11.9 PROPOSED DECOMMISSIONING

This section of the Final ~~Draft~~ Environmental Impact Statement (F~~D~~EIS) evaluates the proposed decommissioning of the bypassed section of the Rondout-West Branch Tunnel (decommissioning) that would occur as part of Upstate Water Supply Resiliency. It provides background on the purpose and need of decommissioning, describes the activities and schedule for decommissioning, and presents the environmental impact assessments for all applicable impact categories.

11.9.1 OVERVIEW

The Delaware Aqueduct is comprised of several segments, the longest of which is the Rondout-West Branch Tunnel (RWBT). The RWBT connects the Delaware water supply system's Rondout Reservoir, located in Ulster and Sullivan counties, New York, to the West Branch Reservoir in Putnam County, New York. The RWBT is 13.5 feet in diameter, lined with concrete, and varies in depth from approximately 300 to 2,300 feet below ground (crossing the Hudson River at nearly 600 feet beneath the water's surface). The tunnel is constructed in deep rock, and is pressurized because of the changes in elevation and distance between the Rondout and West Branch Reservoirs. It has been in nearly continuous service since it was brought online in 1944. It can convey up to approximately 900 million gallons per day (mgd) of water. All water from the Delaware water supply system flows through the RWBT. The RWBT segment of the Delaware Aqueduct is leaking up to 35 mgd, primarily in the portion that travels under the Hamlet of Roseton, which is in the Town of Newburgh, Orange County, New York. A second leaking section is located near the Town of Wawarsing, Ulster County, New York. Both of these areas, which are referred to as the Roseton crossing and Wawarsing crossing, respectively, are located on the west side of the Hudson River (see **Figure 11.9-1**).

To address these leaks, DEP undertook an iterative planning process which resulted in their decision to construct a bypass tunnel and two associated shafts to permanently circumvent the leaking section in Roseton, and to conduct internal repairs to the section near the Town of Wawarsing. The work to circumvent the leaking section within the Roseton crossing is referred to as "RWBT Bypass" and is currently underway (see **Figure 11.9-1**). As discussed in Section 1.1, "Overview of Water for the Future," the potential for impacts from construction of the RWBT bypass were assessed in the previous EIS.

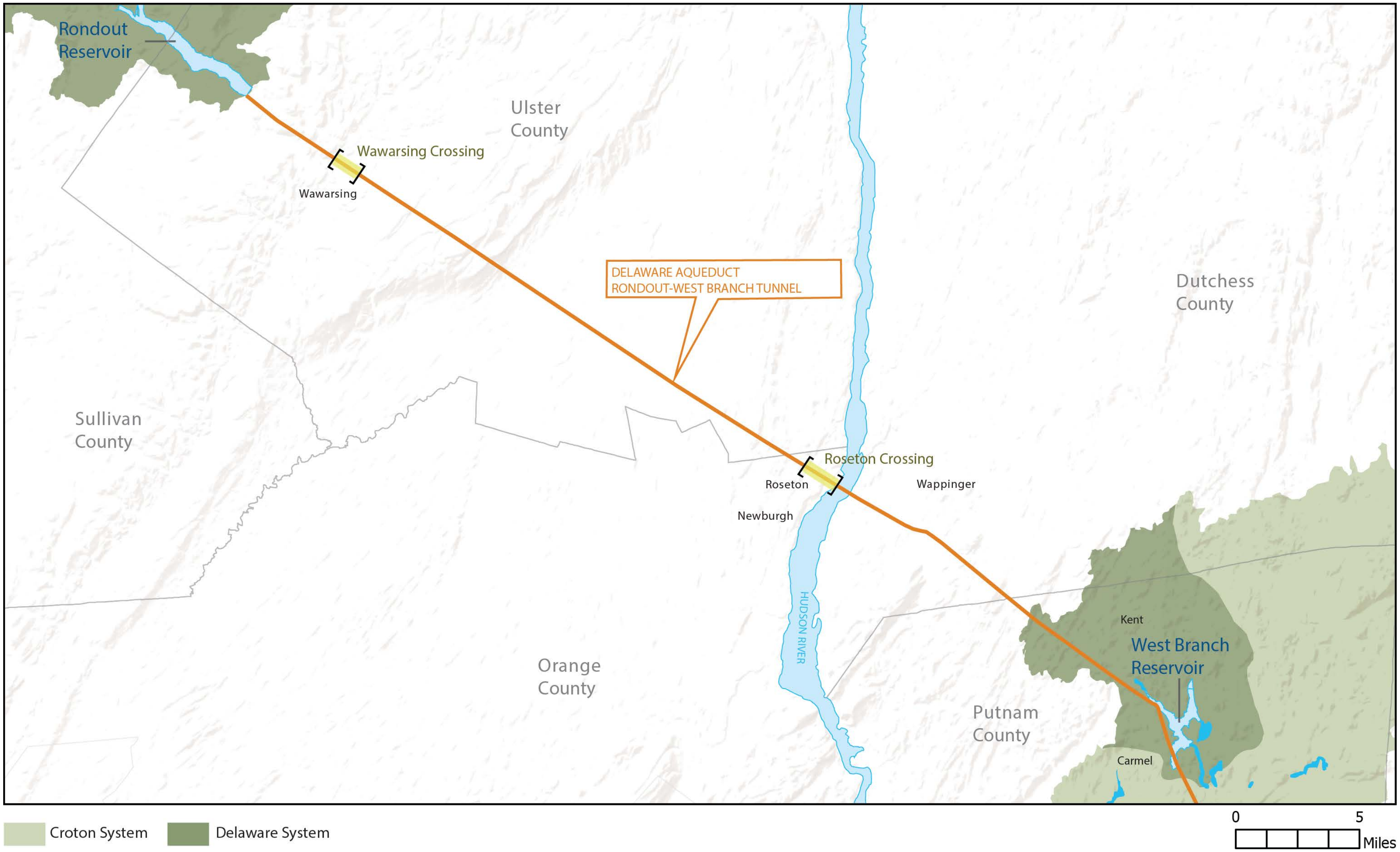


Figure 11.9-1: Rondout-West Branch Tunnel: Wawarsing and Roseton Crossings

Once the bypass tunnel and shafts are completed in 2022, the RWBT would be temporarily shut down beginning October 1, 2022 for a period of up to 8 months, during which it would be drained to:

- Connect the bypass tunnel to the existing RWBT;
- Inspect the tunnel upstream and downstream of the bypass connection points; and
- Carry out internal repairs to the leaking section of the existing RWBT near the Town of Wawarsing. These internal repairs would occur over the course of approximately 10 weeks in mid-November 2022, immediately following completion of the condition assessment. Concurrently with the inspection and repair activities, the connection of the RWBT Bypass would commence once the tunnel is unwatered, with work continuing until the end of May 2023.

Once inspection and repairs to the RWBT are complete and the bypass tunnel is connected to the existing RWBT in spring 2023, the bypassed leaking segment would be permanently decommissioned. Once decommissioned, all existing leaks in the two sections would cease, and DEP's water supply system would return to typical operations. This decommissioning is expected to stop water flow upward and outward from the pressurized RWBT in the vicinity of the leaks and could result in a lowering of both surface water and groundwater levels. These changes to groundwater levels could also result in changes to ground elevations from consolidation settlement in soils with compressible characteristics in the unconsolidated (shallow) aquifer.

Section 11.6, "Shaft 2A and Wawarsing Leak Repair Study Area Impact Analysis" provides a description of inspection and repair activities and an analysis of potential impacts in the Town of Wawarsing. Sections 11.9.2, "Description of Rondout-West Branch Tunnel Decommissioning" to 11.9.19, "Public Health," provide a description of decommissioning and the potential for impacts from the cessation of leaks in the Roseton Study Area.

11.9.2 DESCRIPTION OF RONDOUT-WEST BRANCH TUNNEL DECOMMISSIONING

The Roseton crossing lies just to the west of the Hudson River and consists of two sections of the RWBT totaling approximately 1,030 feet in length. To provide an understanding of how decommissioning could impact groundwater and surface water in Roseton, the RWBT's construction and current conditions of this section of the tunnel are described below.

The RWBT is largely constructed in rock comprised of shale, gneiss, and granite. The Roseton crossing, however, coincides with a geological zone comprised of limestone. Because of limestone's porous and permeable nature, this geology posed risks of tunnel rupture and excessive leaking during construction. To protect against these risks, heavy reinforcement and steel interlinings were installed at the crossing during construction.

The interior of the tunnel section of the Roseton crossing was formed by a heavily reinforced concrete outer lining, a circular steel plate interlining, and a typical concrete tunnel lining. In addition to the interlining, large quantities of grout were applied to prevent groundwater inflows into the tunnel. RWBT monitoring conducted by DEP (as described below) has shown that the leak locations are correlated with the tunnel's surrounding geology. Specifically, DEP's years of comprehensive inspections, testing, and study indicate that cracking and leaks are occurring in the aqueduct where it passes through limestone in Roseton, despite structural reinforcement at those locations.

While the last unwatering and physical inspection of the RWBT occurred in 1957 to 1958, DEP's continuous and varied RWBT monitoring efforts since the 1990s have revealed substantial information about these leaks. Numerous studies and projects have been conducted as part of these monitoring efforts, including hydraulic monitoring and automated visual inspections of the tunnel interior using an autonomous inspection device, and tunnel leak investigations. In addition to identifying the leak locations in these two sections, the monitoring showed that these two sections of the RWBT appear to be leaking a combined total of up to 35 mgd of water. Monitoring conducted since 2008 has shown that the leak rate is stable and has not increased.

In Roseton, the leaks from the RWBT occur approximately 600 feet below ground. Driven by pressure from water flowing within the RWBT, the leak water travels outward and upward through various geologic features such as faults, fractures, joints, and beds. In this manner, the RWBT leaks from deep below ground influence groundwater levels, travel upwards, and manifest at the ground surface at a number of locations, referred to as surface expressions. These leaks also influence water levels at ground surface (surface water), wetlands, and directly below the ground surface (shallow groundwater) in the Roseton area. Because water pressure within the tunnel (tunnel pressure) changes groundwater conditions and drives the leaks to the surface in the Roseton area, establishing the relationship between tunnel pressure and changes in groundwater levels and surface expressions was instrumental in DEP's planning for the RWBT Bypass.

DEP established a network of gauges in 2008 to monitor water levels in surface expressions and bedrock wells in the vicinity of River Road in Roseton to understand this relationship. Between 2008 and 2014, DEP reduced flows in the RWBT and depressurized the tunnel to facilitate certain inspection activities. The RWBT was then subsequently repressurized, which returned flows to typical operations. DEP depressurized the RWBT six times during this period by unwatering the tunnel through a "blow-off" valve at Shaft 6 in the Town of Wappinger, New York. Once inspection activities were completed, the blow-off valve was closed and flow was restored to re-pressurize the tunnel. The depressurization and re-pressurization events are together referred to as a "depressurization" within this F~~D~~EIS.

Specifically, the monitoring effort measured surface water and groundwater responses to changes in RWBT flows and resulting water pressure. Water pressure levels were reported as part of hydraulic grade line (HGL) data that DEP collects as part of typical operations. Unwatering during the depressurizations resulted in lower than typical RWBT water levels, though the unwatering did not completely empty the tunnel of all water. Therefore, while water levels in the RWBT at monitored locations during these depressurizations may not be fully representative of conditions from decommissioning, they provide an indication of groundwater responses since there is reduced water pressure in the tunnel and, therefore, less water escaping through leaks.

