide alternative approach shown herein would not meet the Consent Decree objectives.

2) Sewer separation costs are estimated based on area. Cost per acre ($400,000) was determined from previous District bids; see Section 6 for details. Sewer separation O&M costs were not included since the additional O&M for the new pipes would be insignificant and the capital costs alone make the alternative not cost-effective.

3) Pumping costs are based on EPA Curves using peak design storm flow; see Figure A-1 in Appendix A. (Note: North Meadows, Granby, and Park Street allow for lower pumping costs by pumping the design storm volume back into the system over a two day period)

4) Primary treatment costs based on EPA Curves using peak design storm flow; see Figure A-2 in Appendix A. Costs of outfall are included in the treatment costs.

5) Consolidation pipe costs for satellite treatment and storage options are detailed in Table A-1 in Appendix A.

6) Annual O&M of primary treatment is based on EPA Curve using Typical Year volume; see Figure A-5 in Appendix A.

7) Life cycle cost is the net present value based on a 20-year life cycle. Tables A-3, A-4, A-5, and A-6 detail the 20-year life-cycle cost for satellite treatment, primary treatment and disinfection, high rate clarification and disinfection, and tunnel storage, respectively.

8) Treatment for high rate clarification is based on past installation quotes gathered from Actiflo for various flow rates and other CSO facility planning reports using design storm flow; see Figure A-3 in Appendix A. Costs of outfall are included in the treatment costs.

9) Annual O&M of high rate clarification and disinfection is based on EPA Curve using Typical Year volume; see Figure A-5 in Appendix A.

10) Satellite storage costs are based on EPA Curves using design storm flow; see Figure A-4 in Appendix A.

11) Annual O&M of satellite storage is based on EPA Curves using Typical Year volume; see Figure A-5 in Appendix A.

12) Annual O&M at the HWPCF associated with storage control alternatives (satellite and tunnel) is based on actual 2011 expenditures at HWPCF; see Appendix A for more details.

13) Incremental tunnel storage is based on $4.50/gal based on AECOM's 30% design estimate of the South Tunnel.

14) New pipes (consolidation and new combined sewers) and associated tunnel component costs are detailed in Table A-2.

15) The ratio of contributing Typical Year flow from the CSO Group to the total Typical Year flow determined the portion of the annualized cost for the tunnel maintenance assigned to each CSO group.

Table 12-2

Summary of Net Present Value of Control Alternatives[1]

Approximate Drainage Area[2]	Sewer Separation	Primary Treatment and Disinfection	High Rate Clarification and Disinfection	Satellite Storage	Tunnel Storage
Franklin Avenue	$360	$327	$415	$533	$289
South Branch Park River	$540	$226	$281	$282	$117
Park River	$660	$605	$761	$861	$384
North Meadows	$180	$147	$185	$79	$73
Gully Brook	$480	$175	$228	$182	$68
North Branch Park River	$900	$581	$735	$447	$250
Total Cost	**$3,100**	**$2,100**	**$2,600**	**$2,400**	**$1,200**

Notes:

1) Table 12-2 is a summary of Table 12-1; all 12-1 notes apply.

2) Some regulators are grouped outside of their geographic drainage area. For example, SM-2 is included in the Park River group, thus there is no South Meadows drainage area listed.

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12.3 Recommended Long Term Control Plan Components

Figure 12-1 illustrates the components of the recommended plan. The detailed structural components of this plan are discussed in Sections 10 and 11. The components of the recommended plan included (by project type):

General

- Sediment removal along the upper Connecticut River Interceptor upstream of I-84 and along Gully Brook Interceptor to help control NM 10 and NM-14 and the Gully Brook CSO regulators to the 1-Year Design Storm;

- Continued implementation of the 2007 Interceptor Cleaning Plan to make full use of existing interceptor pipeline capacity;

- Continued implementation of the general sewer cleaning program; the District has experienced a significant decline in system problems that are directly associated with the implementation of this program;

Wet Weather Treatment Capacity

- HWPCF improvements including a new 200 mgd influent pump station, new screenings and grit removal facilities (200 mgd), and a new 110 mgd wet weather treatment process (enhanced primary treatment), chemical storage and disinfection facilities, and combined effluent pumping station);

Sewer Rehabilitation

- Achievement of the 10 percent I/I reduction goal in the separated District communities that border Hartford; this will be accomplished by the continued implementation of the SSES and CMOM programs;

