

Green City, Clean Waters

Facility Concept Plan For the Northeast Water Pollution Control Plant

**Consent Order & Agreement
Revision to Deliverable #IV - a**

City of Philadelphia Combined Sewer Overflow Long Term Control Plan Update

**Submitted to
The Commonwealth of Pennsylvania
Department of Environmental Protection**

By The Philadelphia Water Department

June 1, 2013

Revised December 31, 2013

1. Introduction

In August 2008, the Philadelphia Water Department entered into a Consent Order and Agreement (COA) with the Pennsylvania Department of Environmental Protection (PADEP) which specifies the process for development of an update to the Water Department's Long Term Control Plan commitments as originally included in National Pollutant Discharge Elimination System (NPDES) permit of 2007. On September 1, 2009, a Long Term Control Plan Update (LTCPU) was submitted to PADEP and on June 1, 2011, the Water Department entered into a COA with the PADEP which enforces the implementation of the LTCPU and its supplements. Pursuant to Paragraph 3.a.iv, pertaining to Compliance Requirement Deliverables, a Facility Concept Plan for each of the three Water Pollution Control Plants must be submitted within 24 months of the agreement date. Appendix G of the COA requires the Facility Concept Plans to describe the specific engineering and construction activities proposed to increase the maximum wet weather flow into each water pollution control plant facility and thereby increase the capture rate of combined sewage. The Facility Concept Plans will provide design and construction performance standards for the five-year, ten-year and fifteen-year milestone periods with the completion deadline at the end of a twenty year period.

The Water Department's implementation approach to the 2009 LTCPU has been developed to integrate the management of Philadelphia's watersheds into a larger context such that the program is designed to provide multiple benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to the public and the environment. In a similar approach, the Facility Concept Plans look beyond infrastructure improvements and consider modifications to facility operations as well as collection system optimization to address wet weather flow delivery to the treatment plants.

2. Goals of Facility Concept Plans

The stated goal and commitment of the *Green City, Clean Waters* program for combined sewer overflows (CSOs) is to reduce the water quality impact of CSOs on the receiving waters through: green stormwater infrastructure, stream corridor restoration and preservation, and wet weather treatment plant upgrades. The Facility Concept Plans provide details of the City's treatment plant upgrade strategy to achieve CSO reduction of approximately 1.75 billion gallons annually through:

- Wastewater plant capacity increases,
- Collector system modifications to increase wet weather capture and transmission of wet weather flows,
- Potential operational changes of the existing wastewater plants to ensure sustained treatment capacity,
- Continued study and investigation of strategies and technologies for implementation at the treatment plants to achieve CSO reductions.

All treatment plant and collector system modifications will be completed within the 20-year timeframe as stated in the LTCPU. The Facility Concept Plans represent the current best plans and approach for work to be performed by the Water Department necessary to meet CSO reductions. In addition, the Water Department is committed to continuing research and studying new technologies and improvements to the collection system and treatment plants to increase CSO capture and wet weather treatment. Additional projects may be constructed if studies conclusively show operational advantages.

This Facility Concept Plan is the basis for the development of a comprehensive Wet Weather Facility Plan, which will provide details including schedule, cost and anticipated performance for each project presented in this plan. The Wet Weather Facility Plan will be a document, revisited regularly to evaluate if regulations, technologies, community needs or other criteria require a change to the plan. This ensures the Water Department is responsive to the commitment to increase CSO capture in the drainage district and at the treatment plant in the years ahead.

3. NE WPCP Permit Modifications

As per Appendix G of the 2011 COA, the performance standards of the Facility Concept Plan will become permit requirements when incorporated into future versions of the NPDES permit for each treatment plant. Under the 2009 LTCPU, as described on page 10-52, the Water Department committed to the expansion of the Northeast Water Pollution Control Plant (NE WPCP) to include a 215 million gallon/day secondary treatment bypass. This bypass will allow for the treatment of additional wet weather flow, which will be reflected in future modifications to the NPDES permit as presented in Table 1:

Table 1: Current and Future NE WPCP Permitted Capacity

	2007-2012 NPDES Permit	Future (2031)
Facility Design Flow Rate (Q)	210 MGD	210 MGD
NPDES Maximum Daily Flow	315 MGD	315 MGD
NPDES Peak Instantaneous Flow	435 MGD	650 MGD

To treat the maximum flow rates delivered to the plant, several plant upgrades have been proposed and the planning process has been initiated.