Based on DEP's observations during the monitoring, it was determined that the pressurized leak flow within the RWBT influences the overall water levels deep below the ground surface (referred to herein as groundwater), shallow groundwater, and surface water (streams). In particular, it was determined that the water level in the vicinity of the surface expressions and streams in Roseton is elevated as a result of the leaks. Groundwater influence is believed to extend within an area that is estimated to be approximately 1,500 feet north and south of the existing tunnel alignment and is generally close to the intersection of River Road and Danskammer Road. The effect of tunnel pressure on these leaks influencing water levels was also used to estimate the changes that could occur to water levels in Roseton as a result of decommissioning.

Reduced groundwater influence in the Roseton Study Area would occur beginning in fall 2022, with the unwatering of the existing RWBT in preparation for the connection of the bypass tunnel. Once the RWBT is shut down and depressurized, the influence of pressurized water leaking from the RWBT on the surrounding groundwater and surface water would cease, causing groundwater levels to decline. Following depressurization, unwatering of the tunnel would occur over approximately 10 days and could result in a measurable decline in surrounding groundwater levels. Water levels of surface water and wetlands within the Roseton area influenced by the leaks could also decline during this time as groundwater levels decline.

Once the 8-month temporary shutdown necessary to complete the inspection and repair and decommissioning ends in spring 2023, water in the Delaware Aqueduct would circumvent the decommissioned section of the RWBT, instead flowing through the Bypass tunnel. The Delaware water supply system would return to typical operations, and the empty, bypassed leaking section would remain unpressurized. The bypassed section is expected to fill with water from the surrounding groundwater and surface water system through cracks within the lining of the bypassed section created by the leaks. This would continue until the decommissioned section is filled with water. The declining trend in groundwater levels could continue through this period, but is expected to stabilize as groundwater fills the bypassed section of the RWBT and is recharged from the portion of the aquifer to the west and the Hudson River to the east.

Once the bypassed section is filled with water, a new water level equilibrium would be reached for groundwater and surface water. Changes to groundwater levels in the area and the new water level equilibrium could change stresses on subsurface materials (e.g., soils) currently influenced by the tunnel pressure and leak water. These changes in stress could result in settlement at the ground surface in certain areas currently influenced by the leaking tunnel.

The study area used in the analysis and the potential for impacts to the area in Roseton that could be affected from decommissioning is described in the sections below.

11.9.3 ROSETON STUDY AREA: LOCATION AND DESCRIPTION

As described in Chapter 8, "Analytical Framework," the study area for an EIS analysis is the geographic area in which impacts could occur. There is a potential for changes to groundwater and surface water from decommissioning. By extension, these changes have the potential to affect the water supply wells and natural resources that rely upon these water sources The Roseton Study Area was developed to encompass the largest area beyond which no appreciable changes in groundwater levels or surface water flows would be expected to occur during the temporary shutdown and over the long term after decommissioning due to the cessation of leaks.

The Roseton Study Area lies within the Hamlet of Roseton, Orange County, New York. **Figure 11.9-2** shows an aerial photograph of the Roseton Study Area, including the path of the RWBT, and the Roseton Study Area boundary. As shown in the figure, the RWBT traverses the study area in a general west-east direction. The study area is irregularly shaped and generally bounded by the Hudson River to the east, Old Post Road to the north, Oak Street to the south, and U.S. Route 9W to the west.

The Roseton Study Area has been identified as an area where decommissioning could potentially affect groundwater and surface water levels, wetlands (including shallow groundwater), floodplains, and soils and geology based on previous investigations and RWBT construction documentation.

The Roseton Study Area is located in the Hudson-Mohawk Lowlands between the Hudson Valley Fold-Thrust Belt to the west and the Hudson Highlands to the east. The bedrock formations in the Roseton Study Area include the Normanskill Formation and the Wappinger Group (see **Figure 11.9-3**). DEP investigations show bedrock formations are heavily folded and faulted in the region. Folding has created numerous fractures throughout the bedrock formations. One major fault intersects the RWBT (Roseton Fault) and several other smaller fault zones intersect the tunnel just east of the Roseton Fault. These fractures and faults are concentrated in the limestone/dolostone bedrock units of the Wappinger Group aligned from southwest to northeast in the Roseton Study Area.

Groundwater moves along faults and fractures in the bedrock. Regionally groundwater moves from higher water level elevation in the northwestern portion of the Roseton Study Area to the lower water level elevation in the southeastern portion of the Roseton Study Area. Groundwater is recharged by precipitation in the hills to the northwest, migrates through the Roseton Study Area, and discharges to the Hudson River. Regional groundwater flow is currently altered as it flows around the leaking portions of the RWBT that create a mound in the potentiometric water level in the bedrock. Water from the leaking portions of the RWBT is discharging as surface expressions in locations where the potentiometric water level in the bedrock is above land surface, and the bedrock fractures and faults convey water from the RWBT to the surface.

The Roseton Study Area was identified and bounded by features that act as physical or hydraulic barriers to groundwater flow, beyond which no appreciable changes to water levels would be expected as a result of RWBT decommissioning. The Roseton Study Area includes locations that showed measurable groundwater responses to RWBT depressurization and surface water features that could be affected by decommissioning.

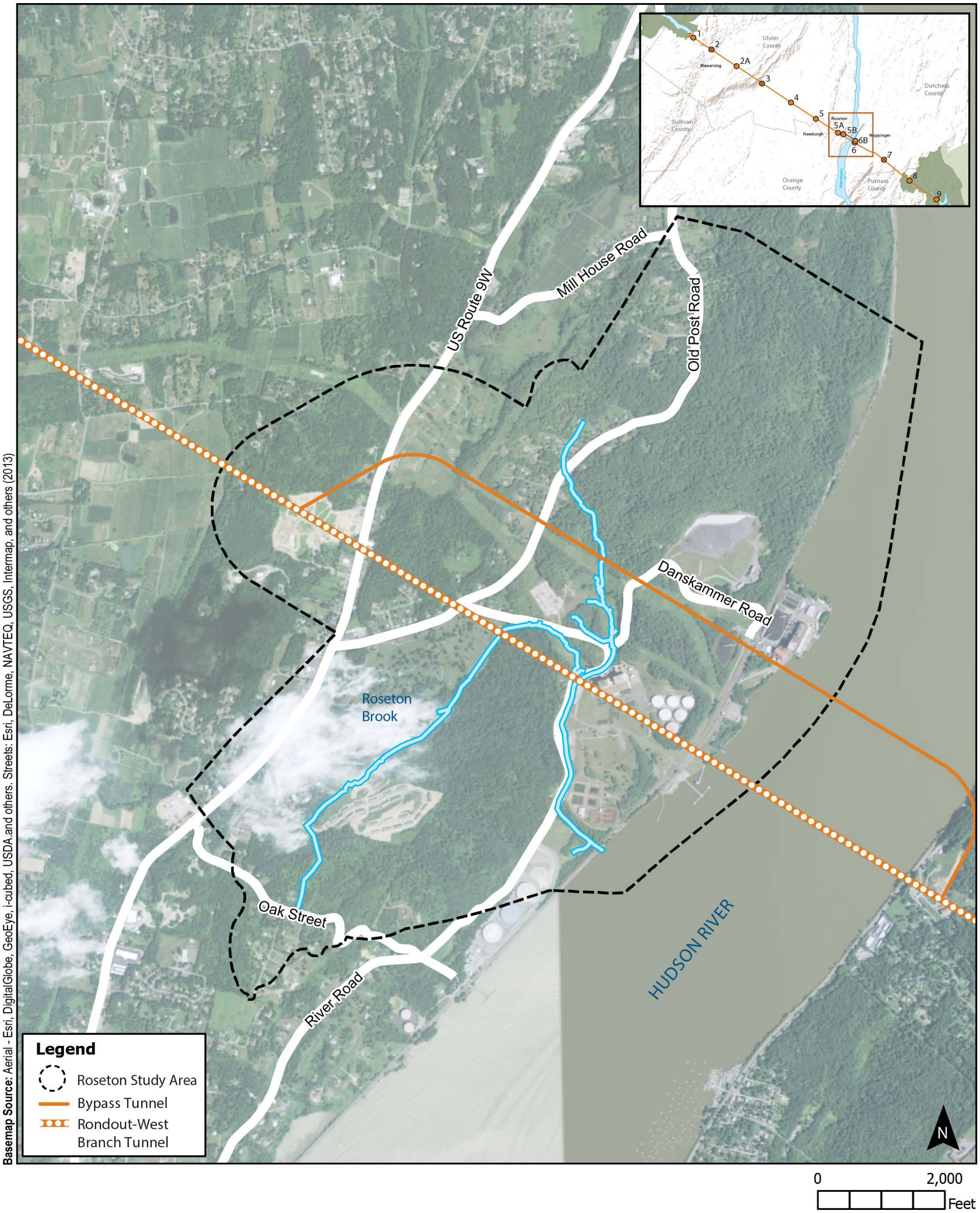
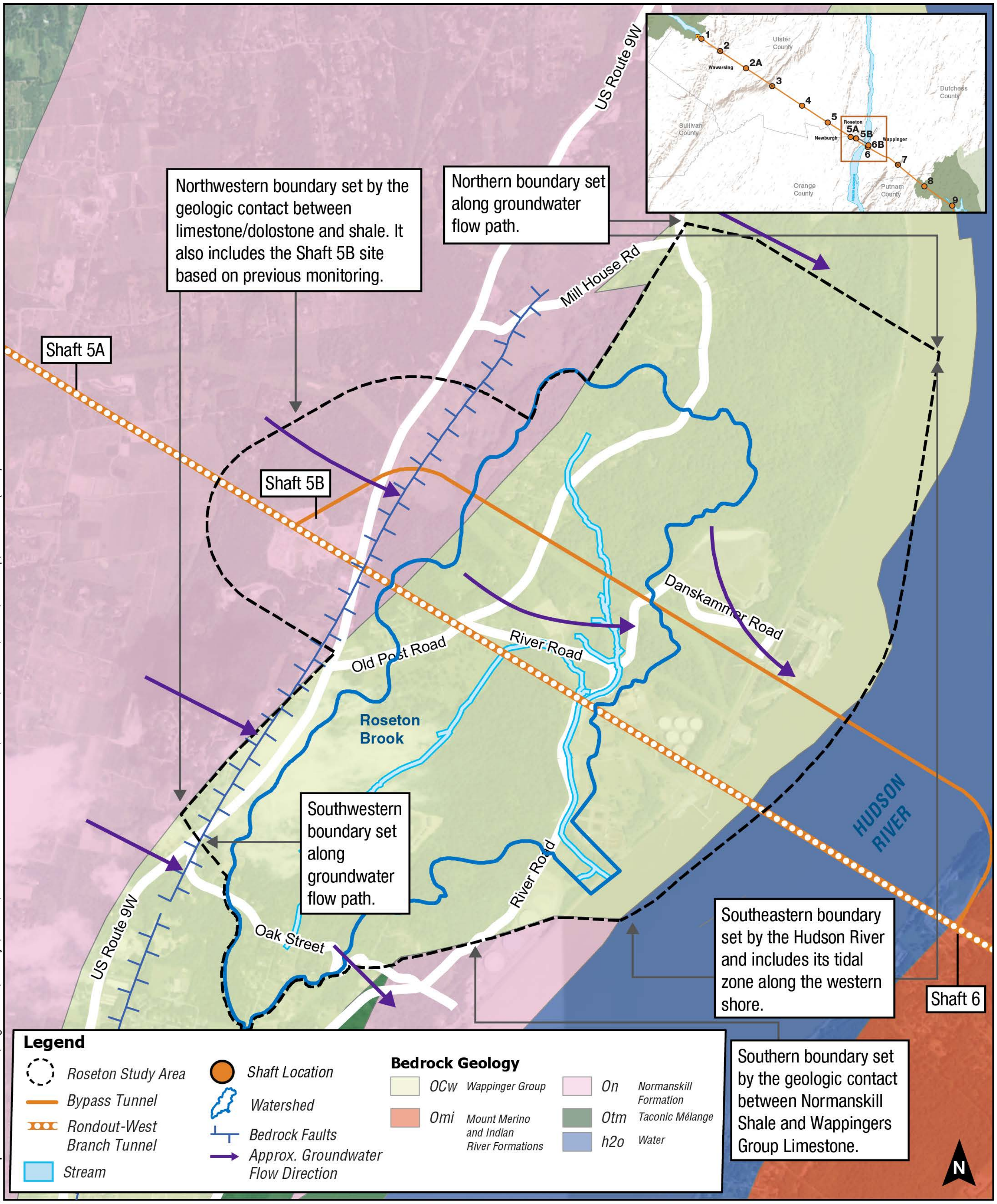


Figure 11.9-2: Roseton Study Area – Hamlet of Roseton, Town of Newburgh, Orange County



Basemap Source: Aerial - Esri, DigitalGlobe, GeoEye, i-cubed, USDA and others. Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)

Note: The boundaries of the study area form a dividing line such that groundwater on one side of the boundary does not influence or interact with groundwater on the other side.

