

## Section 10

# Post-Construction Monitoring

### 10.1 Post-Construction Monitoring Overview

Post-construction compliance monitoring is a required element for all long term wet weather plans, and is intended to provide sufficient information to estimate the effectiveness of the control measures implemented under the *City Beautiful H<sub>2</sub>O Program Plan* (Program Plan). It includes measures appropriate for determining the success of the Program Plan in achieving the designated performance standards and in meeting the water quality requirements of the federal Clean Water Act. Section 9 describes the phased implementation and adaptive management strategy for the Program Plan.

This section describes the Post Construction Monitoring Plan (PCMP) developed to verify that activity commitments have been implemented and to quantify and characterize the effectiveness of CRW Program Plan improvements. The PCMP monitoring and reporting activities presented in this section will document the findings of the Immediate Implementation Phase of the Program Plan. PCMP reporting will have two aspects:

- The first will be conducted on an annual basis and implemented through the existing series of annual Chapter 94 reports submitted by CRW to the US Environmental Protection Agency (US-EPA) and the PA Department of Environmental Protection (PA-DEP). Annual reporting will require the following categories of monitoring defined in this Section: administrative monitoring and reporting, precipitation monitoring and assessment, suburban community system monitoring and assessment, CSO overflow detection monitoring, and CSO discharge projections through H&H modeling.
- The second aspect will be the preparation and submission of a comprehensive report after the Immediate Implementation Phase of the Program Plan has been implemented, anticipated approximately 10 years following approval of this Program Plan. The full suite of monitoring defined in this section will be required to support this comprehensive report, including a full re-validation that the hydrologic and hydraulic (H&H) model reflects the collection and conveyance system improvements achieved during the Immediate Implementation Phase.

Eight categories of monitoring and reporting are included in the PCMP and summarized below.

- ***Administrative Monitoring and Reporting:*** Accounting-based factors including impervious area draining to green infrastructure, miles of rehabilitated sewers, annual debris removal volumes, system maintenance efforts, and other appropriate measures will be documented and reported to verify Program Plan commitments have been implemented.
- ***Precipitation Monitoring and Assessment:*** The existing gauge network and gauge adjusted radar rainfall (GARR) data will be used to quantify and characterize precipitation for the PCMP. The current typical year precipitation volumes and frequencies will be used

by the updated H&H models to quantify and characterize typical year CSO discharge statistics. The high resolution, spatially distributed gauge adjusted radar rainfall (GARR) precipitation data will be used by the H&H models to provide the annual CSO discharge volume, frequency and duration for each CRW CSO outfall location.

- ***Interceptor Monitoring and Assessment:*** The existing network of nine interceptor monitoring sites will be used to quantify and characterize interceptor flow for the PCMP. The flow monitoring equipment will provide the necessary data to successfully measure and typify the distribution of wastewater flow along the CRW interceptor sewer system. Existing interceptor monitoring activities may be suspended until needed to assess the benefits of system improvements as key Immediate Implementation Phase Program Plan items are completed.
- ***Suburban Community System Monitoring and Assessment:*** The existing network of four POC monitoring sites will be used for the PCMP to quantify and characterize dry and wet weather flow from the suburban community separate sanitary sewer systems. The monitors collect and record redundantly monitored wastewater depth, monitored velocity, and calculate flow in 5-minute increments.
- ***CSO Regulator Structure Monitoring and Assessment:***
  - For annual reporting, the daily inspections conducted by CRW crews at all the CSO regulator structures will continue as the Program Plan is implemented. Wooden blocks placed on the crests of the diversion weirs indicate CSO activity, and observations will continue to be logged on a daily basis in the Cityworks asset management system for the PCMP. CRW may use a network of real-time information monitors if a cost effective and reliable technology is identified.
  - To support preparation of the comprehensive report for the Immediate Implementation Phase, the PCMP will also include installing area-velocity meters at 10 selected CSO regulators for a 6-month duration. The resulting data from the inspections and monitoring will be used to validate the revised H&H model.
- ***CSO Discharge Projections through H&H Modeling:*** The calibrated CRW hydrologic and hydraulic model will be used to simulate dry and wet weather flow from all catchment areas within the City of Harrisburg, for both separate and combined sewer systems, and from the suburban community systems. As system improvements are completed as part of the Program Plan, corresponding revisions and updates will be made to the H&H model to reflect these revisions. For the PCMP, the typical year precipitation data will be applied to the updated H&H model, and typical year CSO discharge volume, frequency and duration at each CSO regulator will be computed. The improved condition model results will be compared with the existing condition results to quantify and characterize the performance of the improved CRW system and verify that the level of CSO reductions predicted in the Program Plan are achieved.
- ***Water Quality Monitoring and Assessment:*** Water quality monitoring and characterization for the PCMP will be implemented by partnering with PA-DEP to collect

and assess water quality data. The water quality parameters previously measured by PA-DEP have been total settleable solids, total suspended solids, BOD<sub>5</sub>, total nitrogen, total phosphorus, and fecal Coliform bacteria.