4. Implementation Approach for NE WPCP Drainage District

The Water Department is taking a comprehensive approach to achieving increased wet weather capacity and reduced combined sewer overflow volume. The implementation approach includes construction projects within the NE WPCP, but also looks outside the boundaries of the facility to the collection system to achieve desired flow delivery to the plant. In addition, changes to operational strategies may assist with increasing wet weather flows through the treatment plants and those strategies may also be implemented.

The Water Department has prioritized analysis and planning activities on the NE WPCP drainage district because the improvements to this single district will allow the City to meet the majority of the city-wide wet weather targets that are derived from traditional infrastructure improvements (*i.e.* not derived from green stormwater infrastructure). As a result of the early work in the NE WPCP drainage district, some projects have already been completed and others are well underway and scheduled for implementation. The discussion which follows identifies which projects take place at the facility, in the collection system, or affect facility operations.

As part of the LTCPU, eleven improvements for plant modifications were considered for the NE WPCP to increase CSO capture through increased wet weather treatment capacity at the facility. These projects were presented in Table 8-2 of the LTCPU. Table 2 presents the LTCPU improvement options along with a status resulting from planning studies and analysis performed to date.

Table 2: Current status of LTCPU Improvement projects for the NE WPCP

2009 LTCPU Improvement	2009 LTCPU Improvement Description	2013 Improvement Project Status
1	Frankford Grit Chamber Bypass Replacement	Reopened existing bypass, in service as of 8/2012
2	Frankford High Level Second Barrel Rehabilitation	Design complete , construction bids opening on 5/16/2013
3	New Conduit from Diversion Chamber B to Preliminary Treatment Building	Replaced with new Preliminary Treatment Building (PTB)
4A/4B	Additional Pretreatment at NE/SE Side of PTB with Detritor grit removal technology	Modified to new PTB
5	New Conduit from PTB to Set-1 PSTs	Completed
6A/6B	New Conduit from PTB to Set-2 PSTs in conjunction with 4A/4B	Replaced with new PTB
7	Reactivate Bypass Conduit from Diversion B to Set-2 PSTs with New Bar Screen and Grit Removal	Replaced with new PTB
8	New Influent Baffles in Set-2 PSTs	Included with new PTB
9	Remove Double Deck Effluent Channel in FST Set-2	Completed
10A/10B	New Bypass Conduit from Set-1 PSTs to Plant Outfall with Disinfection Upstream/Downstream of Chlorine Contact Tank	Design completed , 10 A- bypass connects upstream of chlorine contact tank, construction bids to be advertised 7/2013
11	High Rate Treatment System	Replaced with bypass & PTB

Of the improvement projects listed above, LTCPU Improvement 5 (new conduit from Preliminary Treatment Building (PTB) to Set 1 Primary Sedimentation Tanks) and LTCPU Improvement 9 (removal of the double deck effluent channel in Final Sedimentation Tanks (FSTs) Set-2) have been completed. Instead of replacement of the bypass at the Frankford Grit Chamber (LTCPU Improvement 1), the existing bypass has been reopened and is in service as of August 2012. The Frankford High Level Second Barrel (78" Sewer) Rehabilitation (LTCPU Improvement 2) has been designed and construction bids opened on May 16, 2013. In lieu of additional pretreatment at the existing PTB (LTCPU Improvements 4a and 4B), a new PTB will be built upstream of the Set-2 Primary Sedimentation Tanks (PSTs). In conjunction with the new PTB, the Water Department will install new influent baffles in the Set-2 PSTs (LTCPU Improvement 8). The new PTB will make LTCPU Improvements 3, 6A/6B and 7 obsolete and, therefore are no longer under consideration. A new bypass conduit from the Set-1 PSTs to upstream of the Chlorine Contact tanks (LTCPU Improvement 10A) has been designed and construction bids will be advertised in July 2013. The new bypass and PTB will achieve a wet weather treatment capacity of 650 MGD; therefore, high rate treatment (LTCPU Improvement 11) has been rejected as an improvement option.