Figure 11.9-3: Roseton Study Area – Geologic and Groundwater Features

The Roseton Study Area boundary (see **Figure 11.9-3**) was established as follows:

- The northern boundary of the Roseton Study Area is located approximately 1 mile from the RWBT near the intersection of Mill House Road and Old Post Road in the Hamlet of Marlboro. This northern boundary is where groundwater north of this boundary would not be affected by the leaks in the RWBT.
- The northwestern boundary of the Roseton Study Area generally follows the geologic contact between the Normanskill Formation and the Wappinger Group with the exception of an approximately 0.25-mile area in the vicinity of the Shaft 5B site. RWBT construction drawings indicate a prominent fault in this location that could be the controlling water flow resulting in potential RWBT influence on groundwater over this approximate 0.25-mile radius.
- The southern boundary of the Roseton Study Area is located approximately 1 mile south of the RWBT near Oak Street in the Town of Newburgh. This boundary is where groundwater south of this boundary would not be affected by leaks in the RWBT. The Roseton Study Area boundary is also based on the watershed boundary in this area that would direct surface water into or out of the Roseton Study Area. Finally, the boundary was also based on the contact between the Normanskill Formation and the Wappinger Group as water leaking from the RWBT would flow in the more permeable Wappinger Group limestone and discharge to the Hudson River.
- The southeastern boundary of the Roseton Study Area parallels the western shore of the Hudson River as groundwater in the Roseton Study Area discharges to the Hudson River or tributaries. The Roseton Study Area boundary extends approximately 500 feet into the river to include an area that contains surface expressions located along the tidal zone on the western shore.

The Roseton Study Area includes residential properties, DEP-owned and privately held parcels, roadways and a rail line. There are approximately 127 single-family and two-family residences within the study area, primarily located along U.S. Route 9W. DEP-owned parcels house structures associated with the RWBT and Bypass, including the existing Shaft 5A and west connection site (Shaft 5B) that is under construction. Private parcels consist of a cemetery, a golf club, a church, a closed power plant, an operating power generation facility, and properties and structures associated with a power transmission line. Primary roads in the study area include U.S. Route 9W, Oak Street, Old Post Road, and River Road. A freight rail line runs along the west bank of the Hudson River.

Land use types within the Roseton Study Area (see **Figure 11.9-4**) are residential, commercial, public services industrial, agricultural, community facilities, open space and recreation, and vacant land. In addition to the single and two-family residential land uses, there are condominiums located in the southern portion of the Roseton Study Area, on the east and west sides of U.S. Route 9W, and 15 parcels within the study area are designated as commercial land uses. Public service uses in the Roseton Study Area are public utility rights-of-way, including the west connection site, and the power plants which occupy the large area on the eastern portion of the Roseton Study Area between River Road and the Hudson River.

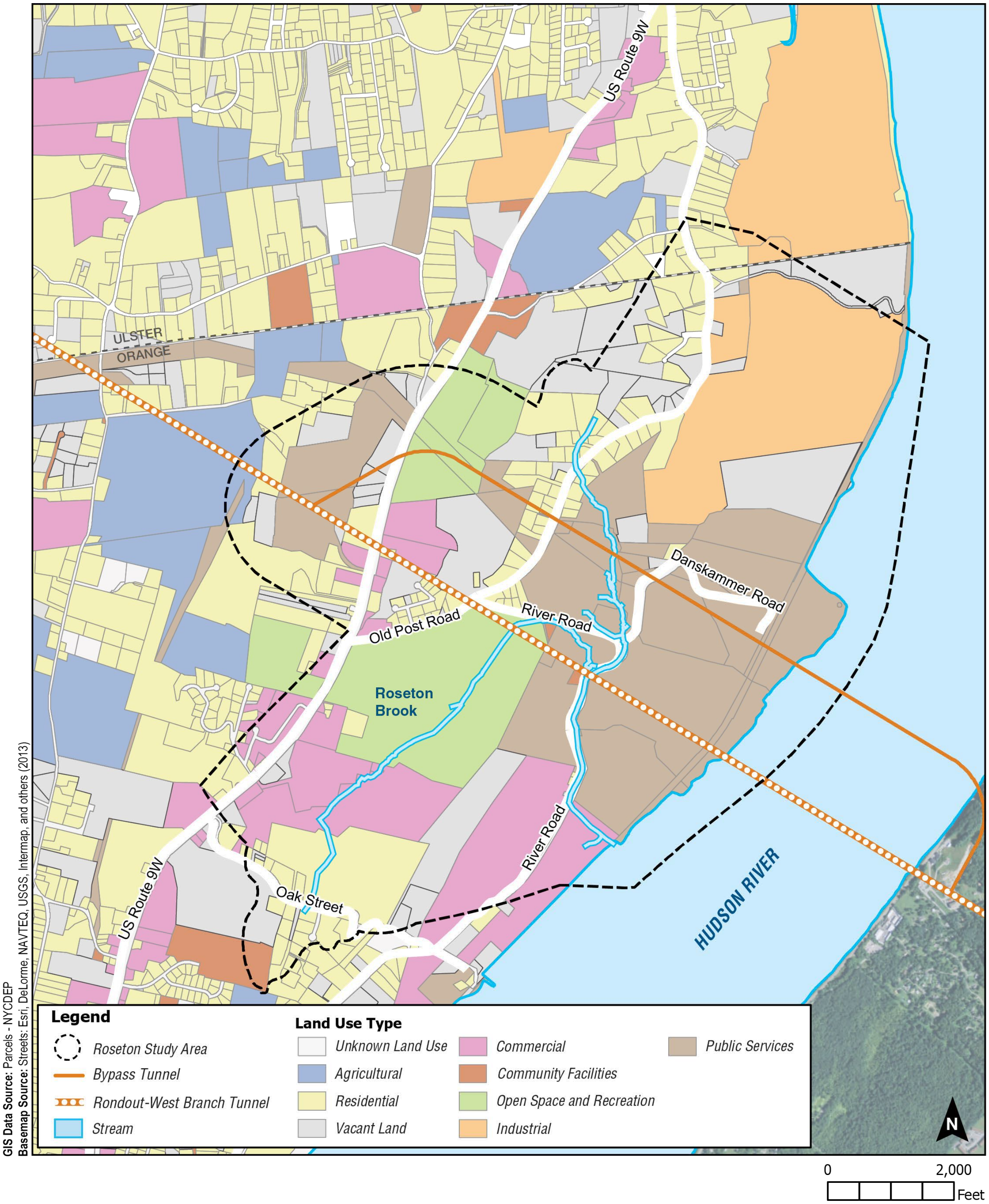


Figure 11.9-4: Land Use – Roseton Study Area

An industrial parcel identified as being used for mining and quarrying activities is located directly north of these public service land uses in the study area. Agricultural land consists of an approximately 99-acre farm located within the western portion of the Roseton Study Area. The one designated community service land use is a church located along River Road across from the power plant. Vacant land is comprised of approximately 42 parcels which may include closed businesses and empty lots along 9W and vacant wooded lots in the eastern portion of the study area.

Open spaces located along U.S. Route 9W are privately owned and include a golf course, a small field, and cemetery. There are no local, State, or federal designated historic districts, landmarks, or known archeological resources within the Roseton Study Area.

Town of Newburgh zoning districts within the Roseton Study Area (see **Figure 11.9-5)** include agricultural residence (AR), residence (R-1 and R-3), business (B), and industrial (I), refer to Chapter 185-Zoning of the Newburgh Town Code. Zoning districts AR, R-1, and R-3 are types of residential zoning districts that are distinguished from each other by the minimum lot area permitted for each land use. Zoning district AR permits single-family dwellings (not to exceed one unit per lot), municipal buildings, town activities, and agricultural operations (e.g., growing of field, greenhouse, and garden crops, vineyards, orchards and nurseries, and keeping of livestock and fowl). Zoning districts R-1 and R-3 permit single-family dwellings (not to exceed one unit per lot), municipal buildings, and town activities. Zoning district I permits light and heavy industrial uses, municipal buildings, town activities, and agricultural operations (growing of field, greenhouse, and garden crops, vineyards, orchards and nurseries, and keeping of livestock and fowl).

Zoning district B permits single-family and two-family dwellings built prior to the establishment of the B district, municipal buildings, town activities, indoor membership clubs, and funeral homes. In addition to permitted uses, all zoning districts may allow additional activities and conditional uses, subject to The Town of Newburgh Planning Board approval.

Existing Town of Marlborough Zoning districts within the Roseton Study Area (see **Figure 11.9-5)** include residential (R-1) and industrial (I) (Chapter 155-Zoning of the Town of Marlborough Town Code). Zoning district R-1 is a type of residential zoning district that is distinguished by the minimum lot area permitted for each land use and permitted use, such as one- and two-family detached dwellings, houses of worship, parks, education/institutional uses, and agricultural uses. Zoning district I permits light mechanical and industrial uses, warehouses, wholesale business, and outside storage. In addition to permitted uses, all zoning districts may allow additional activities and conditional uses, subject to The Town of Marlborough Planning Board approval.

Also, while the Roseton Study Area was initially found to be appropriate for all impact categories, as analyses progressed and additional information was collected and analyzed, impacts for some categories were estimated to occur within even more limited, discrete sections of the Roseton Study Area. Study areas for an EIS can differ depending on the technical area being analyzed. In these cases, smaller focused study areas were described and used for the relevant impact analyses. Specifically, a Natural Resources Study Area (see Section 11.9.5.1, "Natural Resources Study Area") was identified based on the drainage area that contributes to resources which are also influenced by precipitation and surface water runoff in the Roseton area.