- ***Paxton Creek Use Attainability Assessment:*** The water quality compliance strategy for Paxton Creek is to coordinate with PA-DEP to have a Use Attainability Study conducted that would change the use designation for the creek. For the PCMP, CRW will provide progress updates on its coordination activities with PA-DEP as part of its annual Program Plan reporting.

Upon completion of the Immediate Implementation Phase of the Program Plan and annual PCMP reporting activities, a comprehensive Post Construction Monitoring Report will be prepared and submitted to US-EPA and PA-DEP to estimate the effectiveness of the control measures implemented under the Immediate Implementation Phase of the *City Beautiful H<sub>2</sub>O Program Plan*.

## 10.2 Administrative Monitoring and Reporting

Administrative monitoring and reporting activities will be conducted as part of the PCMP to verify that commitments in the Immediate Implementation Phase of the CRW Program Plan have been implemented. Administrative monitoring for the PCMP will be conducted on an annual basis and will be implemented through the existing series of annual Chapter 94 reports submitted by CRW to US-EPA and PA-DEP.

Categories of annual administrative monitoring and reporting for the PCMP will include the following categories of parameters:

- Miles of completed combined sewer CCTV inspections and cleaning that are implemented as part of CRW's ongoing program under its Nine Minimum Control Plan (NMCP).
- Completed rehabilitation or replacement measures to structurally deficient sewer reaches that were identified through CCTV inspections to have NASSCO PACP defect severities of grade 4 and 5 and/or serve as a source of high groundwater infiltration, as identified in the Program Plan.
- Number of catch basins and storm inlets inspected and cleaned under the NMCP and documented using the Cityworks asset management program.
- Miles of street sweeping conducted and tons of debris and solids removed.
- Completed repairs to the Advanced Wastewater Treatment Facility (AWTF), pump stations, CSO outfall pipes, flap gates, and other CRW assets other than sewer pipes.
- Completed modifications to CSO regulator structures such as revising control orifice openings, raising diversion dam crest elevations, repairing outfall pipes, and repairing backflow/river intrusion prevention gates.
- Acres of impervious area draining to completed decentralized green or grey stormwater infrastructure (GSI) control facilities to verify the GSI commitments made in the Program Plan were implemented and functioning properly.

- Acres of combined sewer system separation completed or acres of completed rerouting to an adjacent storm sewer system to verify that Program Plan commitments were implemented.
- Stakeholder engagement activities
- Environment compliance and enforcement activities achieved such as illicit discharges removed, pollution prevention actions, etc.

### 10.3 Precipitation Monitoring and Assessment

To quantify and characterize precipitation patterns within the CRW service area, and support the development of the Program Plan, CRW successfully developed and implemented a precipitation gauge network consisting of eight tipping bucket rain gauges located throughout the service area. The gauge network records rainfall depths in 5-minute intervals with a minimum recorded depth of 0.01 inches. All the gauges are heated to allow for accurate measurement of frozen precipitation events during winter. Hourly rainfall data are also collected from the two National Weather Service gauges located at the Capital City Airport and at the Harrisburg International Airport.

Like any rain gauge network, the CRW network cannot quantify and characterize precipitation volumes, intensities, and patterns that occur between the gauge locations. To characterize the spatial variability of rainfall events over the CRW service area, gauge adjusted radar rainfall (GARR) data are obtained and used along with the gauge network data. GARR precipitation data are provided in 5-minute intervals within a high-resolution pixel grid comprised of 1-km by 1-km (0.6-mi by 0.6-mi) cells. A total of 586 pixel cells define precipitation patterns over the CRW service area, including the City of Harrisburg and the separate sanitary sewer collection systems serving the suburban communities.