4.1 NE WPCP Facility Improvements

To increase CSO capture and peak wet weather flow by 215 MGD at the NE WPCP facility, the Water Department will implement a strategy that includes design and construction of a

secondary treatment bypass to divert up to 215 MGD during wet weather and the design of a new additional PTB. Other modifications to hydraulic bottlenecks in the system include new conduits to connect the existing PTB with the Set-1 PSTs and removing the double deck effluent channel in the FSTs Set-2.

4.1.1 Completed NE WPCP Facility Improvements

Hydraulic bottlenecks at the entrance to the Set 1 PSTs and the effluent of the Set 2 FSTs were causing restrictions to the flow into these treatment tanks. The Water Department completed the following projects to alleviate the bottleneck and improve flow through the plant:

In August 2012, four new conduits were constructed to connect the existing Preliminary Treatment Building with the Set-1 PSTs (LTCPU Improvement 5), which improved hydraulic capacity in the grit tanks during high flow conditions. This project involved the construction of four 48" diameter conduits between the PTB and the Set-1 PSTs. This upgrade, completed in conjunction with the Set-2 secondary clarifier effluent channel upgrades, allows for an incremental total plant flow increase of 15 MGD (total plant flow of 435 MGD) as required by the NPDES permit. Construction of this upgrade was completed in calendar 2012 and placed into service.

In December 2011, the Water Department removed the hydraulic restriction in the FSTs Set-2 double deck effluent channel (LTCPU Improvement 9). Under high flow conditions excessive headlosses caused weir flooding and a hydraulic imbalance between the two sets of final clarifiers. The head loss that occurred in the channels was alleviated by connecting the upper effluent channel directly to the effluent conduit. Removal of this bottleneck required the relocation of the return activated sludge line and the removal of a tank wall. This Improvement was completed in the calendar year 2011 and increased the hydraulic capacity of the secondary treatment system to 435 MGD.

4.1.2 Future NE WPCP Plant Improvements

Two new facilities will be constructed in the future to add to the wet weather treatment capacity of the NE WPCP. A new bypass conduit will allow for up to 215 MGD of wet weather flow to bypass secondary treatment during wet weather events. A new PTB will increase the amount of flow that can be received from the Frankford High Level Interceptor. These projects are described in detail below:

New Bypass Conduit from Set-1 Primary Sedimentation Tanks to Plant Outfall with Disinfection Upstream of Chlorine Contact Tanks

The Water Department will implement LTCPU Improvement 10A, construction of a Secondary Treatment Bypass Conduit from the Set-1 PSTs to upstream of the Chlorine Contact tanks, thereby bypassing aeration and secondary clarification. The Bypass Conduit will include chlorine application at the conduit influent. Pursuant to the existing NPDES permit, the City received approval for a 100 MGD bypass on April, 1 2009 (see Appendix A). Subsequently, upon further engineering analysis and review it was determined that the NE WPCP bypass could accommodate greater wet weather flows of 215 MGD. The 215 MGD was incorporated and

approved within the LTCPU. This Facility Concept Plan now confirms and commits the City to a 215 MGD bypass. Up to 215 MGD of bypassed flow will be blended with 435 MGD of flow receiving full secondary treatment prior to final chlorination and discharge. Disinfection will be provided as the flow enters the bypass, so chlorine contact time is provided within the bypass, as well as at the Chlorine Contact tanks. Chlorination of the bypassed water should precondition this stream resulting in blended water with similar chlorine consumption requirements to minimize potential disinfection performance changes in the chlorine contact tank. The Water Department performed sodium hypochlorite disinfection studies to design a chemical feed system at the head of the bypass conduit. Design is complete and the Water Quality Part II Permit was approved on December 2, 2013. The construction of the bypass has been awarded and a Notice to Proceed is expected in early 2014. Specific dates for completion will comply with the NPDES permit.