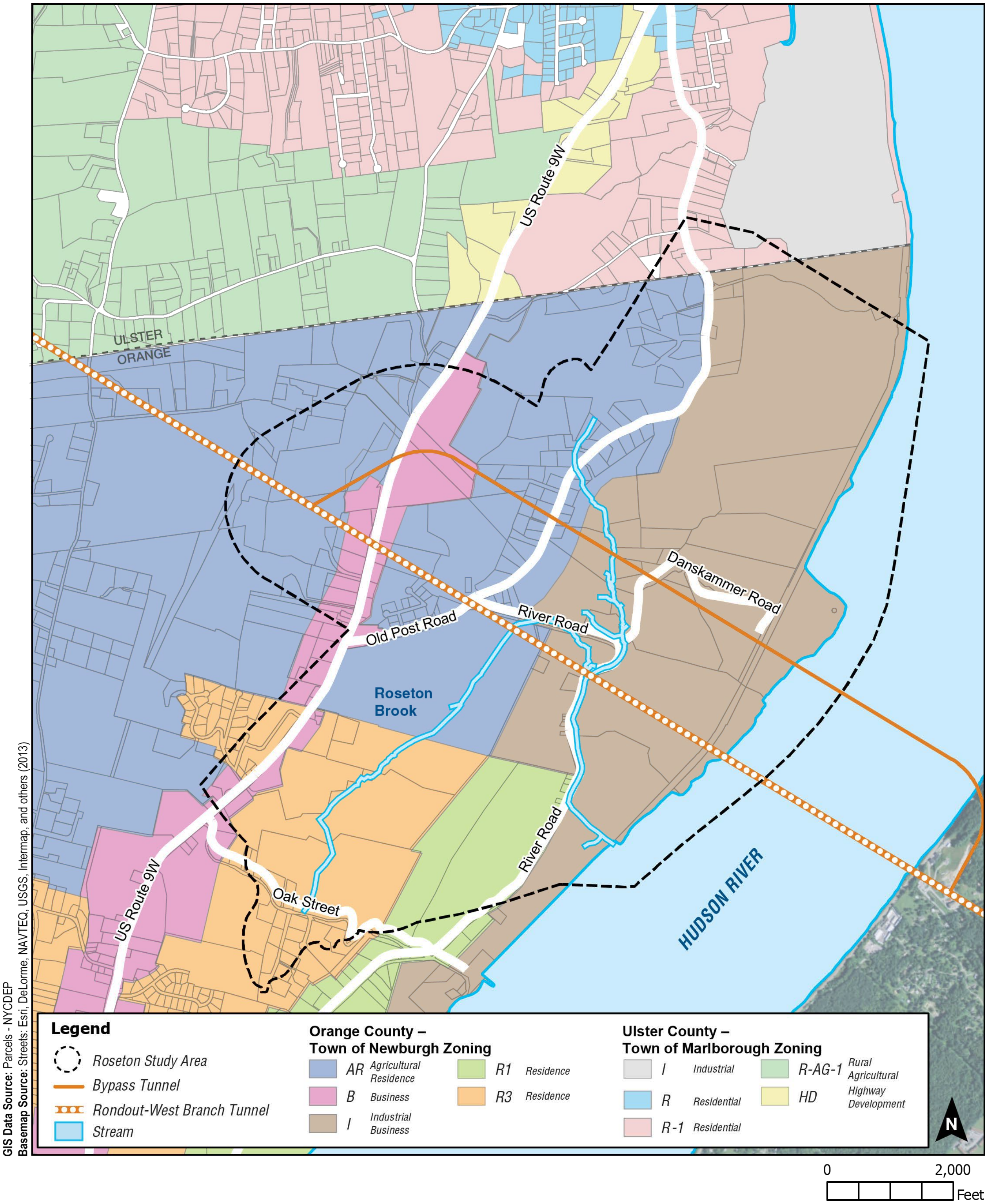


Figure 11.9-5: Zoning – Roseton Study Area

Likewise, a smaller Estimated Unconsolidated Aquifer Groundwater Influence Area and Estimated Bedrock Aquifer Groundwater Influence Area were identified based on groundwater monitoring and modeling conducted in support of the impact analysis (see Section 11.9.5.2, "Groundwater – Impact Analysis Methodology"). The boundaries of these smaller, focused study areas are depicted and described in the sections referenced above.

11.9.4 SCREENING ASSESSMENT, METHODOLOGY, AND IMPACT ANALYSIS OVERVIEW

This section provides a description of the screening assessment, methodology, and impact analysis approach used to evaluate the potential for decommissioning to result in temporary and permanent changes within the Roseton Study Area. As discussed in Section 1.1, "Overview of Water for the Future," the potential for impacts from construction of the RWBT bypass were assessed in the previous EIS.

11.9.4.1 Screening Assessment

Several of the impact categories did not warrant an assessment. A shadows assessment is not applicable because decommissioning would not result in new structures or additions to existing structures greater than 50 feet tall, or be located adjacent to, or across from, a sunlight-sensitive resource. Similarly, a solid waste and sanitation services assessment is not applicable because decommissioning would not result in the generation of 50 tons per week or more of solid waste. In addition, a greenhouse gas emissions and climate change assessment is not applicable because decommissioning would not result in any significant generation of greenhouse gases, and thus would not warrant a climate change related analysis. Finally, a critical environmental area assessment is not applicable because the Roseton Study Area is not located in any critical environmental areas.

11.9.4.2 Methodology and Impact Analysis

For each impact category that did not screen out, an impact analysis was conducted that included an evaluation of baseline conditions, future conditions without decommissioning and future conditions with decommissioning, as described further below.

As part of the impact analyses, baseline conditions applicable to each impact category were generally established by compiling data gleaned from ArcGIS (e.g., hydrologic data, maps, plans, aerial imagery, ArcGIS layers), as well as observations made during field surveys conducted between late 2012 and early 2015. Pursuant to the *City Environmental Quality Review (CEQR) Technical Manual*, future conditions for each impact category both with and without decommissioning were evaluated for the year 2022 to 2023 since the temporary shutdown would commence in October 2022, when the RWBT would be unwatered and inspected and repaired through spring 2023. Once repairs are complete in 2023, the bypass tunnel would be connected to the existing RWBT, and the bypassed segment of the RWBT would be decommissioned in place. Future conditions without decommissioning were based on typical operations during the same time periods and ongoing leaking of the RWBT. The potential for significant adverse impacts for each applicable impact category were then determined by comparing future conditions with and without decommissioning.

The methodology for analyzing impacts to groundwater, surface water, wetlands (including shallow groundwater), and geology and soils took into account DEP's historical and ongoing monitoring data of resources suspected to be influenced by the leaks that, to date, has informed the planning and implementation of Water for the Future. The analysis also includes estimates of the potential for changes to water levels from a groundwater flow model developed specifically for the Roseton area, and calculations that focused on extracting the contribution of leak water that contributes to the unique characteristics of these resources in the Roseton Study Area. The methodology and analysis sections for these categories provide an overview of the approach, data collected, and calculations, followed by more detailed technical descriptions of the data, estimates, and results.

The potential impacts from decommissioning that could result in cumulative impacts is included as part of a cumulative analysis for Upstate Water Supply Resiliency (see Chapter 12, "Cumulative Impacts").

11.9.5 NATURAL RESOURCES

This section presents the data collection and analysis methodology and assessment of potential impacts to natural resources due to decommissioning. It includes a description of baseline conditions, future conditions without decommissioning, and the potential impacts from the incremental change to water levels, waterbodies, and the associated natural resources within the Roseton Study Area. This section specifically focuses on groundwater; surface water; wetlands (including shallow groundwater); floodplains; aquatic and benthic resources; terrestrial resources (ecological communities and wildlife); federal/State Threatened, Endangered, Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species; and geology and soils that could be affected from lower water levels due to:

- The temporary shutdown where the tunnel would be unwatered; and
- The cessation of leaks as a result of decommissioning.

As described in Section 11.9.3, "Roseton Study Area: Location and Description," potential impacts from the temporary shutdown and over the long term after decommissioning could result in changes to more limited, discrete sections of the Roseton Study Area. Applicable study areas used in the analyses are referenced in the sections below. This section describes the potential impacts to the smaller natural resources study area, described in Section 11.9.5.1, "Natural Resources Study Area," or the Estimated Unconsolidated Aquifer Groundwater Influence Area or Estimated Bedrock Aquifer Groundwater Influence Area, described in Section 11.9.5.2, "Groundwater – Impact Analysis Methodology."

11.9.5.1 Natural Resources Study Area

A natural resources study area was established based on the watershed area (see **Figure 11.9-3**), precipitation, and surface water runoff in the larger Roseton Study Area.

The Natural Resources Study Area lies within the Roseton Study Area (see **Figure 11.9-6**). It encompasses the area where the temporary shutdown and decommissioning have the potential to affect surface water, wetlands (and shallow groundwater), floodplains, aquatic and benthic resources, terrestrial resources, and federal/State Threatened, Endangered, Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species. The full boundaries of the Natural Resources Study Area are shown on the inset map in **Figure 11.9-6**.

Surface water features that could be affected by decommissioning coincide with the Roseton Brook watershed associated with the NYSDEC-designated Class C stream that extends through the study area. Surface expressions, natural surface water, and wetlands drain to Roseton Brook and ultimately with the Hudson River. This natural resources study area boundary was developed using ArcGIS data to delineate the Roseton Brook watershed boundary. The location of surface water and leak-influenced streams were also included in the natural resources study area, as shown on **Figure 11.9-6.**

11.9.5.2 Groundwater – Impact Analysis Methodology

The groundwater analysis evaluated the potential for the temporary shutdown and decommissioning of the RWBT to change the water table in the unconsolidated aquifer and potentiometric water level in the bedrock aquifer (see Section 11.9.5.10, "Groundwater – Baseline Conditions," for a description of these terms). Water level changes in these aquifers could potentially affect groundwater resources within the Roseton Study Area.

The groundwater impact analysis was also used in the following three analyses:

- Potential impacts to shallow groundwater are discussed in Section 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning," because of its hydraulic connectivity to wetlands.
- Potential impacts to groundwater deeper than 10 feet below ground surface that could be used by individual water supply wells are discussed in Section 11.9.13, "Water and Sewer Infrastructure."
- Potential impacts to groundwater quality as it pertains to drinking water is discussed in Section 11.9.19, "Public Health."

For this FDEIS, shallow groundwater is defined as groundwater from just below land surface to 10 feet below land surface as groundwater from this depth could discharge to wetlands and is within the root zone of many plants. Shallow groundwater is discussed in Sections 11.9.5.4, "Wetlands – Impact Analysis Methodology," 11.9.5.12, "Wetlands – Baseline Conditions," 11.9.5.20, "Wetlands – Future Without Decommissioning."

Section 11.9.5.10, "Groundwater – Baseline Conditions," presents baseline groundwater conditions in the Roseton Study Area that were determined using the methodology described in this Section. The baseline conditions also contain a description of the groundwater aquifers and definition of groundwater terms to allow the results of the baseline conditions to be put into perspective.

GIS Data Sources: Stream Sege ments - AKRF, NWI - http://www.fws.gov/wetlands/, NYSDEC - http://www.dec.ny.gov/lands/305.html, Hydric Soils - NRCS
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Figure 11.9-6: Surface Expressions, Delineated Wetlands, and Stream Segments – Natural Resources Study Area

The methodology used to conduct the groundwater impact analysis consisted of three steps:

- ***Step 1: Establish Baseline Groundwater Conditions.*** Baseline groundwater conditions are consistent with the current conditions where the regional groundwater flow is augmented by leak water from the RWBT. Baseline conditions were established by conducting a desktop review of available groundwater information for the Roseton Study Area. This included characterizing the aquifers, regional groundwater flow conditions, groundwater use, and aquifer recharge.