The existing gauge network and GARR data will be used to quantify and characterize precipitation for the PCMP. The locations of the gauges and the GARR pixels are provided in Figure 3-14. A listing of the gauge locations and their status are provided in **Table 10-1**. The current typical year precipitation volumes and patterns will be used by the updated H&H models to quantify and characterize typical year CSO discharge statistics. The GARR precipitation data will be used by the H&H models to provide the annual CSO discharge volume, frequency, and duration for each CRW CSO outfall location. The GARR precipitation data will also be used to quantify and characterize the monthly and annual differences between actual precipitation volumes and frequencies with those calculated from the long-term record for typical year precipitation. Under Partial Consent Decree (PCD) requirements, precipitation monitoring will continue through the implementation of the Program Plan.

The currently developed synthetic design storm rainfall volumes and patterns for the 2-year, 5-year, and 10-year statistical recurrence intervals will be used to assess the hydraulic performance of the separate sanitary sewer systems within the City and five of the six suburban communities.

**Table 10-1: PCMP Precipitation Monitoring Sites**

Gauge Name /Number	Gauge Location	Period of Record	Data Collection Status	Data Analysis Status
FAA_ Hourly-KCXY	Capital City Airport	1996 – Present	Ongoing	Ongoing
Harrisburg Int. Airport	Harrisburg Int. Airport	10/1/1991 – Present	Ongoing	Ongoing
RG1	Koons Park	9/3/2014 – Present	Ongoing	Ongoing
RG2	Market Street	8/1/2014 - Present	Ongoing	Ongoing
RG3	CRW AWTP	8/1/2014- Present	Ongoing	Ongoing
RG4	Swatara	9/5/2014 - Present	Ongoing	Ongoing
RG5	United Water	9/12/2014 - Present	Ongoing	Ongoing
RG6	Lower Paxton	9/9/2014 - Present	Ongoing	Ongoing
RG7	East Pennsboro	9/6/2014 – Present	Ongoing	Ongoing
RG8	Steelton	9/5/2014 - Present	Ongoing	Ongoing

## 10.4 Interceptor Monitoring and Assessment

CRW successfully installed and maintained flow monitors at nine critical interceptor sites to provide the necessary data to successfully quantify and characterize the distribution of wastewater flow along the CRW interceptor sewer system. The monitors collect and record redundantly monitored wastewater depth, monitored velocity, and calculated flow in 5-minute time-step increments. The existing network of interceptor monitoring sites will be used to quantify and characterize interceptor flow for the PCMP. The locations of monitoring sites are provided in **Figure 3-21**. A listing of the monitoring sites and their status are provided in **Table 10-2**. The monitoring duration for PCMP reporting will be a 12-month period after the Immediate Implementation Phase of the Program Plan (approximately 10 years after Plan approval).

The following additional interceptor monitoring activities will be conducted to allow CRW to quantify the impacts of system improvements as key Immediate Implementation Phase Program Plan items are implemented. The monitoring data will allow CRW to verify the system-wide hydraulic performance of the rehabilitated pump stations and the reconfigured regulators.

- After the completion of the rehabilitation measures at the Front Street Pump Station, monitoring will be conducted for a duration of 3 months at the FSI and IS1 monitoring sites along the Front Street Interceptor, at the IS3 and IS2 sites along the Paxton Creek Interceptor, and at the PCRI monitoring site along the Paxton Creek Relief Interceptor.
- After the completion of the reconfiguration of the CSO regulator structures, along the Front Street Interceptor, monitoring will be conducted for a 3-month duration at the FSI and IS1 monitoring sites.
- After the completion of the reconfiguration of the CSO regulator structures, along the Paxton Creek Interceptor, monitoring will be conducted for a 3-month duration at the IS3 and IS2 monitoring sites.

- After rehabilitation of the Spring Creek Pump Station is completed, monitoring will be conducted for a 3-month duration at the SCI monitoring site along the Spring Creek Interceptor.

**Table 10-2: PCMP Interceptor System Monitoring Sites**

Monitor ID	Interceptor System	Pipe Diameter (inches)	Data Collection Initiated	Data Collection Status	Data Analysis Status
IS1	Front Street	35.5 H x 30.5 W	8/01/2014	Ongoing	Ongoing
FSI	Front Street	41 H x 42.5 W	8/01/2014	Ongoing	Ongoing
PCI	Paxton Creek	60 diameter	8/01/2014	Ongoing	Ongoing
PCRI	Paxton Creek	48 diameter	8/13/2014	Ongoing	Ongoing
IS2	Paxton Creek	48 H x 59 W (arch)	8/21/2014	Ongoing	Ongoing
IS3	Paxton Creek	60 diameter	8/22/2014	Ongoing	Ongoing
IS4	Paxton Creek	42 diameter	8/18/2014	Ongoing	Ongoing
M250	Hemlock Creek	24 diameter	8/01/2014	Ongoing	Ongoing
SCI	Spring Creek	34 H x 32.5 W	8/13/2014	Ongoing	Ongoing