Additional Preliminary Treatment Facility #2

The existing influent hydraulic capacity of pumping and screening facilities at the NE WPCP is 550 MGD, comprised of 425 MGD pumped from the Low Level service area and 125 MGD by gravity from the Frankford High Level Sewer (according to the 2001 NE Stress Test Report). To achieve a peak maximum influent wet weather flow rate of 650 MGD, additional pretreatment facilities are required (alternative to LTCPU Improvements 4A and 4B). The new preliminary treatment facility #2 will allow increased flow from the Frankford High Level sewer by improving the hydraulic gradeline in the plant. The detailed design of a 300 MGD pretreatment facility (250 MGD with one process unit out of service) is currently underway.

The construction of future PTB #2 will result in the replacement or elimination of improvements initially discussed as options in the 2009 LTCPU. This includes Improvement 3 - New Conduit from Diversion Chamber B to the existing PTB, Improvements 6A and 6B - New Conduit from the existing PTB to Set-2 PSTs, and Improvement 7 - Reactivate Bypass Conduit from Diversion Chamber B to Set-2 PSTs with New Bar Screen and Grit Removal.

The Water Department performed a high rate treatment alternatives evaluation in 2009 and selected to construct a new PTB and secondary treatment bypass conduit to utilize existing capacity of the PSTs and the chlorine contact chamber to reach 650 MGD wet weather capacity without the need to construct a separate high rate treatment train. Therefore, Improvement 11 - High-Rate Treatment System, is no longer being considered as an option for CSO control under the 2009 LTCPU.

Constructing the additional PTB #2 requires obtaining parcels outside the existing NE WPCP. The City of Philadelphia has obtained legal counsel to assist in acquisition of privately held parcels, followed by demolition, and potential soil remediation prior to Notice to Proceed with an anticipated 36 month construction schedule. The Water Department has projected the land acquisition and preparation process will take three to five years to complete. In addition, ongoing activities associated with the PENNDOT expansion of I-95 require cooperative land acquisition and construction coordination. Due to the many unknowns, PWD will commit to the

requirements to complete the project by 2031 as stated in the COA. A schedule for this project will be provided once land acquisition is complete. Specific dates for design and completion will comply with the NPDES permit.

New Influent Baffles in Set-2 Primary Sedimentation Tanks

The Water Department will construct influent baffles as part of the new PTB option to ensure increased flow into the PTB will not re-suspend any settled solids (LTCPU Improvement 8). The construction of gravity sludge thickeners (GSTs) will allow the NE WPCP to operate the PSTs with a minimal sludge blanket, further reducing the likelihood of re-suspending settled solids in the PSTs with high wet weather flows.

4.2 Collection System Improvements in the NE WPCP Drainage District

The NE WPCP drainage district collection system is continually being studied and optimized for delivery of wet weather flows to the NE WPCP. The work performed to date has concluded the need for specific modifications to the collection system. The projects described below provide the collection and delivery necessary for the Water Department to achieve the wet weather treatment targets in the NE WPCP drainage district.

Secondary 66" Frankford Grit Chamber Bypass In Service

The Water Department reopened an out-of-service, 66" bypass conduit around the Frankford Grit Chamber in August 2012 in lieu of replacing the existing bypass (LTCPU Improvement 1) in preparation to increase the Frankford High Level Sewer capacity. This project consisted of removing debris in the out-of-service 66" bypass conduit and opening a gate valve to allow flow through both 66" conduits around the former Frankford Grit Chamber. In 2013, the Water Department completed hydraulic modeling of the Frankford High Level Sewer to evaluate the effect of rehabilitating the out-of-service 78" conduit (LTCPU Improvement 2). The goal of putting the Frankford Grit Chamber Bypass into service is to reduce some potential bottlenecks and/or constrictions that may be associated with flow delivery to the Frankford High Level 78" conduit by increasing the cross sectional area of the pipes that are in service.