  Baseline groundwater conditions were also established using groundwater data collected between 2008 and 2015 in the Roseton Study Area. These data were used to assess the seasonal groundwater water level and temperature variations in the Roseton Study Area. The water level data and temperature data were also compared to the changes in flow, water level, and temperature of water in the RWBT.

- ***Step 2: Develop a Groundwater Flow Model.*** A groundwater flow model was developed using regional published information and site-specific information generated during Step 1. The model was used to estimate the area where there could be changes to groundwater levels within the Roseton Study Area during the temporary shutdown and over the long term after decommissioning.

- ***Step 3: Assess Potential Impacts to Groundwater.*** The groundwater flow model was used to estimate potential changes in the water table in the unconsolidated aquifer and potentiometric water level in the bedrock aquifer during the temporary shutdown and over the long term after decommissioning. The model results were used to define the Estimated Bedrock Aquifer Groundwater Influence Area that also encompasses potential effects in the unconsolidated aquifer.

The analysis conducted for each of these steps is described in further detail below.

Step 1: Establish Baseline Groundwater Conditions

Baseline conditions were established based on a desktop review of available information on the groundwater system in the Roseton Study Area. This included characterizing the aquifers, regional groundwater flow conditions, and groundwater use. This also includes an analysis of potential changes in the unconsolidated and bedrock aquifers as a result of RWBT depressurizations. The approach for determining each of these components is described further, below.

- Aquifers: The unconsolidated and bedrock aquifers were classified using regional published information and site-specific information collected during the drilling of unconsolidated and bedrock wells. The thickness and grain size of the unconsolidated deposits were evaluated to assess if water in these deposits could be used as a potential groundwater supply. The amount of faults and fractures in bedrock that store and transmit groundwater were also evaluated to assess if water in the bedrock could be used as a potential groundwater supply. The amount of water recharging the bedrock aquifer at each residential parcel in the Roseton Study Area was calculated based on the lot size (1-acre zoning), precipitation, and geologic conditions. These calculations are described in Section 11.9.5.10, "Groundwater – Baseline Conditions."

- Groundwater Flow Conditions: The regional groundwater flow direction was estimated based on review of the Orange County Groundwater Study (OCWA 1994) and NYSDEC aquifer mapping. The groundwater conditions in the Roseton Study Area were assessed by measuring groundwater levels in monitoring wells for one year to document the seasonal water table fluctuations in the unconsolidated aquifer and potentiometric water level fluctuations in the bedrock aquifer. Groundwater temperature was also measured in monitoring wells for one year to document the seasonal groundwater temperature fluctuations. Seasonal groundwater level and temperature variations were used to differentiate natural groundwater from water leaking from the RWBT. Groundwater level measurements were collected from monitoring wells shown on **Table 11.9-1** and **Figure 11.9-7**.

- Groundwater Use: The Town of Newburgh, Orange County and Ulster County records (GIS maps and water billing records by tax parcel identification) were reviewed to identify groundwater users in the Roseton Study Area. This review identified municipal water district boundaries near the Roseton Study Area that rely on groundwater as a water supply. Individual users of groundwater resources in the Roseton Study Area were identified based on a review of NYSDEC's database of well completion reports (NYSDEC 2014), municipal water system billing information, and GIS-based water district maps.

- RWBT Depressurization Monitoring: DEP reduced the HGL (i.e., depressurized and reduced the flow and water level) in the RWBT six times between 2008 and 2014. Bedrock monitoring wells in the Roseton Study Area were monitored during depressurizations to assess if changes in HGL resulted in decreased water levels in unconsolidated and bedrock wells (see **Figure 11.9-8** and **Figure 11.9-9**). Depressurization events, the maximum HGL change and duration of each depressurization event, and the number of wells monitored during the depressurization are listed in **Table 11.9-2** below.

Step 2: Develop a Groundwater Flow Model

A groundwater flow model was constructed to estimate the area and magnitude of groundwater level changes that could result from the temporary shutdown and over the long term after decommissioning. FRAC3DVS numerical finite element code (Therrien et al. 1997) was used to characterize groundwater flow through subsurface geology. The model incorporates surface topography, subsurface geology, surface water streams and rivers, the RWBT and information collected during RWBT construction. Model calibration was performed using static groundwater levels and groundwater levels that were measured during depressurizations.

Once the groundwater flow model was calibrated, it was used to simulate the pressure (i.e., water level) changes at the interface between the bedrock and unconsolidated aquifer during the temporary shutdown and over the long term after decommissioning. These data were used to estimate potential changes to the water table in the unconsolidated aquifer during the temporary shutdown and over the long term after decommissioning. The model was also used to estimate the potentiometric water levels in the bedrock aquifer during the temporary shutdown and over the long term after decommissioning.

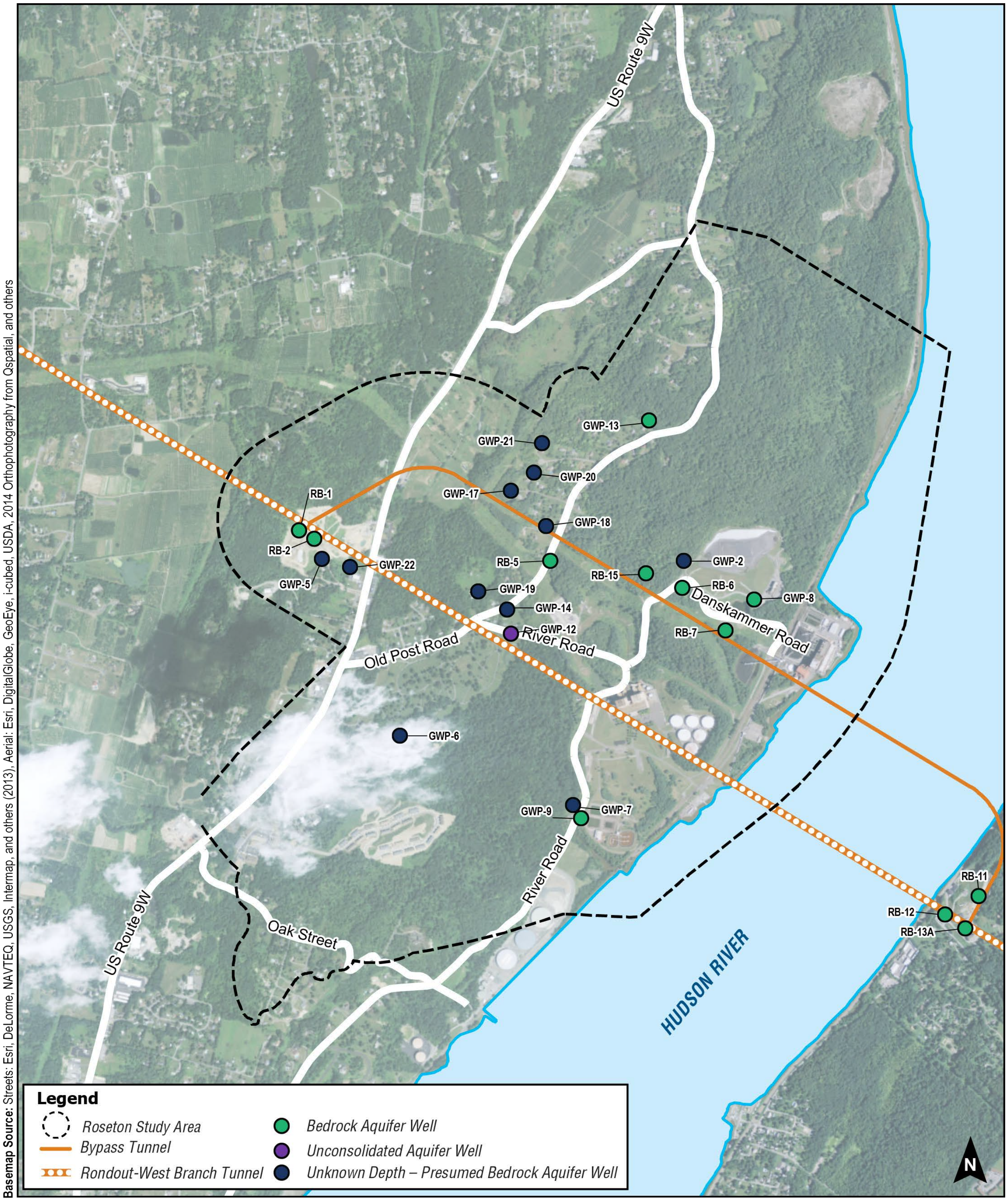
Table 11.9-1: Roseton Study Area Groundwater Monitoring Locations

Well	Location
GWP-2	Parcel 8-1-71 Residential
GWP-5	Parcel 8-1-15.3 Residential
GWP-6	Parcel 9-1-17 Cemetery
GWP-7	Parcel 9-1-32 Residential
GWP-8	Parcel 8-1-75.22 Willowstick #1
GWP-9	Parcel 9-1-29 Willowstick #2
GWP-12	Parcel 9-1-17 Cemetery
GWP-13	Parcel 8-1-47 Residential
GWP-14	Parcel 8-1-35.221 Residential
GWP-17	Parcel 8-1-101 Residential
GWP-18	Parcel 8-1-89 Residential
GWP-19	Parcel 8-1-34.1 Residential
GWP-20	Parcel 8-1-42.33 Residential
GWP-21	Parcel 8-1-43.44 Residential
GWP-22	Parcel 8-1-15.1 Commercial
RB-1	Parcel 8-1-19.1
RB-2	Parcel 8-1-19.1
RB-5	Parcel 8-1-67.2
RB-6	Parcel 8-1-75.22
RB-7	Parcel 8-1-75.3
RB-11	Parcel 6056-01-288977-0000
RB-12	Parcel 6056-01-288977-0000
RB-13A	Parcel 6056-01-288977-0000
RB-15	Parcel 8-1-69

Notes:
GWP: (Groundwater Point) groundwater monitoring locations
RB: Tunnel design geotechnical borings with multi-level piezometers

Table 11.9-2: Depressurization Events

Depressurization Period	Maximum HGL Change	Duration	Number of Wells Monitored
February - March 2008	510 Feet	14 Days	8 Wells
October - November 2008	510 Feet	44 Days	2 Wells
November 2009	510 Feet	11 Days	6 Wells
December 2009	510 Feet	12 Days	6 Wells
January 2010	500 Feet	15 Days	6 Wells
October 2014	120 Feet	6 Days	15 Wells 3 Piezometers



Note: Wells identified as presumed bedrock aquifer wells are wells that are reported to be bedrock wells due to field observations and monitoring data, but whose depths are unknown.