## 10.5 Suburban Community System Monitoring/Assessment

CRW installed and maintained flow monitors at each of the four point of connection (POC) monitoring sites where most of the wastewater flows from the suburban community collection systems are conveyed to the CRW system. The existing network of four POC monitoring sites will be used for the PCMP to quantify and characterize dry and wet weather flow from the suburban community separate sanitary sewer systems. The monitors collect and record redundantly monitored wastewater depth and monitored velocity, and calculate flow in 5-minute time-step increments. The monitoring site information and status are summarized in **Table 10-3** and the monitoring locations are provided in **Figure 3-21**. Under Partial Consent Decree (PCD) requirements, suburban community POC monitoring will continue through the implementation of the Program Plan. The collected data for a 12-month period will be analyzed for integration into the PCMP after the Immediate Implementation Phase of the Program Plan (approximately 10 years after Plan approval).

**Table 10-3: PCMP Suburban Community POC Monitoring Sits**

Monitor ID	Pipe Diameter	Catchment Area (acres)	Data Collection Initiated	Data Collection Status	Data Analysis Status
M9	24 inches	847	8/01/2014	Ongoing	Ongoing
M13	42 inches	12,602	8/15/2014	Ongoing	Ongoing
M32	34 inches	6,716	8/14/2014	Ongoing	Ongoing
M167	24 inches	2,334	8/14/2014	Ongoing	Ongoing

## 10.6 CSO Regulator Structure Monitoring and Assessment

CRW crews conduct daily inspections of all the CSO regulator structures. Wooden blocks are placed on the diversion weirs and wired to the side wall, and serve as indicators if CSO activity



occurred. If the water level in a regulator structure topped the crest elevation of the diversion dam, and a CSO discharge occurred, the wooden block would be dislodged from the weir crest. The crews check the wooden blocks as part of their daily inspections and log their observation in the Cityworks asset management system. The resulting Cityworks records are used to verify that the H&H model simulations accurately reflect the field inspection observations.

These activities will continue as the Immediate Implementation Phase of the Program Plan is implemented and will serve as the CSO regulator structure monitoring component of the PCMP. The recorded wooden block inspection observation data will be used to verify that as revisions are made to the H&H model to reflect completed improvements to the sewer system, the model simulation results continue to correlate with field observations. As a potential alternative regulator structure monitoring activity, and a possible extension of the completed CSO Activation Monitoring Pilot (CAMP) Study, CRW may elect to use a network of real-time information monitors if an affordable and reliable technology can be identified. The recommendation of the 2016 *CAMP Study Report*<sup>1</sup> was that while a more automated approach of detecting CSO and dry weather overflow activity shows promise, it is premature to implement such technology at present. Existing manual monitoring methods remain reliable and are currently affordable and cost effective compared to the automated approaches. Available technologies are anticipated to evolve as the Program Plan is implemented.

The PCMP will also include installing area-velocity monitoring equipment at eight selected CSO regulators. The equipment will continuously monitor the depth and velocity of the wastewater flowing into the regulator structures, in 5-minute increments, and calculate the influent flow. Redundant depth sensors will also be placed at the diversion dam to monitor the frequency and duration of CSO discharges and estimate the corresponding CSO volumes. The monitoring duration for all eight sites will be a six-month period, after the Immediate Implementation Phase of the Program Plan (approximately 10 years after Plan approval), extending through the spring and summer seasons, and the resulting data will be used to further validate the revised H&H model. A listing of these eight CSO regulator sites is provided in **Table 10-4** and their locations are shown in **Figure 3-22**.

Each of these sites were successfully monitored for a 12-month duration in 2014 and 2015 to calibrate and verify the existing condition model. The eight sites for the PCMP were selected because significant reductions to CSO discharges were predicted to result from implementing the Immediate Implementation Phase of the Program Plan. Previous monitoring sites at regulator structures where significant CSO reductions were not expected under the Immediate Implementation Phase activities were not selected for the PCMP.

