FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE CATSKILL/DELAWARE UV FACILITY
METHODOLOGIES

3.15. WATER RESOURCES

3.15.1. Introduction

This chapter describes the methods used to evaluate existing surface water and groundwater resources at the Eastview Site and the associated off-site work locations. The surface water, stormwater, and groundwater analyses provided an assessment of the potential impacts to hydrology, natural resources, and local stormwater conveyances resulting from the construction and operation of the proposed UV Facility. The objective of this analysis was to assess the potential impacts of the proposed facility and also to propose short-term and long-term control measures to mitigate these potential impacts. At the Eastview Site, a key project concern was the maintenance of existing runoff rates and total runoff volume to Mine Brook and its associated forested wetlands, as well as maintenance of other wetlands associated with tributaries and watershed contributing areas to Mine Brook.

3.15.2. Baseline Conditions

3.15.2.1. Existing Conditions

The following section presents methods used to describe the existing water flows and water quality conditions on-site, including surface water, stormwater, and groundwater. One of the keys to a successful modeling effort is the accurate representation of existing conditions in the study area. The first task conducted in the stormwater and groundwater assessment was data collection, which included site visits and a review of available data such as the existing geotechnical survey and previous groundwater modeling results, plans of the existing storm drainage in the vicinity of the Eastview Site, and adjacent surface water and wetland hydraulic conditions.

3.15.2.1.1. Surface Water

The surface waters were identified using field information and local and State mapping. The waters were then examined by considering the changes in water quality resulting from the increase in impervious surfaces associated with the layout and design of the project site. Developmental conditions could increase both stormwater flow rates (i.e., velocity) and stormwater pollutant concentrations during rain events, which could potentially degrade on- and off-site surface waters.

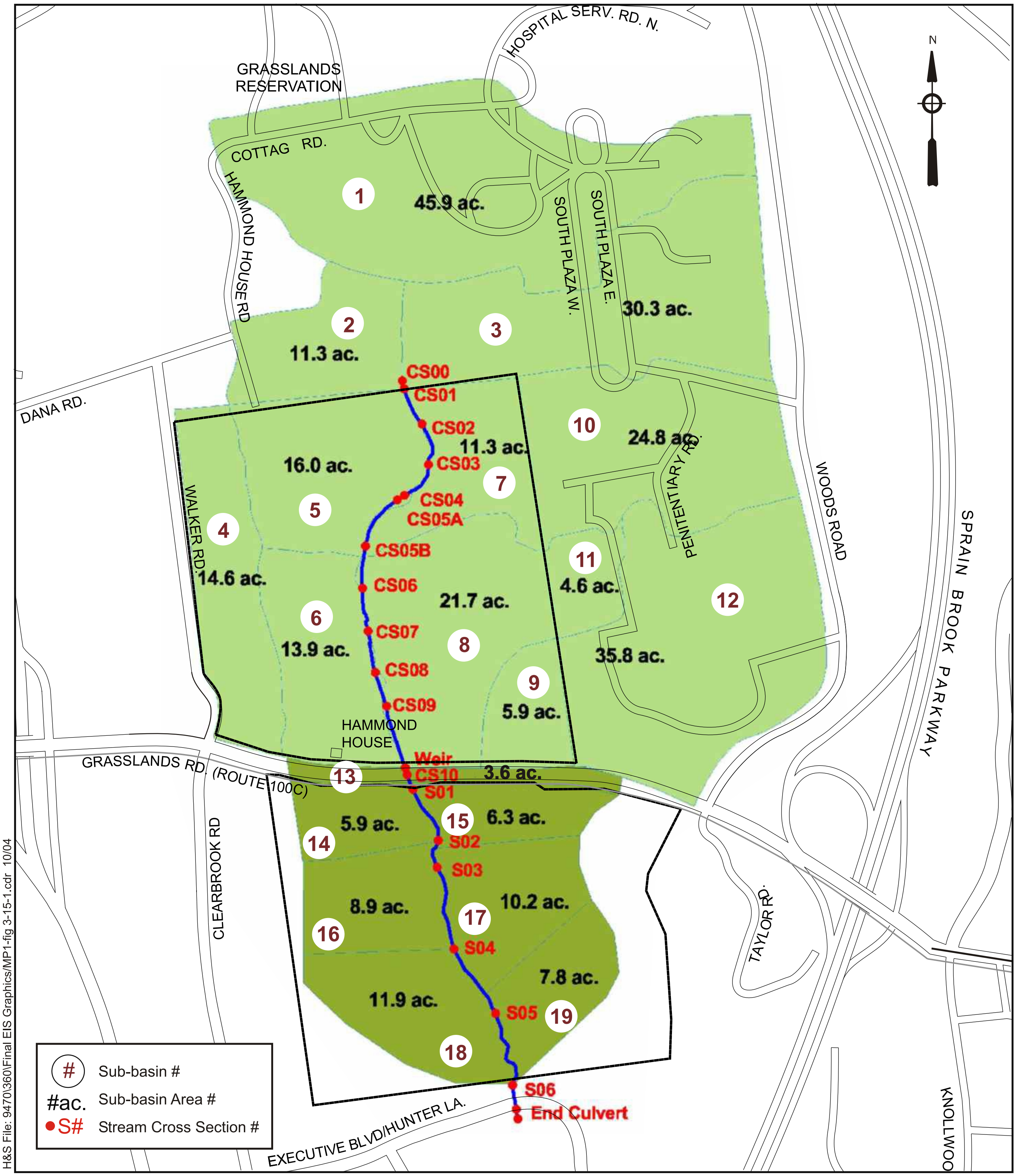
The source of these pollutants is primarily atmospheric deposition, but also includes litter, animal droppings, and other debris. Deposited on impervious surfaces, these pollutants make their way, or "run off", into surface waters during rainfall events. Studies have shown that increases in the concentrations of these pollutants are directly related to the percent of impervious surface within developed areas. Using empirical data from national studies, pollutant loadings, in pounds per acre per year, can be estimated for any location depending on the land use cover type (pervious versus impervious condition), the annual rainfall, and drainage area size.