Figure 11.9-7: Groundwater Monitoring Locations – Roseton Study Area

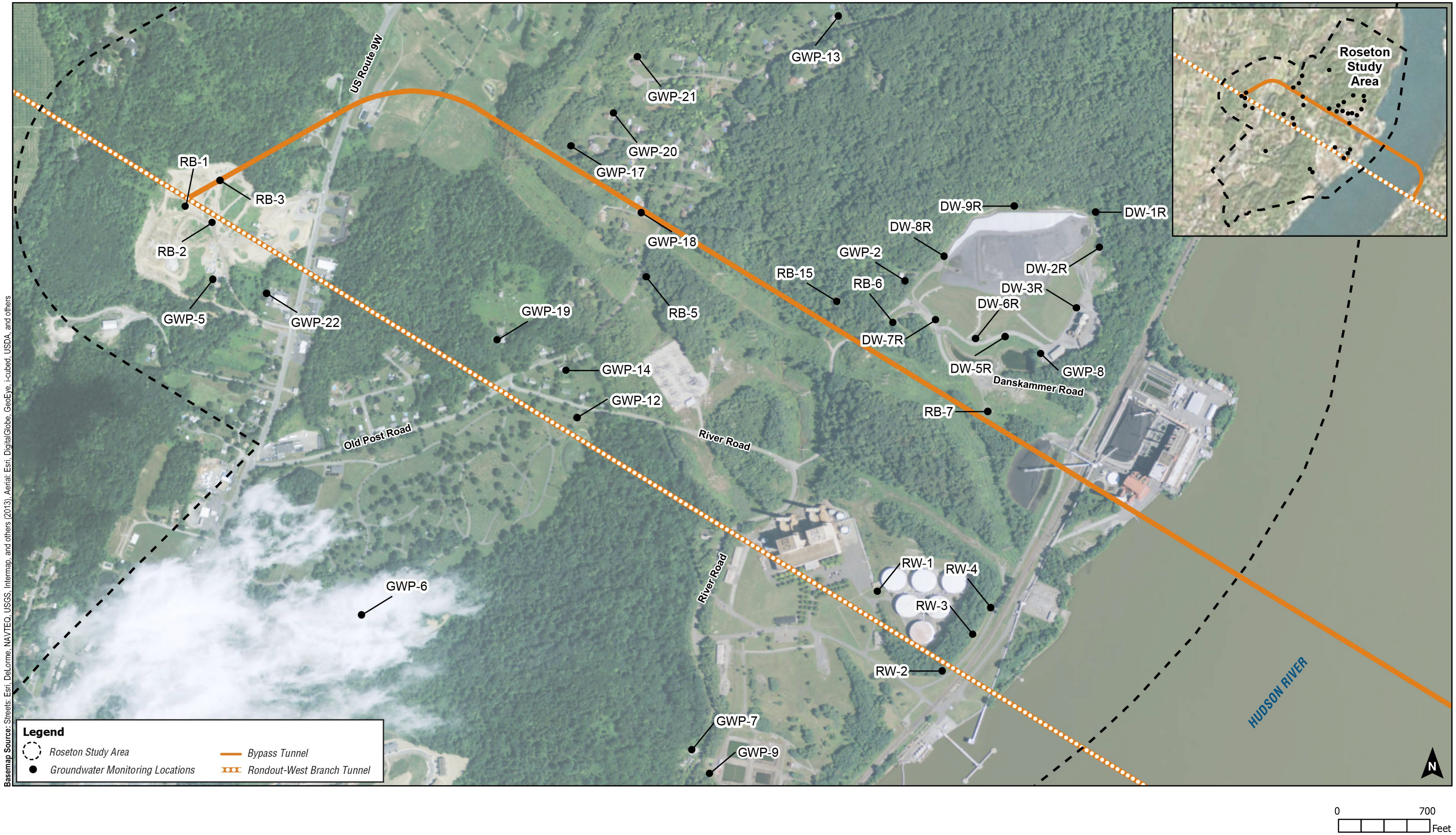
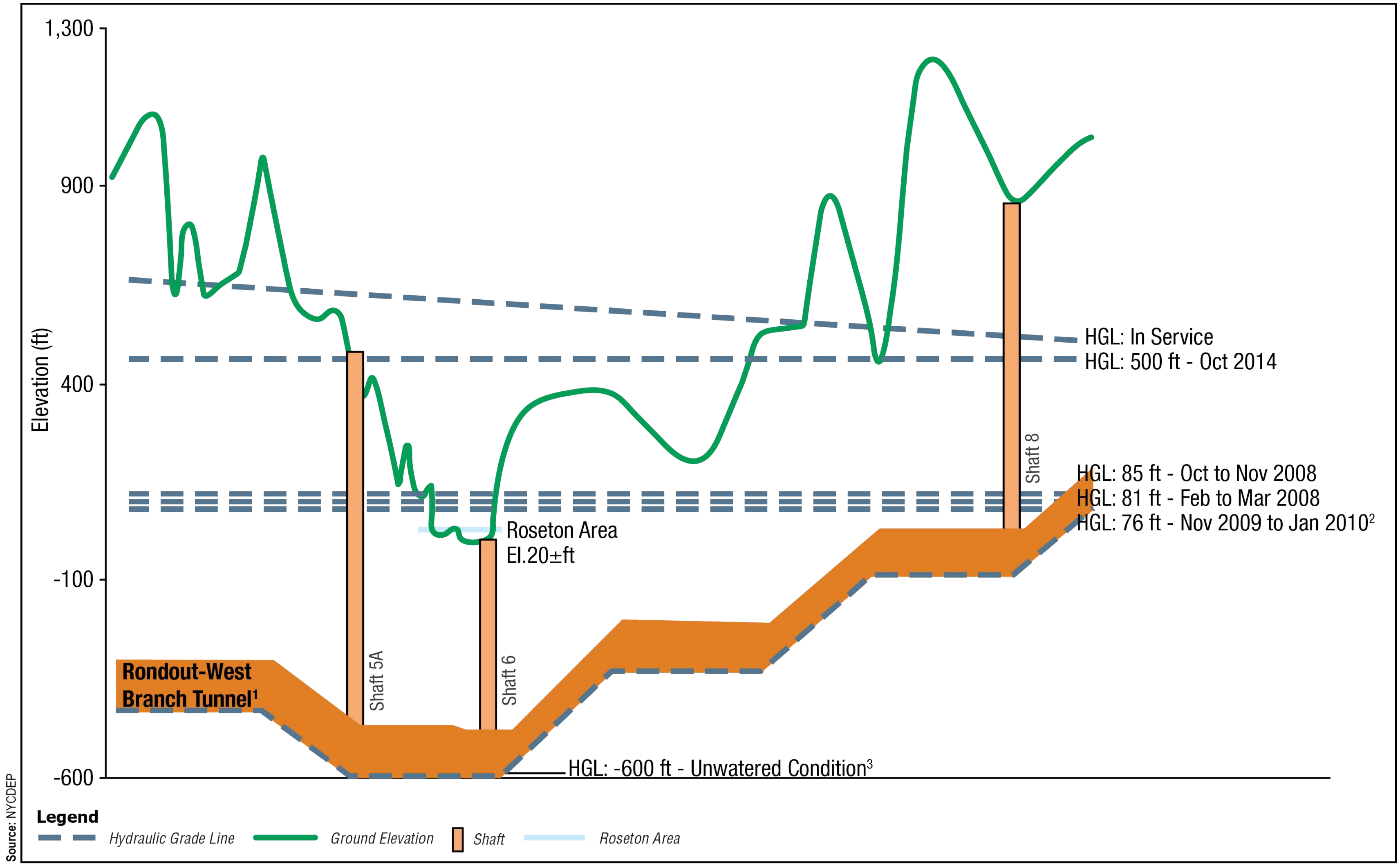


Figure 11.9-8: Prior Depressurization Monitoring Locations – Roseton Study Area



Notes:

[1] Tunnel bottom and ground elevation shown to scale. Tunnel height enlarged for clarity.

[2] The stabilized level varied between 76 and 85 ft. 76 ft shown.

[3] -600 ft at the lowest point. Shown as dotted line near the bottom of the RWBT.

HGL = Hydraulic Grade Line

Not to scale

Figure 11.9-9: Hydraulic Grade Line in the Rondout-West Branch Tunnel

Step 3: Assess Potential Groundwater Quantity Impacts

Potential groundwater quantity impacts were assessed based on the estimated changes to groundwater levels during the temporary shutdown and over the long term after decommissioning using the data developed in Steps 1 and 2.

The area with estimated groundwater levels changes were defined by comparing the potential changes in the unconsolidated aquifer to potential changes in the bedrock aquifer. The larger of the two has been identified as the Estimated Bedrock Aquifer Groundwater Influence Area for the impact analysis.

As previously noted, the potential for impacts to the users of groundwater for water supply is discussed under Section 11.9.13, "Water and Sewer Infrastructure," and the analysis of changes to groundwater quantity and quality as it pertains to drinking water standards for these users is discussed in Section 11.9.19, "Public Health."

11.9.5.3 Surface Water – Methodology

The surface water analysis consisted of evaluating the potential for cessation of leaks to result in changes to the quantity and quality of water flowing above the ground surface, referred to herein as surface water or streams. Streams in the natural resources study area (described in Section 11.9.5.1, "Natural Resources Study Area,") were assessed on both an annual and seasonal (growing and non-growing) basis using the following approach.

- ***Step 1: Establish Baseline Surface Water Conditions*****.** A desktop review was completed to establish surface water conditions in the natural resources study area. Field surveys were conducted and streamflow and water quality monitoring data were collected to document baseline conditions.

- ***Step 2: Conduct a Surface Water Analysis.*** Streamflow measurements were collected and plotted as hydrographs. The hydrographs were used to separate surface water that is from groundwater and surface water that is direct runoff from precipitation. The amount of groundwater in the streamflow in Roseton was compared to groundwater in streams with similar watershed characteristics, such as percent urban land use; percent forest cover; mean annual temperature; mean annual precipitation; and dominant geology. Considerable differences in these comparisons were attributed to leak water, which was then quantified for each stream segment. Additionally, baseline surface water conditions were established using streamflow duration curves that plot relationships between frequency (i.e., likelihood of occurrence) and flow rate, and a seepage investigation to characterize the leak water contributing to each of the stream segments.

- ***Step 3: Assess Potential Impacts to Surface Water.*** Based on the results from Step 2, projected streamflow hydrographs were developed by assuming leak contributions to be constant for each stream segment but variable between stream segments. The assumed leak contributions were subtracted from measured hydrographs for each stream segment. These data were then converted into a time series of stream stages (i.e., water levels) from which various percentiles were plotted on stream segment cross-sections. Changes to water quality were qualitatively estimated based on comparisons with stream segments likely uninfluenced by the leaks.

The analysis conducted for each of these steps is described in greater detail below.

Step 1: Establish Baseline Surface Water Conditions

The first step in analyzing the potential for impacts to surface water was to establish baseline conditions of the surface water. A desktop review was completed by compiling and analyzing surface water monitoring data to document baseline conditions on the surface water system in the natural resources study area.