Tunnel Storage System and Conveyance

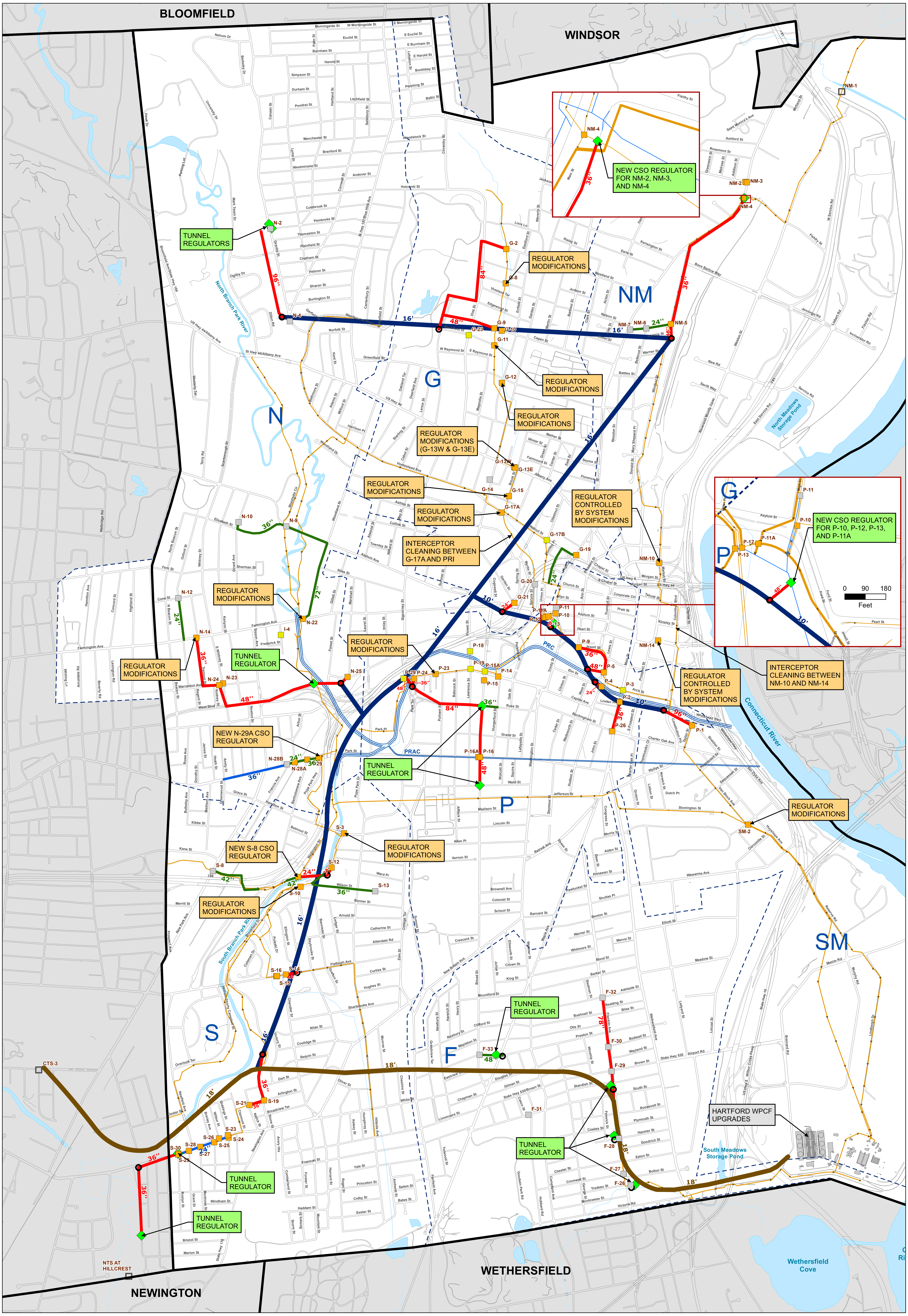
- A 87 MG deep rock tunnel storage system including a new dewatering pump station, connecting drop shafts, and odor control; see Table 12-3.

Table 12-3

Tunnel Storage System Components

Tunnel	Start	End	Diameter (ft)	Length (LF)	Storage (MG)
South Tunnel	HWPCF	West Hartford	18	21,800	41.5
North Tunnel	Brookfield St	Loomis St	16	20,900	31.0
Granby Spur Tunnel	Loomis Street	Granby St	16	9,700	14.5
Total				**52,400**	**87**

- A 5,600 foot long, 10-foot diameter shallow-rock Downtown Spur Tunnel from Asylum Street to Columbus Boulevard including drop shafts and odor control; the Downtown Spur Tunnel is conveyance only and not part of the tunnel storage system.



Legend

- NorthTunnel
- South Tunnel
- Consolidation Pipe
- New Combined Sewer
- New Drain
- Existing Interceptor
- Drop Shaft
- New Structure
- Drainage Area

Regulators

- CSO - Controlled to Design Storm
- CSO - Inactive in Design Storm
- CSO - Eliminated (Brick and Mortar)
- SSO

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Figure 12-1
Recommended Plan

New Pipes

- 9,800 feet of consolidation pipes ranging from 36 to 78 inches and associated CSO/SSO/Tunnel Regulators to connect three SSO Regulators (CTS-2, CTS-3, and NTS), CSO regulators in the South Branch Drainage area (CSO regulators S-19 through S-30), and elimination (via brick and mortar) of all CSO regulators in the Franklin Avenue area;
- 3,400 feet of micotunneled consolidation pipes (24-inch to 48-inch in diameter) to connect the Park River area CSO regulators to the Downtown Spur Tunnel, including new CSO/Tunnel Regulators, modifications to existing CSO regulators, and influent control gates and instrumentation (CSO regulators SM-2, P-2 through P-5, P-9 through P-13, and P-11A);
- 1,400 feet of 24-inch new combined sewer to convey flow from CSO G-19 to the HAIE;
- 3,900 feet of 42-inch and 36-inch new combined sewer and 1,200 feet of 24-inch and 48-inch of microtunneled consolidation pipe for the middle South Branch Park River CSO regulators, connecting drop shafts to the North Tunnel, new CSO/Tunnel Regulators, modifications to existing CSO Regulators, and influent control gates and instrumentation (CSO regulators S-14 through S-16, S-3, S-8, S-10, S-12, and S-13);
- 830 feet of new 24- and 36-inch combined sewer and 1,600 feet of new 36-inch drain along Park Street to control the Park Street area CSO regulators (N-28, N-28A, and N-29);
- 370 feet of 36-inch new combined sewer on Russ Street, 4,000 feet of 36-, 48-, and 84-inch microtunneled consolidation pipe along Russ Street and Broad Street, connection to tunnel shaft at Capital Avenue, new CSO/Tunnel Regulators, modifications to existing CSO regulators, and influent control gates and instrumentation (CSO regulators P-15, P-14 P-16, P-16A, P-23 and P-24);
- 1,000 feet of 24-inch new combined sewer along Oxford Street to eliminate CSO regulator N-12;
- 2,900 feet of 48-inch microtunnel consolidation pipe along West Boulevard and 2,500 feet of 36-inch diameter open-cut consolidation pipe, New North Branch Interceptor Relief Structure, connection to the Hawthorne Street North Tunnel shaft, CSO Regulator modifications, new CSO/Tunnel Regulators, and influent control gates and instrumentation to control Farmington Avenue area CSO regulators (N-14, N-23 through N-25);
- 1,400 feet of 36-inch (open-excavation) combined sewer and 3,100 feet of 72-inch diameter (microtunnelled) combined sewer along Elizabeth Street, Asylum Avenue, and Woodland Street, modifications to existing an existing CSO regulator, and a new Tunnel Regulator to the New North Branch Interceptor (NNBI) to eliminate a troublesome reach of the NNBI, eliminate CSO regulators N-9 and N-10, and control CSO N-22 to the 1 year event;
- 3,800 feet of 36-inch consolidation pipe, 350 feet of 48-inch consolidation pipe, and 1,000 feet of 24-inch new combined sewer, to eliminate CSO regulators NM-6 and NM-7 and convey the flow from all North Meadows CSOs (NM-2 through NM-7) to the North Tunnel;
- 3,500 feet of 84-inch (microtunnel) and 1,300 feet of 48-inch (open excavation) consolidation pipe in the northern Gully Brook area, connection to the Granby Spur Tunnel shaft at Keney