In addition to the regulator structure monitoring activities, CSO catchment area monitoring will be conducted at selected sites after the Immediate Implementation Phase of the Program Plan (approximately 10 years after Plan approval). At this point, CRW should have completed its NMCP activity of cleaning and, where necessary, reconstructing all of its catch basins and storm inlets, as well as cleaning and repairing high priority structural deficiencies in collection system sewers. The monitoring will be conducted at four selected sites for a duration of four months to quantify

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<sup>1</sup> *CSO Activation Monitoring Pilot Study Evaluation Report*, December 2016.

the increase in wet weather flow resulting from removing existing bottlenecks in the City combined sewer system due to historical practices of deferred maintenance.

**Table 10-4: PCMP CSO Regulator Structure Monitoring Sites**

Monitored CSO Regulator Identification	Monitored Catchment Identification	Catchment Area (acres)	Pipe Size H x W or Diameter (inches)	Interceptor System
CSO-005	S-005	69.5	61 H x 48 W	Front Street
CSO-014	S-014	29.9	34.5	Front Street
CSO-021	S-021	149.3	51 and 24	Paxton Creek
CSO-031	S-031	220.0	60 H x 48 W	Paxton Creek
CSO-037	S-037	74.2	66 H x 48 W	Paxton Creek
CSO-050	S-050	41.8	48	Front Street
CSO-052	S-052	21.9	30 H x 36 W	Front Street
CSO-062	S-062	10.4	15	Hemlock Street

## 10.7 CSO Discharge Projections through H&H Modeling

The calibrated CRW hydrologic model simulates dry and wet weather flow and represents all catchment areas within the City of Harrisburg contributing to the conveyance system, for both separate and combined sewer systems. The hydrologic model also simulates the wastewater flows from the suburban community systems. The hydraulic model simulates how the flows are conveyed through the sewer system, including the CSO regulator structures and pump stations, to the AWTF. The GARR high-resolution precipitation data are input to the H&H model, and CSO discharge volume, frequency and duration at each CSO outfall are computed. These CSO discharge statistics are reported to PA-DEP. These modeling and reporting activities will continue, on an annual basis, as the Immediate Implementation Phase of the Program Plan is implemented during the first 10 years after Plan approval. Existing condition CSO discharge statistics resulting from typical year precipitation were computed for the CRW Program Plan, and will serve as a baseline for quantifying the CSO reduction benefits resulting from implementing the Program Plan.

As system improvements are completed as part of the Program Plan, such as the rehabilitation of pump stations, the reconstruction of regulator structures, and the installation of green stormwater infrastructure projects, corresponding revisions and updates will be made to the H&H model to reflect these revisions. It is envisioned that these model revisions will be made on an annual basis. For the PCMP, the typical year precipitation data will be applied to the updated H&H model, and typical year CSO discharge volume, frequency and duration at each CSO regulator will be computed. The improved condition model results will be compared with the existing condition results to quantify and characterize the performance of the improved CRW system and verify that the level of CSO reductions predicted in the Program Plan are actually achieved.

## 10.8 Water Quality Monitoring and Assessment

Water quality monitoring and characterization for the CRW PCMP will be implemented by partnering with the PA Department of Environmental Protection (PA-DEP) to collect and assess



water quality data. Available sampling data and analysis results from ongoing PA-DEP studies and those of the Susquehanna River Basin Commission will be obtained and reviewed. The water quality parameters previously measured by PA-DEP have included total settleable solids, total suspended solids, BOD<sub>5</sub>, total nitrogen, total phosphorus, and Fecal Coliform bacteria.

## 10.9 Performance Standards

The CRW PCMP will include quality assurance and quality control (QA/QC) measures to determine if the network of precipitation and flow monitoring equipment provides representative, accurate, and reliable data. QA refers to programmatic efforts to ensure the quality of monitored and field measured data and increase confidence in the validity of the reported analytical data. QC, a subset of quality assurance, refers to the application of procedures designed to obtain prescribed standards of performance in monitoring. The QA/QC protocols, standards and procedures used to implement past and existing monitoring and sampling activities will continue to be utilized and implemented for the PCMP.

## 10.10 Paxton Creek Use Attainability Assessment

There is currently no contact recreation within Paxton Creek and the physical configuration of the channel would not support or encourage contact recreation. The compliance strategy for CRW is to coordinate with PA-DEP to have a Use Attainability Study conducted that would change the use designation for Paxton Creek. For the PCMP, CRW will provide progress updates on its coordination activities with PA-DEP as part of its annual Program Plan reporting.

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