Frankford High Level Second Barrel Rehabilitation

Improvement 2 in the LTCPUC was to rehabilitate the Frankford High Level Second Barrel (78" sewer) from O St. and E. Erie Ave to the NE WPCP entrance. Thirteen sewer manholes will be rebuilt with pressure seals, plus two manholes in the NE influent conduit, and a cover over diversion chamber B. In addition, 200 reinforced concrete pipe joints will be re-sealed from Almond St. to the plant entrance east of Richmond St. Hydraulic modeling completed in 2013 confirmed the Frankford High Level Sewer capacity of 200 MGD with the 78" barrel returned to service, in conjunction with the existing 66" sewer barrel in operation, both 66" Frankford Grit Chamber Bypass Conduits in operation, and improvements completed at the plant influent. The Water Department has completed the detailed design and has issued construction Notice to Proceed on July 29, 2013.

Studies to identify collection system modifications in the NE WPCP drainage district are underway and discussed in Section 4.4.

4.3 Operational Improvements at the NE WPCP

A change to the way the plant is operated can result in an increase in the amount of flow the treatment plant can process. The Water Department will continue to look at ways to improve the operation and treatment capacity of the NE WPCP plant. The operation of the PSTs with a minimal sludge blanket when the GSTs go into operation is one way to achieve additional flow. This operational strategy is described below.

Operate with Minimal Sludge Blanket when Gravity Sludge Thickeners In Service

The Water Department is committed to constructing GSTs to control odors generated inside the plant boundaries. The new GSTs will allow for future operation of the PSTs with a minimal sludge blanket, minimizing potential odors. A secondary benefit of this operational change is increased PST capacity. Implementation of GSTs will allow continuous removal of primary solids, thereby improving primary clarifier capacity, particularly under wet weather solids loading conditions. The 2001 NE Stress Test indicates an improved PST capacity of 567 MGD could be achieved with improved sludge pumping and modification of inlet baffles in the Set-2 PSTs (LTCPU Improvement 8). Further Stress testing in 2009 indicated a PST capacity of 650 MGD based on a surface overflow rate of 3,200 gpd/ft² to maintain NPDES permitted total suspended solids effluent limits. In addition, without overloading the digester bank, the GSTs will reduce wet weather solids loading on the secondary clarifiers. The design for this facility is complete, and the anticipated construction duration is 36 months. On September 3, 2013, the Water Department filed a Plan Approval Permit with the City of Philadelphia Air Management Services as a prerequisite for construction.

4.4 Continuing Studies for the NE WPCP Drainage District

The Water Department is committed to studying ways to optimize the wet weather capture and treatment of flows at the NE WPCP. The Water Department is currently evaluating options to expand the NE WPCP peak instantaneous wet weather flow from 435 MGD to 650 MGD, a total increase of 215 MGD. This additional flow to come from either the Frankford High Level Sewer, in excess of 200 MGD or from the Low Level Sewers.

4.4.1 Collection System Improvement Studies for the NE WPCP Drainage District

Potential Replacement of Frankford Grit Chamber Bypass Conduit/ Construct New Frankford High Level Sewer and Modify R-18 Weir

In 2012, the Water Department completed a conceptual design study of expanding the Frankford High Level Sewer to 350 MGD capacity. This sewer expansion option would require significant collection system modifications including replacing the Frankford Grit Chamber Bypass. If the additional flow to reach 650 MGD comes through the NE WPCP Low Level Sewers, then the replacement of the Grit Chamber bypass may not be necessary.

Potential Modification to the Upper Delaware Low Level Sewer

Based on the NE influent pumping capacity, hydraulic and hydrologic modeling of the Upper Delaware Low Level sewer capacity, and operational data, the Water Department began a detailed investigation of existing limitations in the Upper Delaware Low Level Sewer. Potential removal of any constrictions may be a cost effective option for increased conveyance to the NE WPCP.