Park, CSO regulator modifications, and influent gate controls and instrumentation (CSO regulators G-2, G-8 through G-12 and G-23);

- 2,200 feet of 96-inch (microtunnel) consolidation pipe from CSO regulators N-2 to N-4, new Tunnel Regulators, connection to the Granby Spur Tunnel at the Granby Shaft, influent control gates and instrumentation to eliminate CSO N-2 and N-4 (permanently close via brick and mortar); and
- Miscellaneous CSO Regulator modifications to CSO regulators G-13W, G-17A, G-10, G-11, G-12, NM-10, NM-14, and P-15 to raise weirs or increase the CSO regulator Outlet Pipes to control CSO discharges to the 1-Year Design Storm.

12.4 Recommended Plan Flexibility

The District has developed this LTCP Update recognizing the importance of advancing the Clean Water Project while incorporating flexibility into the implementation plan. The plan was developed assuming that the South Tunnel could proceed to final design and construction and that there could be appropriate flexibility in the future North Tunnel project to account for potential changes that might be identified in the respective conceptual and preliminary design phases. As currently configured, the tunnel system will provide a minimum storage volume of 87 MG, which meets (and exceeds) the requirements of the Consent Order. The South Tunnel size includes a 48 percent reserve capacity, and therefore, the District does not foresee any circumstances in which the alignment or diameter of the South Tunnel would need to change as the North Tunnel preliminary design advances.

However, similar to the South Tunnel design approach to-date, the North Tunnel project requires a BODR and preliminary (approximately 30 percent) design to provide sufficient analysis of tunnel operation under normal and surcharged (large storm) events to determine the best location, length, diameter and volume of the tunnel. These early design phases will also evaluate hydraulic surge conditions (during filling of the tunnel system) and confirm the arrangement of tunnel control features to protect the tunnel infrastructure and meet the wet weather control objectives. It is anticipated that the BODR phase will commence in 2014 and the more refined recommended tunnel alignment and volume will be presented in the next LTCP Update, which will be submitted by December 31, 2017.

12.5 LTCP CSO Reduction/Benefits

The Recommended Plan (which includes system improvements already implemented since 2005) captures or eliminates CSO volume resulting from the 1-Year Design Storm, eliminates 12 CSO regulators for compliance with the Consent Order, and eliminates CSO discharges to Wethersfield Cove and the North Branch Park River (at a total cost of about $2.1 billion (FY 2012 dollars)).

The LTCP will reduce annual average CSO volume from the District's combined sewer system from almost 1 billion gallons per year in 2005 to zero, based on a typical year after all improvements are implemented. Annual average CSO discharges, which currently occur about 60 times per year, will be reduced to zero during a Typical Year.

In addition to these capital expenditures, O&M costs will be incurred to support the new facilities and to improve the performance of the CSS annual system maintenance programs, including the CMOM and Interceptor Cleaning Plan programs.

12.6 Post Construction Monitoring

The District's Overflow Alarm and Monitoring System currently monitors 83 of the 85 CSO regulators and all active SSO Regulators. The system consists of ultra-sonic depth sensors that record and transmit flow depth every five minutes. The District's SCADA system calculates the overflow volume based on the flow depth, the weir elevation, and type of weir in the CSO or SSO Regulator. The system alerts the District of active overflows and quantifies an approximate overflow rate and overflow volume.

G-13E (Gully Brook Area) and I-4 (North Branch Park River Area) are not part of the Overflow Alarm and Monitoring System. G-13E and G-13W regulate the upstream and downstream end of a siphon on the Gully Brook Interceptor that flows under the Gully Brook Conduit. G-13W overflows first, before G-13E, and is part of the overflow alarm system. G-13E provides additional relief under intense storm events. As shown in Section 4, G-13E is not active even in the 1-Year Design Storm.

I-4 regulates a small area upstream of the New North Branch Interceptor and is not active during the 1-Year Design Storm.

The District will evaluate the G-13E and I-4 CSO regulators to determine if the regulators are necessary or if they can be eliminated. If it is determined G-13E and I-4 are necessary to protect the system and properties against extreme events (larger than the 1-Year Design Storm), the District will evaluate ways to include them in the Overflow Alarm and Monitoring System.

As part of the South Tunnel Final Design, the District will evaluate the appropriate technology to monitor and operate the Tunnel Regulators and CSO regulators. The monitoring and operations approach selected for the South Tunnel Design will be applied to the North Tunnel area as well. The improved Overflow Alarm and Monitoring System will continue to operate after the completion of the Clean Water Project to guide in the operation of the tunnel storage system and assure the appropriate level of control is maintained.

12.7 Clean Water Project Costs and Schedule

Table 12-4 summarizes the current CWP costs for the total $2.1 billion program (2012 dollars). Approximately $800 million has been spent or is targeted to ongoing projects. A second referendum passed in November 2012 for an additional $800 million. The District will ultimately need another referendum to complete the Clean Water Project.

Figure 12-2 shows the implementation schedule for the proposed LTCP, SSO, and BNR projects. The LTCP improvements projects will end in 2026. The existing Consent Order, which has various milestone dates for the completion of projects and the elimination of the North Branch Park River and the Franklin Avenue area CSO regulators will be revised upon the adoption of the new schedule (and issuance of a compliance order by CTDEEP), which requires the completion of the system-wide tunnel systems prior to the completion of most of the connecting pipeline projects. The CWP project cost will continue to be re-evaluated as the projects move forward through final design, and as details of the SSO improvement projects are developed.