In order to assess the potential impacts associated with increases in stormwater pollutant concentrations, the NYSDEC's *Stormwater Management Design Manual (October 2001*) was used to estimate the pollutant loads produced by the Eastview Site under existing conditions. In addition, surface water sampling was undertaken in October 2000 at the Eastview Site to assess the current condition of the site's surface water quality. Streamflow measurements were collected between August 2000 to December 2001, December 2003, and from March to August 2004 to provide the basis for estimating groundwater discharge, or baseflow, which represents the groundwater contribution to surface water flows.

The major surface water feature on-site, Mine Brook, was modeled using InfoWorks. As in any hydrologic-hydraulic model, InfoWorks calculates runoff volumes first and routes the runoff over sub-areas (sub-basins) to generate runoff hydrographs. It then applies the hydrographs to the channel-sewer system for hydraulic routing. The first step in constructing the runoff volume model is to divide each sub-basin into impervious and pervious areas. The fixed runoff coefficient method was used to calculate runoff volume in impervious areas. It is assumed that there is no rainfall infiltration in impervious areas and there is an initial loss of 0.02 inches due to initial interception, which was derived empirically. The rest of the rainfall in the impervious area becomes runoff. In the pervious areas, the initial rainfall loss is assumed to be 0.20 inches after which the rainfall begins to infiltrate the soil. Runoff from pervious areas is generated by the model if the rainfall intensity is greater than the soil infiltration rate. The InfoWorks modeling program incorporates the Storm Water Management Model (SWMM) to route overland runoff. The SWMM runoff routing model is non-linear reservoir routing model developed for the U.S. Environmental Protection Agency (USEPA). Sub-basins are modeled as idealized rectangular areas with the slope of the sub-basin perpendicular to the width. The sub-basins are analyzed as spatially lumped non-linear reservoirs. Figure 3.15-1 shows the InfoWorks model network, which simulates the Mine Brook watershed. The model for existing conditions includes 19 sub-basins and 21 nodes. Nodes are typically joined by one or more links. The type and number of links within the Mine Brook drainage corridor are as follows:

- River (a stream reach): 17, and
- Other links (e.g. culverts or weir): 3

Each node must be connected by a link to at least one other node. However, a single node may have several links to other nodes. Any pair of nodes can be connected by only one link. Detailed information on the sub-basins, nodes, and links within the InfoWorks model can be found in Appendix H.



Mine Brook Watershed Sub-basins with the "InfoWorks" Model Network

Catskill/Delaware UV Facility

Figure 3.15-1

3.15.2.1.2. Stormwater

The stormwater collection system for the Eastview Site was modeled using concepts and data presented in H.R. Malcom's Elements of Urban Stormwater Design (EOUSD), the USDA's Urban Hydrology for Small Watershed (TR-55), and the Westchester County Stormwater Management Handbook. In addition, to evaluate the stormwater runoff impact on the surface waters, the InfoWorks model was used. The InfoWorks model was used to route the stormwater flows and simulate the response of the surface waters for a variety of 24 duration storms such as 3-month, 2-year, 5-year, 10-year and 100-year return frequency storms.