Balancing CSO Regulator Wet Weather Treatment Capacities

Studies are underway for balancing CSO regulator treatment capacities for the NE WPCP drainage district. Numerous combinations of regulator chamber improvements will be evaluated to seek optimum combinations that can achieve overflow reduction volume in a balanced manner. Examples include rebuilding regulating chambers with increased overflow weir elevations and increased weir lengths to meet flood protection requirements; increasing orifice and connector pipe sizes; adding stop logs or “bricks and mortar” improvements to raise weir elevations and others.

4.4.2 Facility Improvement Studies for the NE WPCP

Potential Modification to the Secondary Treatment System for Increased Wet Weather Treatment Capacity

Evaluations are currently underway to increase capacity of the secondary treatment system through the addition of coagulants in both sets of FSTs.

5. Design and Implementation Schedule

The design and implementation schedule below (Table 3) presents the design and construction performance standards in percent complete for the NE WPCP drainage district as a whole for the five-year, ten-year, fifteen-year and twenty-year milestone periods. Specific detail for each of the currently proposed capital projects in terms of percent complete for the five-year, ten-year, fifteen-year and twenty-year milestone periods for the NE WPCP and collection system is included within Table 4 below.

Table 3: Design and Implementation Schedule for NE WPCP Drainage District

NE WPCP and Drainage District Improvements	June 1, 2016	June 1, 2021	June 1, 2026	June 1, 2031
Design Schedule	25%	50%	100%	
Construction Schedule	0%	25%	50%	100%

Table 4: Anticipated Design and Implementation Schedule for Identified NE WPCP Drainage District Projects

NE WPCP Improvements	Construction Completion Schedule			
	June 1, 2016	June 1, 2021	June 1, 2026	June 1, 2031
Facility Improvements				
Remove Double Deck Effluent Channel in FST Set-2 (LTCPU Improvement 9)	100%			
New (4 x 48") conduits from PTB to Set-1 PST (LTCPU Improvement 5)	100%			
Secondary Treatment Bypass (LTCPU Improvement 10A)	50%	100%		
GSTs	25%	100%		
Additional PTB #2 (LTCPU Improvement 4)	0%	0%	50%	100%
Pending Results of Studies	--	--	--	--
Collection System Improvements				
Second 66" Frankford Grit Chamber Bypass In Service	100%			
Frankford High Level Second Barrel Rehabilitation (LTCPU Improvement 2)	100%			
Pending Results of Studies	--	--	--	--
Operational Improvements				
Operate with minimal sludge blanket when GSTs in service	0%	100%		

The Water Department will submit a comprehensive Wet Weather Facility Plan prior to the next milestone date of 2016, which will provide details including schedule, cost and anticipated performance for each project presented in this plan. The Wet Weather Facility Plan will also provide an update on ongoing studies and new concepts being developed by the Water Department to increase flow and CSO capture in the NE WPCP drainage district. The studies include:

- Development of a NE WPCP Wet Weather Facility Plan
- Replace Frankford Grit Chamber Bypass conduit
- Construct New Frankford High Level Sewer and modify R-18 weir
- Modify Upper Delaware Low Level Sewer
- Balancing CSO Regulator Wet Weather Treatment Capacities
- Potential Modification to the Secondary Treatment System for Increased Wet Weather Treatment Capacity

The schedule for completion of the Wet Weather Facility Plan is presented in Table 5.

Table 5: Anticipated schedule for the development and completion of the Wet Weather Facility Plan

Task	Completion Date
Perform Hydraulic Studies listed in section 4.4.1	December 31, 2014
Develop technologies list and identify viable alternatives	December 31, 2014
Perform alternatives analysis, select alternatives for detailed evaluation, and complete modeling	September 30, 2015
Cost comparison, Evaluation and Implementation schedule	February 29, 2016
Writing and completion of report	May 31, 2016
Submit Wet Weather Plan to PADEP	June 1, 2016

Projects identified by studies conducted by the Water Department will be implemented by 2031 to achieve CSO capture and wet weather flow treatment as required by the 2011 COA and NPDES permit modification.