Table 12-4
Clean Water Project Estimated Costs

		Estimated Cost
CSO Program		
Sewer Separation Areas		
Franklin		$90,000,000
Tower		29,000,000
Granby		39,000,000
Upper Albany		53,000,000
Park River		11,000,000
Farmington		17,000,000
Consolidation Conduits		35,000,000
North Tunnel System, incl. Conduits, Interceptors and Sewers		565,000,000
South Tunnel, incl Conduits and Pump Station		500,000,000
HWPCF Improvements		489,000,000
Green Infrastructure		3,000,000
	CSO Total	$1,831,000,000
SSO Program		
General		
Sewer Rehabilitation		$128,000,000
Capacity Improvements		40,000,000
Rocky Hill WPCF		54,000,000
Consolidation Conduits to SHCST		5,000,000
	SSO Total	$227,000,000
Biological Nutrient Removal (BNR) Program		
Hartford WPCF		$42,000,000
Rocky Hill WPCF (included above)		
	BNR Total	$42,000,000
	Grand Total	**$2,100,000,000**

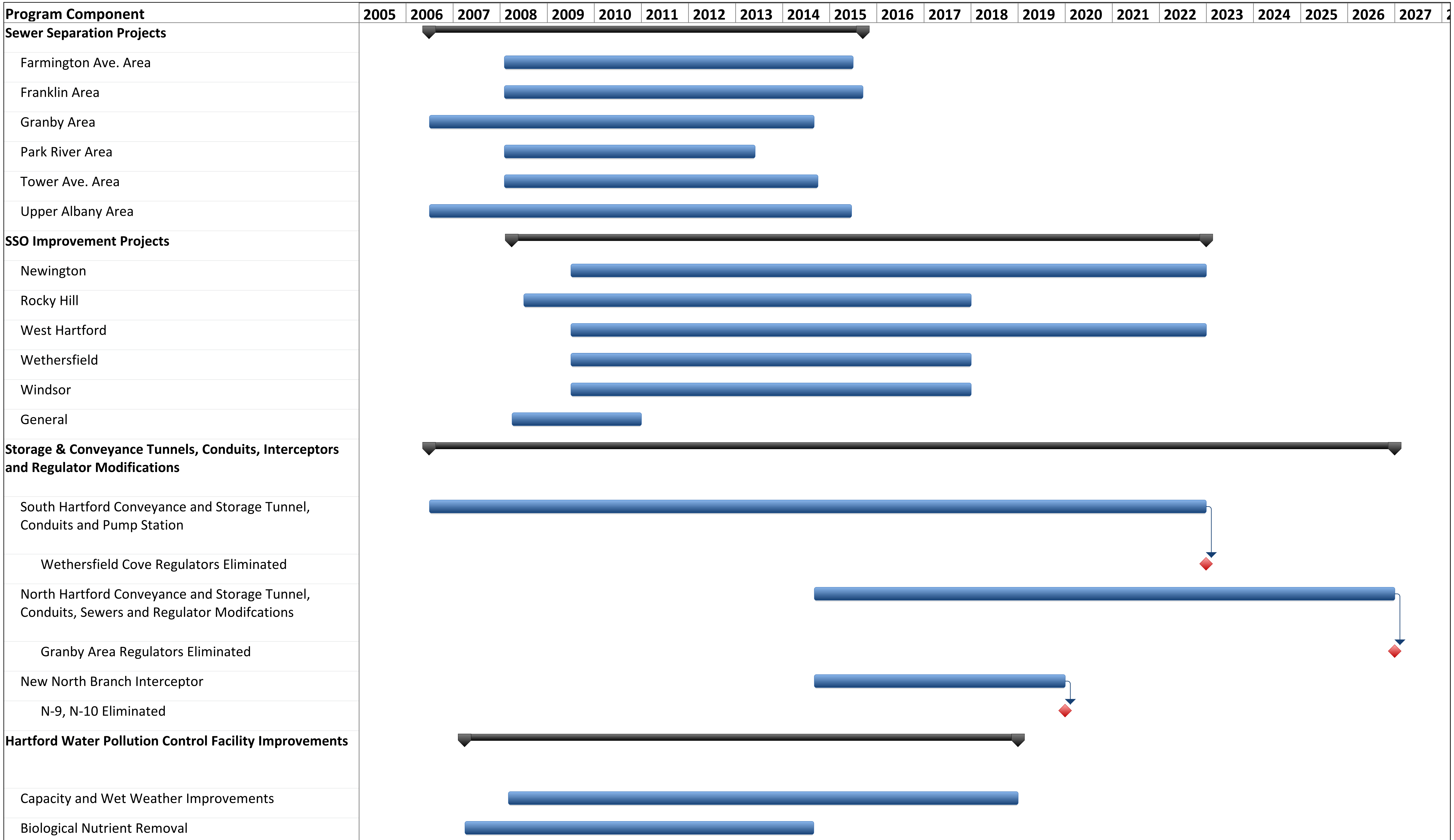

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Figure 12-2
CWP Schedule

Appendix A

Cost Backup Information

This Appendix includes backup information on the development of the costs in the "Alternatives Summary Table". Information on data sources and assumptions appear below, and capital cost curves utilized for the summary table are attached.

Capital Costs

Costs for sewer separation projects were based on a figure of $320,000/acre and $400,000/acre for 60 percent and 80 percent separation respectively. These two figures were included in Section 6.3 of the 2012 LTCP Update. They are primarily based on the costs to date for sewer separation projects in Hartford, including private I/I removal.

The estimated incremental cost of tunnel storage was $3/gallon, based on a comparison of tunnel costs for various diameter and length. This cost was used for initial screening of subbasin alternatives. The cost of the final recommended plan included an estimate for the proposed length and volume of the tunnel based on the results of the subbasin alternatives analysis.

Costs for the following items were based in part on the attached capital cost curves:

- Pumping stations;
- Primary treatment facilities, which included screening, sedimentation, and disinfection;
- High-rate clarification and disinfection; and
- Storage facilities.