Using preliminary designs, catch basins were initially placed on the project site and the exercise of placing and sizing necessary pipes to convey the collected stormwater from the catch basins to a detention pond began. Once the pipes were in place, they were then sized according to the amount of flow they would be required to convey. The flow rate to each individual catch basin was calculated using the Rational Method.

Rational Method: $Q = C \times I \times A$

Where: Q = Peak runoff, cfs
C = Rational runoff coefficient, dimensionless
I = Rainfall intensity, in/hr
A = Drainage Area, acres

To determine the runoff coefficient a weighted average of various types of land cover in the drainage area was used. Table 3.15-1 provides various types of land cover in EOUSD.

TABLE 3.15-1. RATIONAL RUNOFF COEFFICIENTS

Description	C	Information Source
Roof, inclined	1.00	Malcom
Street, driveway, sidewalk	0.95	Chow, 1964
Parking lot	0.90	Malcom
Roof flat	0.90	Malcom
Commercial, generalized	0.85	Malcom
Apartments, schools, churches	0.60	WSSC,c.1968
Residences, 10 dwelling/acre	0.60	Malcom
Residences, 6 dwelling/acre	0.55	Malcom
Residences, 4 dwelling/acre	0.50	Malcom
Residences, 2 dwelling/acre	0.40	Malcom
Unimproved cleared area	0.35	Malcom
Lawn, dense soil, steep >7 %	0.35	Chow, 1964
Playground	0.35	Chow, 1964

TABLE 3.15-1. RATIONAL RUNOFF COEFFICIENTS

Description	C	Information Source
Park, cemetery	0.25	Chow, 1964
Lawn, dense soil, average 2-7%	0.22	Chow, 1964
Wooded, sparse ground litter	0.20	Malcom
Lawn, dense soil, flat 2%	0.17	Chow, 1964
Lawn, sandy, average 2-7%	0.15	Chow, 1964
Lawn, sandy, flat <2%	0.10	Chow, 1964
Wooded, deep ground litter	0.10	Malcom

Determining the rainfall intensity depends on the geographic location and the design storm of interest and the time of concentration for the drainage area. For the proposed facility, piping was designed for the 10-year design storm and critical path piping was designed for the 25-year storm. Critical path piping was selected for pipes that are on the main branch of the stormwater collection system and often convey off-site as well as on-site runoff. The time of concentration was generally assumed to be five minutes for each individual drainage area.

As calculations progress down the system, the time of concentration increases due to the time it takes for the pipes to convey the runoff (also known as "pipe time"). The summation of the calculations proceeds downstream in the system to account for the cumulative flow that would be contributed by each individual catch basin upstream.

The piping was sized using the Manning's Equation, as noted in EOUSD, to calculate velocity and required size.

Manning's Equation: $Q = 1.49/n \times A \times R^{(2/3)} \times S^{(1/2)}$

Where:

Q = Flow, cfs (from Rational Method)
N = Manning's coefficient, dimensionless
A = Cross-sectional area of flow, ft^2
R = Hydraulic radius, ft.
S = Longitudinal channel slop, ft/ft

Piping was assumed to be flowing just full for the purposes of these calculations. Unknowns in the equation include: cross-sectional area and hydraulic radius. These were solved for to determine the minimum necessary pipe size. The minimum size was then rounded up to the next commonly available pipe design size. Preliminary sizing of the required stormwater detention was completed using the routing method outlined in EOUSD. With the preliminary design of the stormwater collection complete and establishing the detention requirements, the InfoWorks model simulated and analyzed the entire watershed. The simulations were conducted for 3-month, 2-year, 5-year, 10-year and 100-year return frequency 24-hour duration storms. In addition to comparing the peak flows, routed runoff volumes and water surface elevations for the two scenarios the 5-year and 100-year floodplain elevations were also compared to determine if any of the proposed actions would result adversely impacting the floodplains.

Pre-Developed and Post-Developed Calculations. Calculating pre-developed and post-developed runoff quantities required gathering several pieces of information concerning the drainage area prior to calculating runoff numbers. Necessary information collected includes:

- Selecting a point of interest that would capture all runoff from the Eastview Site in its post-developed condition.
- Overall drainage area to a given point of interest
- Time of concentration for the overall drainage basin.