Desktop Review and Field Surveys

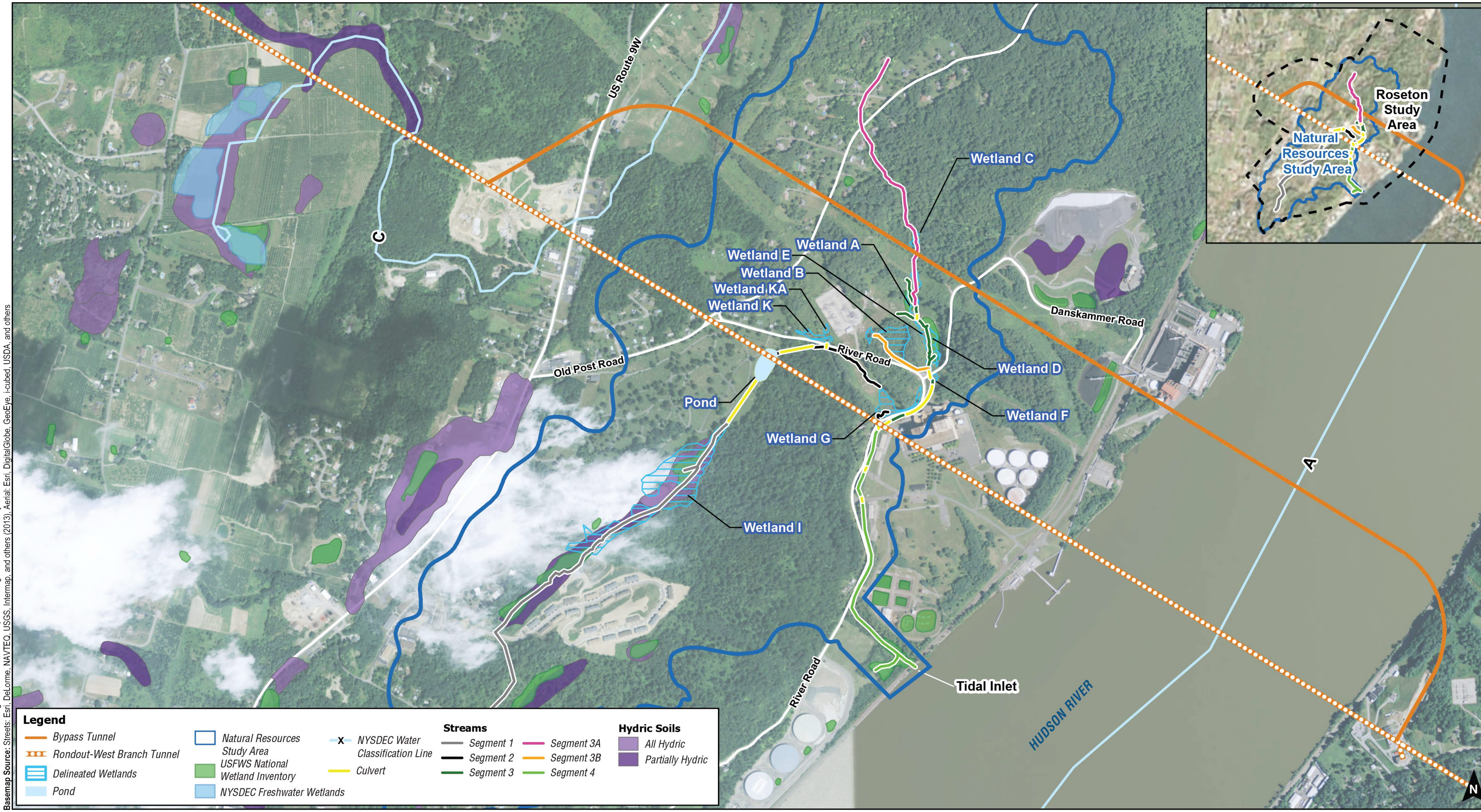
Existing surface water features were identified through a review of stream segments identified on aerial photographs and USGS hydrography data. A general survey, including field documentation of wetlands and watercourses in the natural resources study area, was conducted between October 1 and 4, 2012, and on October 19, 2012. Return visits were made to the wetlands and watercourses during June and August 2013 to verify observations from 2012 and to conduct wetland and watercourse delineations following U.S. Army Corps of Engineers (USACE) procedures (Environmental Laboratory 1987) (USACE 2012). Surveys generally followed contiguous wetlands and watercourses associated with Stream Segments 1, 2, 3, 3A, 3B, and 4 (see **Figure 11.9-10**), which together comprise a perennial tributary to the Hudson River known as Roseton Brook (see Section 11.9.5.4, “Wetlands – Impact Analysis Methodology,” for a description of the wetland delineations). Watercourses within the study area were delineated using indicators of ordinary high water marks as described in 33 Code of Federal Regulations (CFR) 328.3. Flags were placed on either side of the stream banks at the locations of ordinary high water marks and then recorded using a Trimble Differential Global Positioning System (DGPS) unit. The data was post-processed with ArcGIS software.

Surface Water Monitoring

Baseline surface water levels and quality were established by analyzing monitoring data that has been ongoing in the study area since 2008, and through a surface water monitoring network consisting of 15 surface water monitoring locations. The surface water monitoring network was installed in 2013 consisting of seven stilling wells equipped with water level meters, and seven water quality meters. All meters recorded data at 10-minute intervals.[1] The surface water monitoring stations are shown in **Table 11.9-3**. **Figure 11.9-11** provides a map of the monitoring station locations, while **Figure 11.9-12** provides a surface water network diagram that illustrates the monitoring locations and their connection between stream segments, conveyances (i.e., culverts), and storage features (i.e., ponds).

[1] An additional water level meter, S3-SW-05, was installed in late 2014. However, data from this water level meter was not included in the surface water assessment due to the short monitoring period.

GIS Data Sources: Stream Segments - AKRF, NWI - http://www.fws.gov/lands/305.html, Hydric Soils - NRCS
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others



Note: USFWS = U.S. Fish and Wildlife Service
NYSDEC = N.Y.S. Department of Environmental Conservation

0 1,000 Feet

NYC Environmental Protection

Figure 11.9-10: Surface Water – Natural Resources Study Area

Table 11.9-3: Natural Resources Study Area Surface Water Monitoring Stations and Instrumentation

Stream Segment	Location	Station ID	Stream Instrumentation
Segment 1	Middle	S1-SW-01	Water Level Meter
		S1-WQ-01	Water Quality Meter
Segment 3A	Upstream End	S3-SW-01	Water Level Meter
		S3-WQ-01	Water Quality Meter
Segment 3	Above Confluence with 3A	S3-SW-02	Water Level Meter
		S3-WQ-02	Water Quality Meter
	Above Confluence with 4	S3-SW-05	Water Level Meter
Unnamed Tributary	Above Confluence with 3	S3-SW-03	Water Level Meter
		S3-WQ-03	Water Quality Meter
Segment 3B	Above Confluence with 3	S3-SW-04	Water Level Meter
		S3-WQ-04	Water Quality Meter
Segment 4	Upstream End	S4-SW-01	Water Level Meter
		S4-WQ-01	Water Quality Meter
Segment 4	Downstream End	S4-SW-02	Water Level Meter
		S4-WQ-02	Water Quality Meter

Notes:
WQ: Water quality station
SW: Stilling well with staff gauge

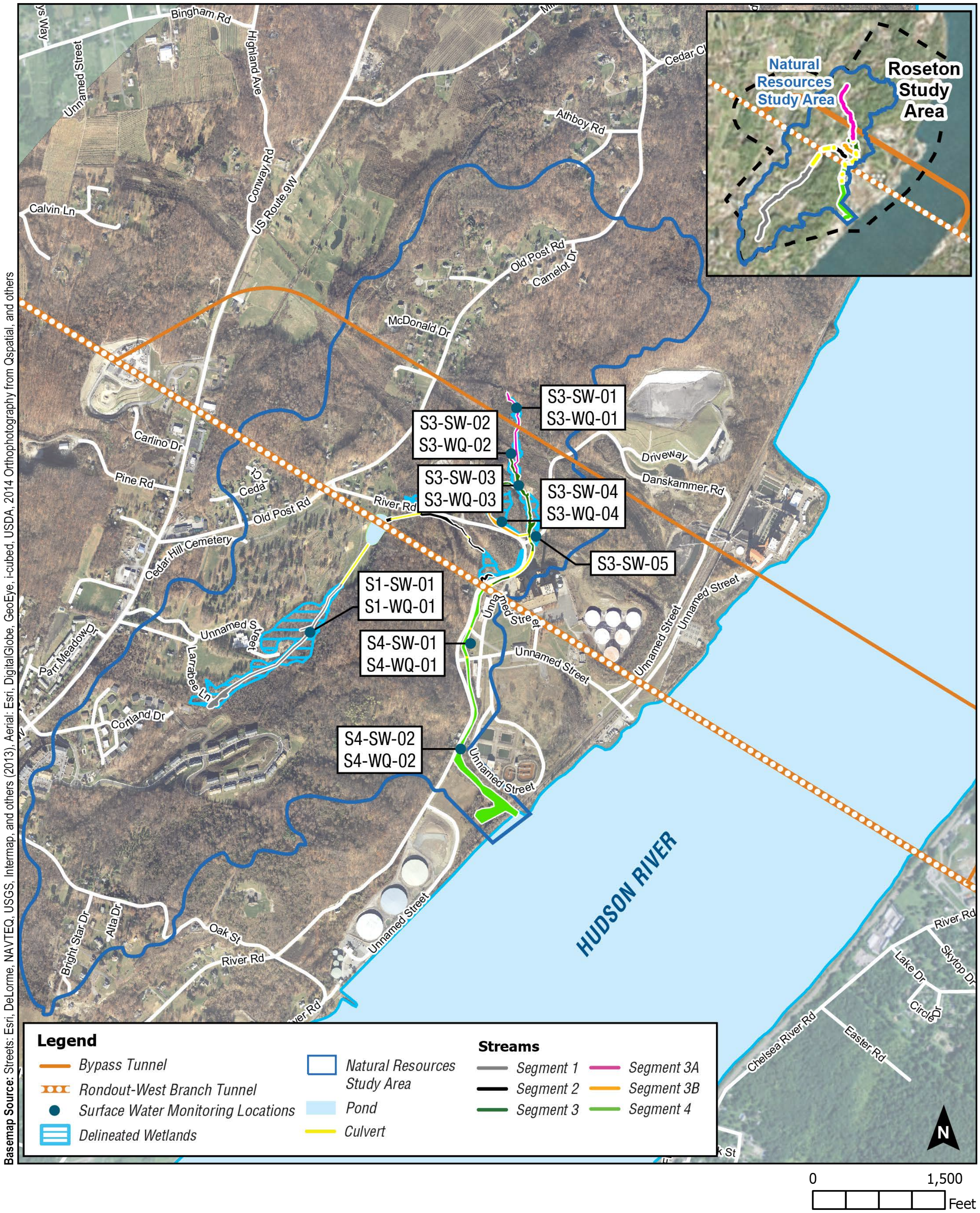


Figure 11.9-11: Surface Water Monitoring Station Locations – Natural Resources Study Area