These construction costs are based on the 1993 U.S. Environmental Protection Agency (EPA) guidance cost manual *Combined Sewer Overflows Control* and other bid/constructed project costs obtained from similar projects in the country. EPA does not have costs for high-rate clarification (HRC). Capital costs for HRC were estimated based on past installation that included screening and disinfection, quotes gathered from Actiflo for various flow rates, and other CSO facilities planning reports. To arrive at the construction cost for each of the facilities options, the costs for each treatment process were added together to obtain a total cost for each option.

These facility construction costs have been adjusted for an ENR escalation rate suitable to the Hartford metropolitan area including construction constraints in a heavily urbanized area and the stringent soils replacement requirements for projects in the city. These costs do not include engineering and contingencies, land acquisition, unstable subsurface conditions, rock excavation, soil remediation, and other unforeseen or unanticipated conditions.

Costs for pipeline projects were based on cost estimates generated by CDM Smith cost estimators from conceptual plan and profile drawings. These costs were summarized by length, pipe diameter and depth. Average costs per foot were calculated for pipes, based on size and average depth.

Pumping costs for satellite storage facilities were based on the assumption that the entire flow would be pumped instantaneously, for regulators with consolidation piping greater than 25 feet deep. For piping 25 feet deep or less, it was assumed the stored volume would be pumped over a 2-day period.

O&M Costs

O&M costs for primary treatment and disinfection, high-rate clarification and disinfection, and satellite storage were taken from curves on the attached cost curve sheet. In a similar manner to the capital costs, individual treatment process O&M costs and pumping costs were added to generate the total O&M cost curve for each facility alternative.

Pumping, disinfection, high-rate clarification, and sedimentation costs are based on adjusted EPA O&M cost curves. The EPA pumping cost information was from the labor and material cost from the EPA *Innovative and Alternative Technology Assessment Manual*. The EPA disinfection and HRC costs were from the 1993 USEPA report *Combined Sewer Overflow Control*.

O&M costs for screening and storage were estimated based on an adaptation of the budget-developing approach presented in the WEFTEC 2007 paper, "Budget Development for Operations/Maintenance Requirements for CSO/SSO Control Facilities". For this approach we used a labor cost of $50/hr for facility operator, and annual-event hours for each grouping were given by the system model.

The tunnel O&M and tunnel pumping station O&M were summed into a single column. These costs were derived as follows:

- For O&M costs for the North Tunnel system, O&M cost estimates were prepared by HMM for the North Tunnel system. They were as follows:

  - Tunnel inspection, $455,000, once per decade
  - Tunnel sediment cleaning, $400,000, once per decade
  - Microtunnel inspection, cleaning and repair: $44,000, annually
  - Odor control, $126,000, every three years

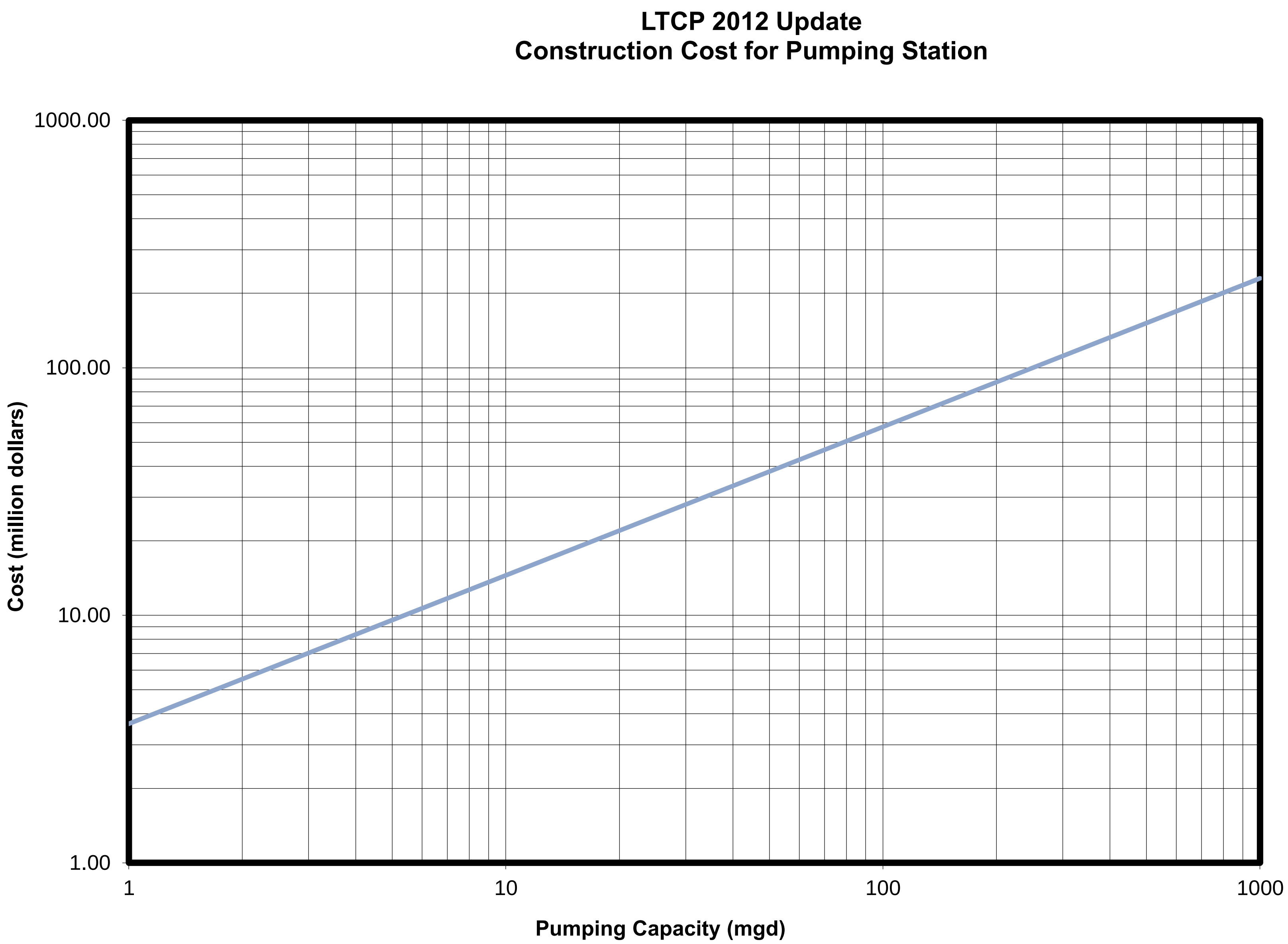
  On the summary table, these costs were apportioned to each CSO group that is tributary to the North Tunnel in a manner proportional to design storm peak flow.