Post-developed drainage to the point of interest includes the built out project site as well as the remainder of the overall drainage basin that would not be directly affected by construction (off-site drainage).

Curve numbers for pre-developed and post-developed conditions were developed using weighted averages after determining the total surface areas of all types of land covers present within the delineated drainage area. In the post-developed condition, curve numbers were assigned to all of the sub-areas, which included each individual catch basin and off-site drainage areas. The InfoWorks model then applied these curve numbers as necessary while modeling the stormwater conveyance system, the pretreatment forebay, on-line storage and the proposed outlet structures and compared the pre-developed and post-developed flows.

3.15.2.1.3. Groundwater

The groundwater existing conditions were evaluated at the Eastview Site based on field data collection and analysis and the development and application of a site-specific groundwater flow simulation model. The data collection efforts included on-site field work. The field program included drilling of borings, installation and monitoring of observation wells, installation and measurement of surface water staff gages, and monitoring of streamflows along Mine Brook and in some of its tributaries.

The conceptual model consisted of on-site/off-site mapping of topographic and hydrologic features, cross sections of geologic layering and bedrock-overburden contact elevations, estimation of wetland-groundwater and stream-groundwater interaction, characterization of rainfall-recharge and groundwater discharge rates, and analysis of long-term precipitation for identifying high water table conditions. The conceptual model development also included application of analytical techniques to estimate hydraulic properties. A numerical groundwater flow model was developed to simulate groundwater flow patterns and groundwater levels at the site.

The model selected for this analysis was DYNFLOW, a three-dimensional model approved by NYSDEC and the U.S. Environmental Protection Agency (USEPA) for use on water supply and contaminated groundwater projects in the State of New York. The model uses a numerical approximation to solve the basic equation describing the flow of groundwater in aquifer systems.

It utilizes a computational grid, or "mesh," that can be varied, focusing with greater detail on the areas of concern. The grid covers an area of 3.2 square miles. The model extends from the Saw Mill River eastward to a surface water divide east of the Eastview Site. The southern extent of the model is defined as the confluence of the on-site stream with the Saw Mill River.

The model consists of four layers and includes a representation of the bedrock and overburden. The overburden is subdivided into a dense till layer, and a less dense, more permeable veneer layer. The lower two model layers represent bedrock with uniform aquifer properties. The upper two model layers represent the dense till layer and the upper veneer layer. Table 3.15-2 lists the hydraulic properties assigned to the model layers.

TABLE 3.15-2. GROUNDWATER FLOW MODEL AQUIFER PROPERTIES AT EASTVIEW SITE

Formation	Horizontal Hydraulic Conductivity Estimated From Field Tests (feet/day)	Horizontal Hydraulic Conductivity (feet/day)	Vertical Hydraulic Conductivity (feet/day)	Specific Storativity (1/foot)	Specific Yield
Upper stratum/ weathered till	---	3	1	0.00001	0.01
Till	0.002 – 3	0.08	0.005	0.00001	0.01
Bedrock	0.008 - 5	0.15	0.01	0.00001	0.1

The study area, or domain, for the model was defined by regional hydrogeologic features that control groundwater flow at the Eastview Site. The domain was defined for shallow groundwater flow in the overburden material (soil above the bedrock), and bedrock groundwater flow since the geologic setting consists of bedrock formations overlain by unconsolidated sediments of glacial-fluvial origin. The conceptual groundwater flow model indicated that shallow groundwater is controlled by surface features: therefore, the model extent is defined by surface watershed boundaries. A specified head boundary condition representing surface water elevations in the Saw Mill River was assigned to the western edge of the model. No-flow boundaries form the northern, eastern, and southern edges of the model. On the Eastview Site, the groundwater flow model includes a representation of Mine Brook. An areal average recharge rate of 10 inches per year was used, based on the measured streamflows and the evaluation of climatic conditions.

Information for modeling efforts was obtained from a variety of published sources and from data collected as part of the proposed facility. Published sources of information include:

- Previous studies on aqueduct and reservoir construction from NYCDEP's Bureau of Water Supply;

- Data from well construction in the area collected by the U.S. Geological Survey (USGS) and the New York State Department of Health, as well as information from Westchester County;
- Geological and hydrogeological reports prepared by USGS and the New York State Geological Survey for Westchester County;
- Meteorological data from the National Oceanic and Atmospheric Administration (NOAA); and
- Westchester County's *Best Management Practices Manual for Stormwater Management*, 1984.