- For tunnel pumping station O&M, the costs were based primarily on a detailed annual O&M cost assessment for the Cavern Pump Station presented in a Technical Memorandum titled "South Hartford Conveyance and Storage Tunnel -- Life Cycle Cost Comparison: Submersible Pump Station and Dry-Pit Cavern Station", dated June 4, 2013, and prepared by AECOM in association with Black & Veatch. In that Technical Memorandum, the annual O&M cost was $0.72 million, for a 40 MGD pump station which will process 815 MG in a typical year. Expressing the O&M cost on a cost-per-MG basis, we have $883/MG. The typical annual flows for each CSO group are listed on the Alternatives Summary Table. Those flows were multiplied by $883/MG to obtain the listed annual O&M costs for the Tunnel Pumping Station.

To determine the annual O&M cost associated with treating the tunnel flow at the Hartford WPCF, we reviewed the actual 2011 WPCF expenditures as presented in the 2013 budget. The total cost presented therein was $11.77 million, to treat 24.255 billion gallons. We then excluded certain costs that are not flow-dependent, such as clothing, office supplies, custodial services, and more, to derive an adjusted total of $11.37 million. Dividing that value by the annual flow, the resulting cost was $470/MG. This unit cost was utilized along with the typical annual flows for each CSO group to derive the WPCF O&M values listed in the Alternatives Summary Table.

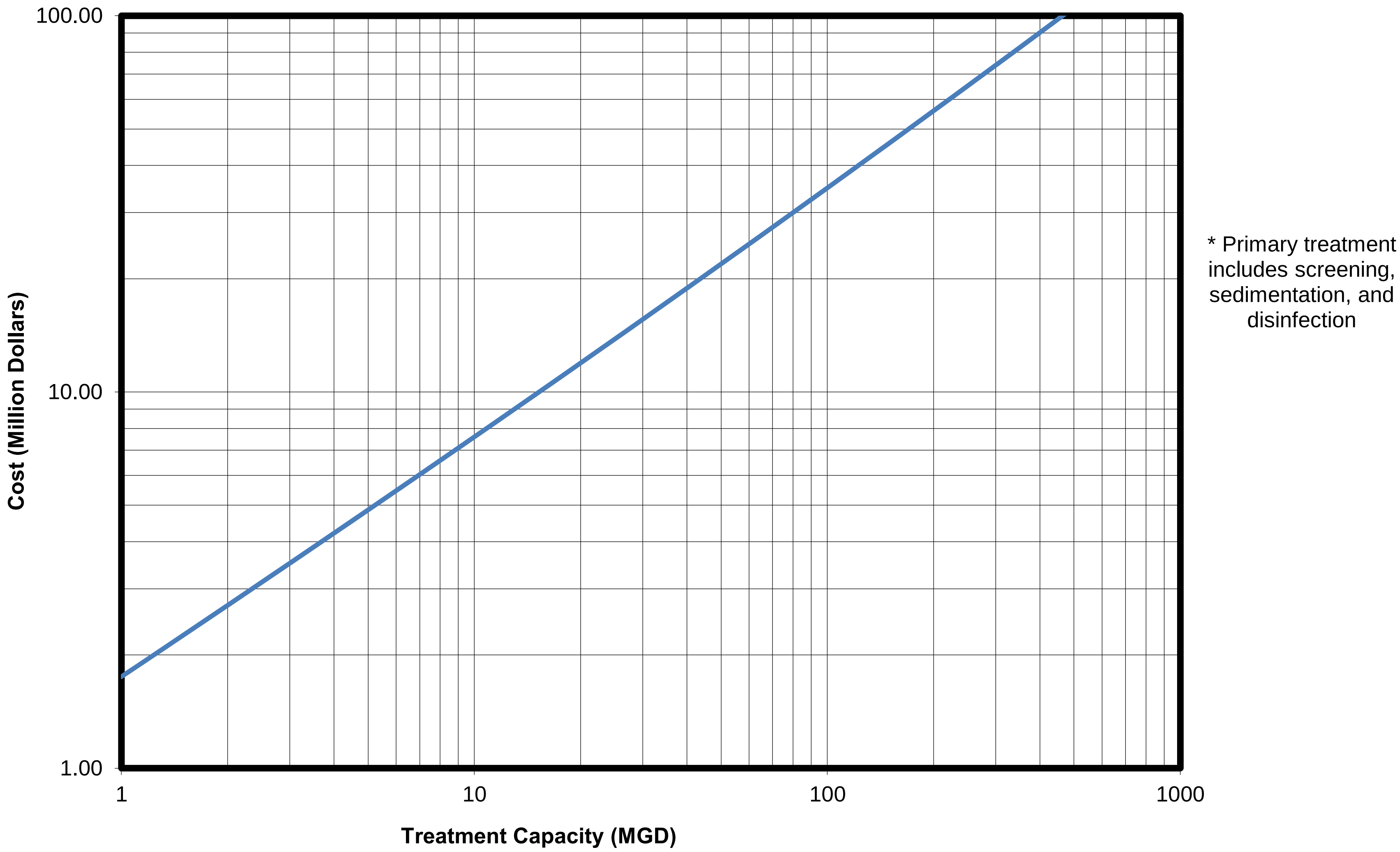
Life Cycle Costs

"Life Cycle Costs" as defined herein are the sum of the capital costs and the net present value of the annual O&M costs. For calculating the net present value, a discount rate of 3.25% over 20 years was utilized. The discount rate was selected for consistency with the above-referenced AECOM Technical Memorandum.



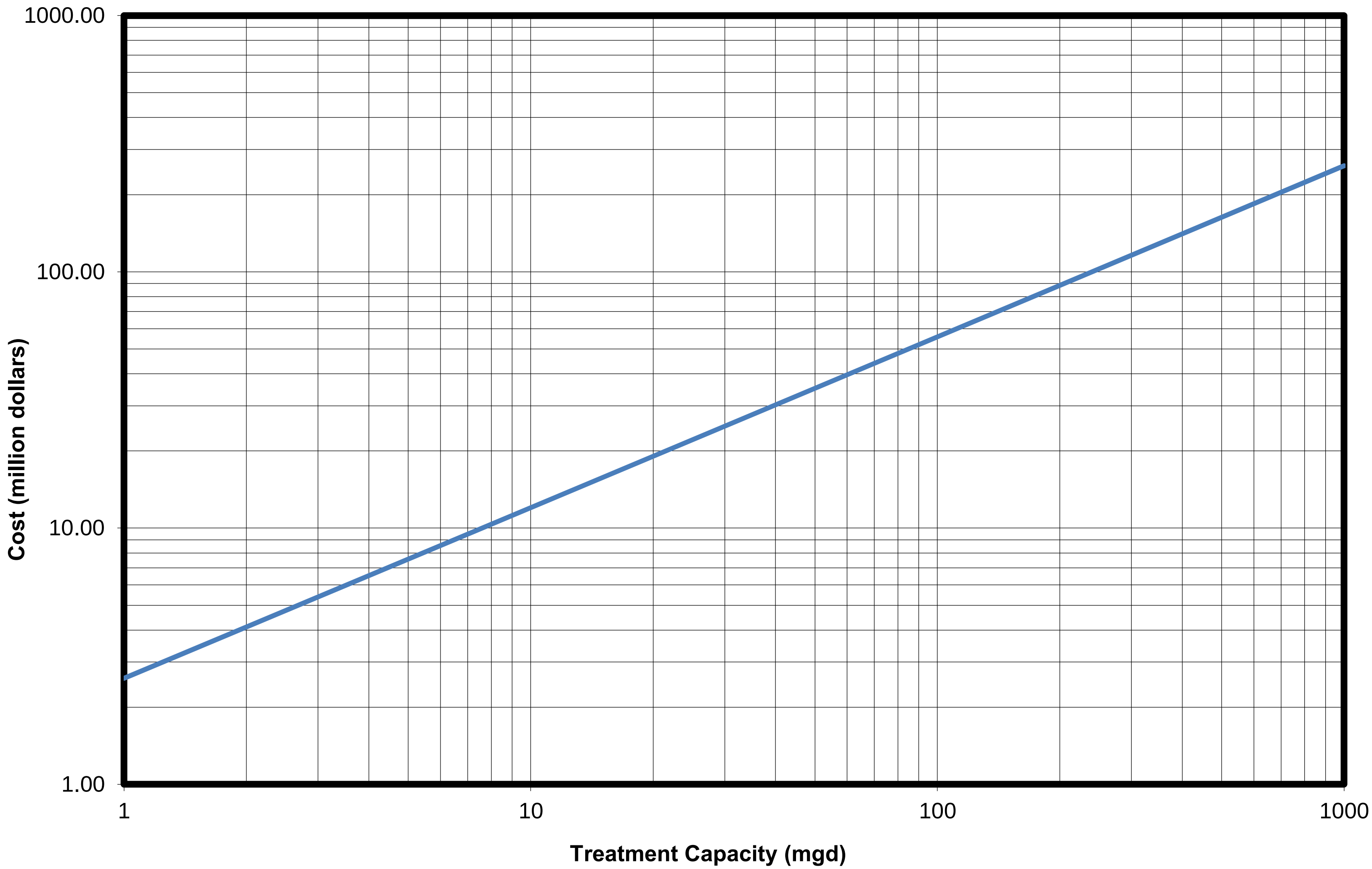
Based on modified U.S. Environmental Protection Agency guidance cost manuals cost curves.

LTCP 2012 Update
Construction Costs for Primary Treatment Facilities



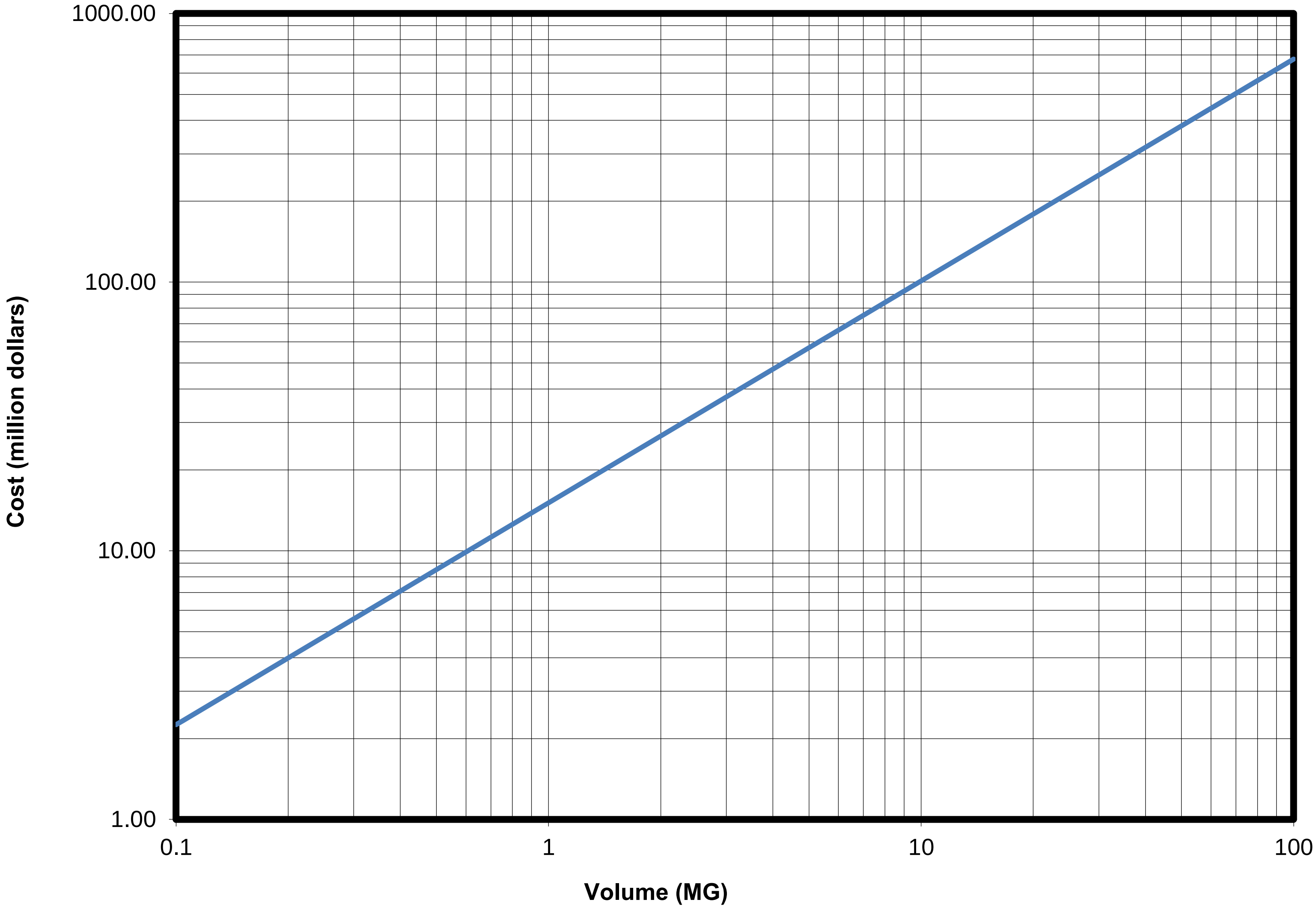
Based on modified U.S. Environmental Protection Agency guidance cost manuals cost curves.