Data developed for the proposed facility and used in the modeling included on-site stream base flow measurements, which were recorded between August and October of 2000 and again in December 2003. This data was used to estimate base flow in the stream, which is predominantly fed by groundwater. The proposed facility's geotechnical studies provided boring logs. Groundwater levels were measured in the monitoring wells that were installed as part of the on site studies.

The numerical groundwater flow model developed for the Eastview Site consists of four model layers and represents three geologic units: bedrock, till and upper till/veneer. The lower two model layers represent bedrock with uniform aquifer properties. The upper two model layers represent the dense till layer and the upper veneer layer. The border between the overburden and bedrock was estimated from the boring program, and where the borings did not penetrate down to the bedrock. The source of groundwater was simulated as direct infiltration of precipitation. The model was calibrated for site conditions by varying the hydraulic conductivity in the two units, as well as making adjustments in other parameters including recharge rates, to match the observed water elevation in the monitoring wells and the on-site stream.

3.15.2.2. Future Without the Project

The project site was evaluated for the stormwater runoff, surface water quality and groundwater flows at the Eastview Site; the evaluation included both the peak construction and operation years of the proposed UV Facility for the two scenarios (with and without the Croton project). This evaluation forms the Future Without the Project baselines against which the proposed facility could be evaluated. Future conditions at the project site were projected based on known proposals for development, as presented in the Land Use, Zoning and Neighborhood Character analysis.

3.15.3. Potential Impacts

3.15.3.1. Potential Project Impacts

3.15.3.1.1. Stormwater Analysis

The potential impacts resulting from the operation of the proposed UV Facility at the Eastview Site on surface water and stormwater were predicted by modifying the InfoWorks model to reflect long-term basin changes. The existing stormwater runoff model and GIS maps were also modified to reflect the final site drainage plans. Peak flows and total runoff volumes were estimated based on the various design storms described previously. An assessment of pre- and post-construction stormwater runoff was conducted, and long-term mitigation measures incorporated. The goal of the long-term stormwater mitigation plan is to provide long-term control and treatment of stormwater runoff from the site, to the maximum extent practicable. This includes landscaping to ensure proper stabilization of the site, providing treatment of stormwater runoff from all impervious services, and maintaining flows to adjacent natural resource areas at pre-construction rates and volumes.

The long-term impact of the project on adjacent surface water and wetlands would depend on the extent to which groundwater levels are influenced by the proposed structure. The long-term operation was simulated by imposing fixed dewatering levels in the groundwater model at the locations of the proposed structures. The effects were predicted in terms of dewatering flow rates, lowered water table levels in the wetlands and stream areas, and capture zones due to the dewatering activities.

Potential long-term impacts to wetlands and upland trees were assessed by reviewing predicted changes to stormwater flows and volumes and groundwater elevations. Based on the detailed hydrologic modeling described here, any potentially significant change predicted to occur on stormwater or groundwater that would affect the hydrology, vegetation, or functions of wetlands would result in stormwater management considerations that would be incorporated into the proposed facility. Similarly, any significant stormwater changes that would adversely affect water available for infiltration in upland areas would be addressed in the project best management practices (BMPs), because these changes could potentially alter soil moisture regimes. The BMPs were identified and summarized in the impact sections.

3.15.3.1.2. Groundwater Analysis

The groundwater flow model developed for the Eastview Site was used to evaluate potential groundwater-related impacts resulting from operation of the proposed facility. The following groundwater flow model simulated results were used to evaluate potential groundwater-related impacts:

- Water table elevation contours and drawdowns, under long-term average conditions, using steady state simulations
- Transient model simulations, for assessing seasonal high water table conditions with emphasis on wetland vegetation and the growing season from April through June

- Dewatering and drainage rates, for construction related activities and facility operations following construction, using steady state simulation of long-term average conditions
- Changes to groundwater discharges, for construction and operational situations, under long-term average hydrologic conditions

All of these simulations were conducted for "baseline" conditions, defined for the "future without the project," and for four future situations – with and without the Croton project for both construction and post-construction operations situations. Changes in groundwater-related conditions were assessed, by comparing the future situation simulation results with the baseline simulations.

The simulated steady-state water table elevation contours and drawdowns from future without the project conditions were mapped. The simulated drawdown contours were used to identify locations where wetlands may be impacted by water level reductions. The one-foot drawdown contour served as the basis for identifying potentially impacted wetland areas.

Transient model simulation results, which depict seasonal changes in groundwater elevations, were used to refine estimates of wetland locations that would be impacted by facility operation. The method for identifying potentially impacted wetlands was based on the criterion that a depth-to-water greater than two feet, during the early growing season (April-May-June), would cause loss of wetland function. Therefore, the model was used to determine if such a condition would be triggered by the construction dewatering, or by post construction groundwater drainage.

Simulated steady state dewatering and drainage rates depict the long-term average flow rates from construction dewatering operations and post-construction groundwater drains surrounding and beneath built structures. For the construction dewatering, the groundwater flow model does not simulate short-term rates during initial construction dewatering or during rainfall events or seasonal high water table conditions. Those rates would be higher, for the short periods in which significant rainfall conditions occur, and during longer term periods of wetter-than-average conditions.

Simulated changes in groundwater discharge to surface waters and wetlands produced estimated base flow rates for each scenario that was simulated. The changes in base flows and groundwater discharges to wetlands along streams were computed, by comparing the simulation results from the construction and post-construction scenarios to the baseline simulation results.

On site stormwater basins have been designed to detain stormwater but they have not been designed for infiltrating significant flow rates to the ground. It is therefore assumed, in the groundwater flow modeling, that the stormwater basins are not acting as infiltration facilities. They are assumed to be large enough to control the design storm without having to infiltrate stormwater to meet performance requirements. This assumption is conservative with respect to simulation of groundwater-related impacts on wetlands, because simulation of infiltrating stormwater at detention basins would potentially over-estimate water table elevations, thereby underestimating wetland impacts.

Potential groundwater impacts associated with individual and combined construction of the Croton project and the proposed UV Facility were evaluated using the groundwater flow model developed for the site. The Croton project's stormwater recharge basin was not simulated, because its recharge could produce unrealistically high estimates of water table elevations in nearby wetlands. Therefore, omitting the basin from the simulations produces conservative estimates of drawdowns in wetland areas and of reductions in groundwater base flows to Mine Brook. In addition, this basin is far enough from the proposed facility and the Croton project to ensure that its influence on simulated dewatering or drainage flow rates at those two locations would be insignificant.

3.15.3.2. Potential Construction Impacts

Construction phasing for the proposed facility include: site preparation (the temporary installation of paved haul roads and gravel parking and storage areas during construction to facilitate equipment movement and storage); excavation and foundation preparation; and building construction (including access roads and parking area).

The potential construction impact on stormwater and surface water in the basins draining from the Eastview Site were predicted by modifying the Infoworks model to reflect basin changes resulting from potential temporary stream diversions; increased flows; and dewatering activities. The model and GIS base maps were modified based on changes in site conditions and land use changes, to predict runoff during the major phases of construction sequencing.

The 3-month, 2-year, 5-year, 10-year, and 100-year storms were simulated under construction conditions. BMPs were identified and summarized to ensure that peak flows would be dissipated to avoid erosion impacts, and that total storm volumes would be maintained to avoid alterations in wetland hydrology.

During temporary disturbance of pipeline and stormwater basin construction, temporary dewatering would occur in stages as the construction proceeds along the pipeline route. Because the dewatering would occur for relatively short periods, in comparison to the construction time frame, and over relatively short distances, it is not necessary to conduct groundwater simulations of the pipeline construction dewatering impacts on groundwater flow. For post-construction conditions, the pipelines would be built with collars designed to prevent groundwater from draining along the pipeline and surrounding bedding materials. In addition, the bedding materials would allow groundwater to flow from one side of the pipe to the other, thereby providing a sufficient hydraulic connection across the pipeline route for maintaining existing groundwater flow patterns.

3.15.4. Mitigation

The proposed BMPs would be designed to avoid potential impacts wherever possible. If potential impacts were impossible to avoid, the potential impact areas were minimized. Where potential impacts are unavoidable, conceptual mitigation plans are described in the subsequent chapters for each site. The BMPs included design of a pretreatment forebay with on-line storage to provide the Eastview Site with long-term control of stormwater runoff in accordance with local design criteria.

In general, mitigation activities have been designed to compensate for unavoidable potential impacts after reasonable attempts have been made to avoid and minimize them. When feasible, the potential effectiveness of mitigation measures was predicted by using computer modeling. Mitigation measures are described in this section based on the specific potential impacts.