LTCP 2012 Update
Construction Cost of HRC and Disinfection Facility

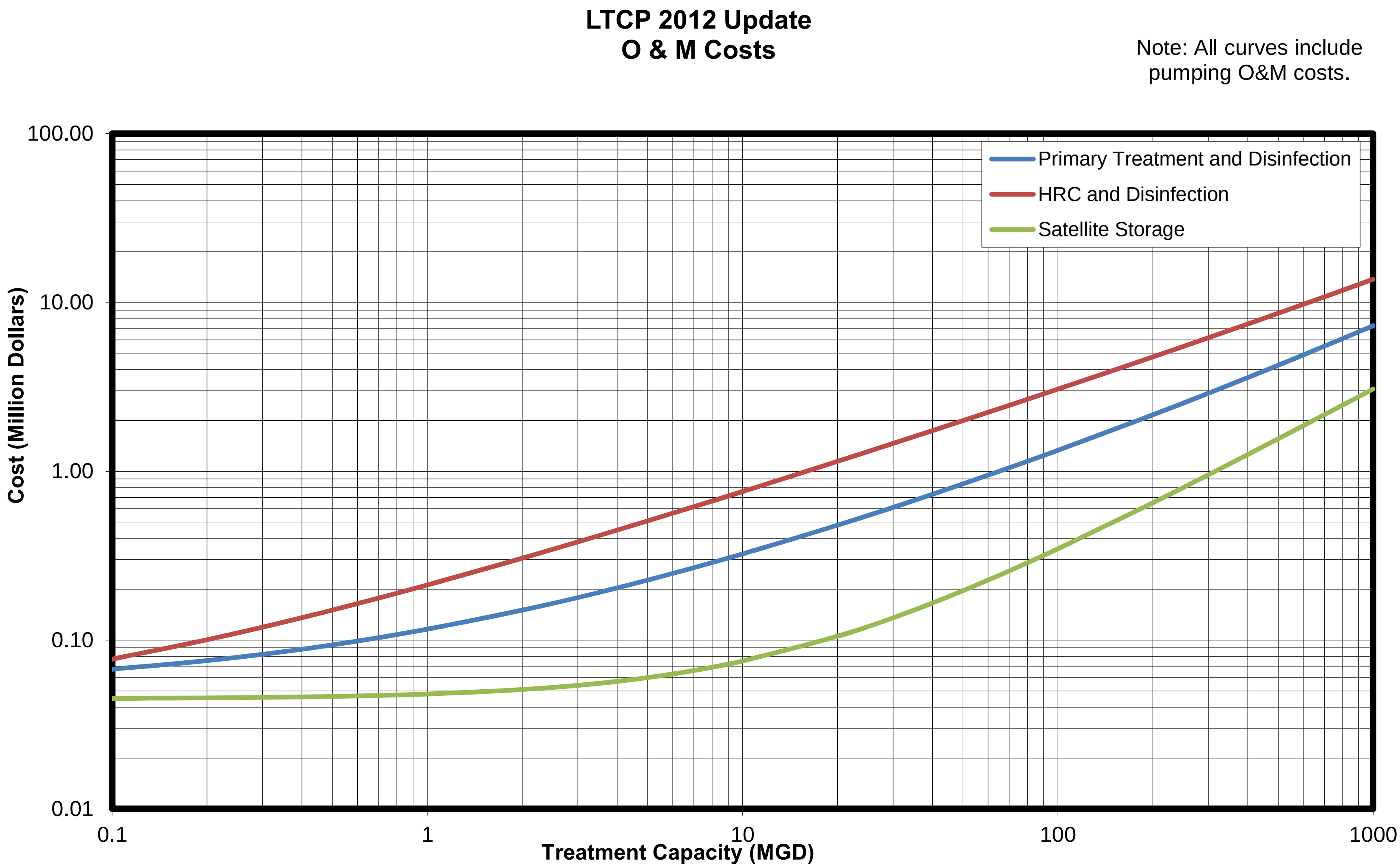


Based on past installations quotes gathered from Actiflo for various flow rates, and other CSO facilities planning report.

LTCP 2012 Update
Construction Cost of Storage Facility



Based on modified U.S. Environmental Protection Agency guidance cost manuals cost curves.



Based on modified U.S. Environmental Protection Agency cost curves.
Source: USEPA *Innovative and Alternative Technology Assessment Manual* and 1993 USEPA report *Combined Sewer Overflows Control*.

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