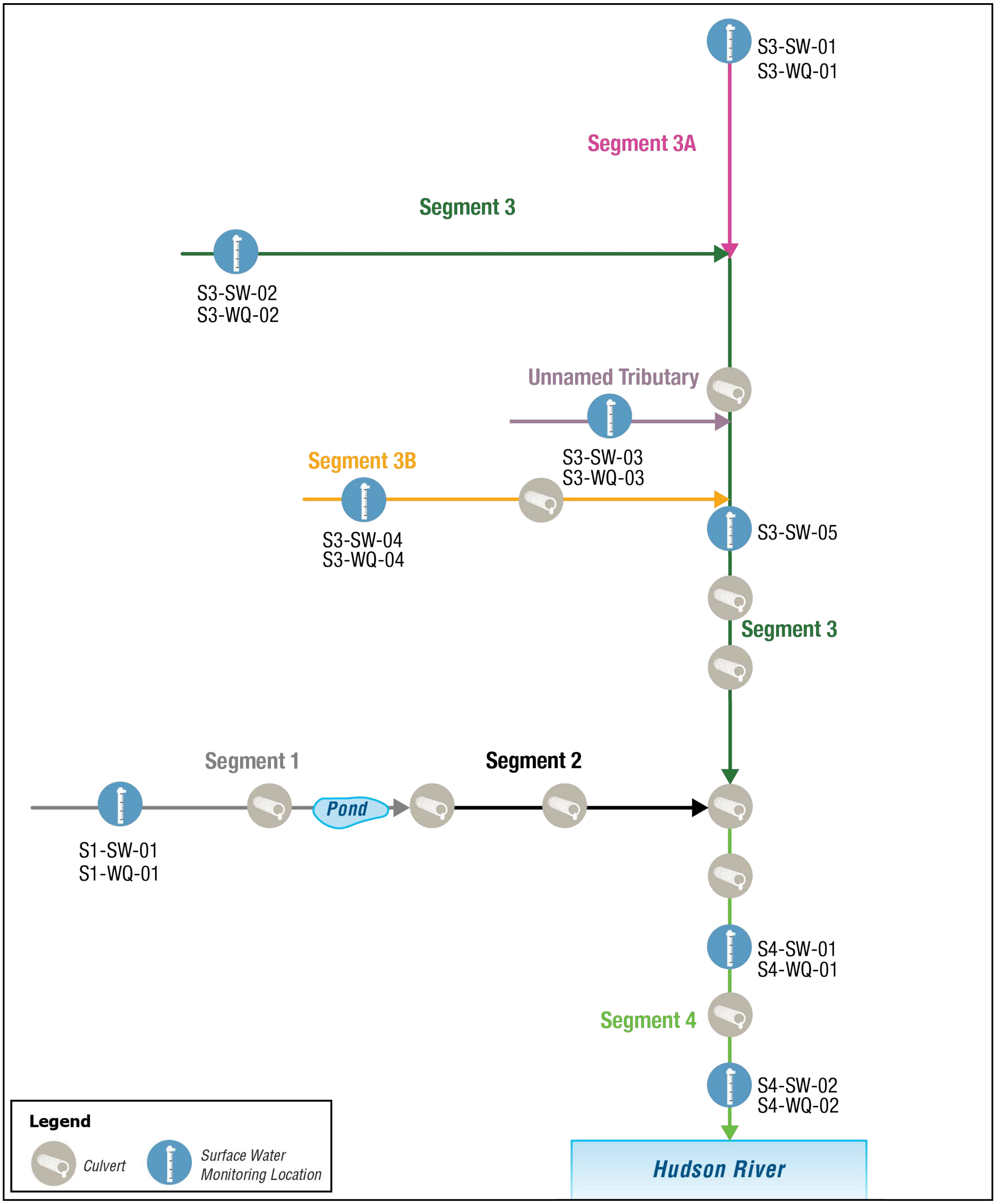


Figure 11.9-12: Surface Water Network Diagram – Natural Resources Study Area

Field visits to the stations were made on a quarterly basis to retrieve data and verify it against manual observations, in addition to measuring dissolved oxygen and pH. Water quality data was also collected as part of aquatic surveys conducted at 14 macroinvertebrate/electrofishing locations in 2012, 2013, and 2015 (see Section 11.9.5.30, “Aquatic and Benthic Resources – Probable Impacts With Decommissioning”). Also, a weather station was established in the Roseton Study Area on DEP property to record air temperature and precipitation and used for comparison to changes in groundwater and surface water levels recorded by the surface water monitoring network. Annual and seasonal precipitation totals were compared to long-term (1949 to 2014) mean annual and seasonal precipitation totals at the nearby Dutchess County Airport National Weather Service station to assess the wetness of the monitoring period.

DEP periodically reduces the flow in the RWBT. Surface water observations from the prior depressurizations between 2008 and 2010 were reviewed. During the October 2014 depressurization, data from the surface water monitoring network was collected, along with measurements of the RWBT’s pressure profile, which drives the rates at which water flows through, and consequently, leaks from the RWBT. The pressure profile data and RWBT temperature and turbidity observations were compared with the surface water monitoring data to identify correlations that could imply leak water influence.

Step 2: Conduct a Surface Water Analysis

Surface water monitoring data was analyzed to determine if leak water was entering the surface water system. Leak water could contribute to the streams’ baseflow, which is the portion of streamflow that comes from groundwater and sustains the stream during dry weather. Its counterpart, quickflow (also referred to as direct runoff), is the more rapid contribution that increases streamflow in reaction to a precipitation event. For stream segments affected by leaks, baseflow would likely decrease from cessation of leaks due to decommissioning. However, quickflow due to precipitation and runoff would not change.

Streamflow, baseflow, and leak contributions were estimated for each stream segment using the following methodology.

- ***Streamflow Estimates Were Developed***. The Manning’s equation (described below) was used to develop flow rating curves to convert water level measurements into streamflow at surveyed cross-sections of stream segments. These stream segments were then assessed for potential impacts during RWBT depressurizations.

- ***A Baseflow Index Analysis Was Conducted.*** Hydrographs were separated into baseflow and quickflow components. The baseflow index was calculated for each stream segment representing the percentage of streamflow that is made up of baseflow over a specified period of time. These baseflow indices were compared to baseflow indices for streams with similar watershed characteristics in the region of the study area that are not influenced by leaks.

- ***Leak Contributions Were Estimated.*** Baseflow indices for the streams were used to establish a range of baseflow rates that would be typical for the study area under natural conditions. This range was used in conjunction with baseflow indices calculated for stream segments in the study area to estimate mean leak contributions.

- ***A Seepage Investigation Was Conducted.*** To validate the estimated leak contributions, a seepage investigation was conducted during a period of no rain. During the field investigation, near-simultaneous measurements of streamflow were recorded at many locations along the stream system to determine the amount of water entering and exiting each stream segment from sources other than precipitation (i.e., groundwater).

A more detailed description of each of these analyses is provided below.

Develop Streamflow Estimates

The processing of most surface water records requires the application of one or more rating curves, which are graphs depicting relationships between stream stage (independent variable) and streamflow (dependent variable) at a particular location. For this analysis, rating curves were developed to convert observations of stream stage into estimates of streamflow using USGS standard procedures. The rating curves were based on Manning's equation, an empirical formula that relates the velocity of a liquid flowing under gravity in an open channel to the level of the liquid within that channel. Parameters used for Manning's equation include the slope of the channel, the surface roughness of its bed and banks (referred to as Manning's roughness coefficient), and the geometry of its cross-section. The velocity is then multiplied by the cross-sectional area of flow to obtain estimates of streamflow:

$$V = \frac{1.49}{n}(A/P)^{2/3}S^{1/2} \quad \text{and} \quad Q = AV$$

In this formula, V is average velocity, n is the Manning's roughness coefficient, A is the cross-sectional area of the channel that is submerged by water, P is the portion of the streambed and banks in contact with water (known as the wetted perimeter), S is the slope of the energy grade line (roughly equivalent to the slope of the channel bed), and Q is streamflow.

To determine submerged areas and wetted perimeters for various stream stages and the slope of the channel bed, stream segment cross-sections and longitudinal profiles were developed from field surveys. Estimates of Manning's roughness coefficient were based on size-class frequency distributions of pebble samples from the stream substrate using RiverMORPH, a software program for stream assessment. Rating curves based on Manning's equation were then developed and applied to the observed stream stage data, and the resulting flow rates were averaged into hourly and daily flow rates for use in the analysis.

Conduct a Baseflow Index Analysis

Once the streamflows were estimated, time series of these estimates were partitioned into baseflow and quickflow components. A computer program developed by Wahl and Wahl (Wahl and Wahl 1988) was used to perform the hydrograph separation. The Wahl program uses empirical techniques to identify periods of storm-induced streamflow and generate a smooth curve separating the baseflow from the flashier quickflow. Once the hydrographs had been separated, streamflow and baseflow duration curves, which show relationships between flow rates and frequency, were developed and interpreted for each of the monitoring stations.

Baseflow index represents the percentage of streamflow that is made up of baseflow (flow in the stream during periods of no precipitation) over a specified period of time, typically obtained through hydrograph separation. It is an important metric for this analysis since it has been demonstrated to be related to the hydrogeologic characteristics of a watershed. Several studies have used these characteristics to successfully estimate baseflow indices, including Neff et al. (Nef et al. 2005) and Stuckey (Stuckey 2006). For this analysis, baseflow indices were computed for reference streams in the region of the study area with similar watershed characteristics and used to establish a range of baseflow indices that would be typical for the study area under natural conditions.

Reference streams were selected from the GAGES-II database (Falcone et al. 2010), which is a compilation of several hundred watershed characteristics, including long-term baseflow indices, for 9,322 streamflow gauges maintained by the USGS.[2] Selections were limited to the northeast United States (Pennsylvania, New Jersey, and northwards) and based on streams whose watershed characteristics – parameters related to land use, climate, and geology – are within a particular range of values bracketing those values for the study area. Additional reference streams, some of whose watershed characteristics may be slightly outside these ranges, were selected within 20 miles of the study area.

Once the reference streams were selected, baseflow indices were computed for the observed monitoring data, collected under baseline (leak-influenced) conditions, following a three-step process. First, the Wahl program was used to separate hydrographs for the reference streams, and long-term baseflow indices (representing the entire time period of each streamflow record) were computed and validated against baseflow indices from the database. Next, baseflow indices for just the period of January 1, 2014 to September 30, 2014, which coincided with the period of monitoring data for the study area, were computed for each reference stream.[3] Finally, baseflow indices for this same period were computed for the seven monitoring stations in the study area.

Estimate Leak Contributions

A mean leak contribution was estimated for each monitoring station by assuming a typical range for its baseflow index under non-leak-influenced conditions. This range was based on baseflow indices computed over the monitoring period for the reference streams and expected standard errors based on the baseflow estimation literature (Neff et al. 2005 and Stuckey 2006, as cited above). For each monitoring station, the range of the total non-leak groundwater contribution for the monitoring period was estimated based on the equation:

$$Q_g/(Q_g + Q_q) = \text{Baseflow Index}$$

[2] Falcone et al. 2010; http://water.usgs.gov/GIS/metadata/usgswrd/XML/gagesII_Sept2011.xml.

[3] The actual monitoring period began in October 2013; however, for the first three months, the monitoring equipment for one station was faulty and was therefore not used.

In this equation, Q_g is the total estimated groundwater contribution, Q_q is the total observed quickflow during the monitoring period, and Baseflow Index is either the upper or lower bound of the typical baseflow index range under non-leak conditions. Next, the leak contribution for this same period was estimated based on the equation:

$$Q_g + Q_l = Q_b$$

In this equation, Q_l is the total estimated leak contribution and Q_b is the total observed baseflow during the monitoring period. Finally, the mean leak contribution was estimated by dividing Q_l by the number of days in the monitoring period. A sensitivity analysis was also performed to demonstrate the effect of the choice of baseflow index on leak estimates.

Conduct a Seepage Investigation

Seepage investigations allow the assessment of gains (increases in streamflow over a stream reach as a result of groundwater seeping in) and losses (decreases in streamflow over a reach as a result of streamflow seeping out) within a stream system through the nearly simultaneous collection of precise streamflow observations at many different locations (Ely et al. 2008; Lee 2011). Stream reaches with disproportionately large gains could suggest the influence of leaks. To validate the baseflow index analysis and further inform the surface water analysis, a seepage investigation was performed during a dry period in September 2014.

For the seepage investigation, field data were collected over a two-day precipitation-free period that was preceded by dry conditions for at least 3 days. During this time, streamflow and various water quality parameters (temperature, conductivity, dissolved oxygen, and pH) were measured at 21 locations throughout the six-segment stream system. Seven of these locations coincided with the long-term streamflow monitoring stations described above. Measurements of streamflow were taken using a hand-held acoustic Doppler velocimeter (ADV) in accordance with USGS Office of Surface Water protocols, policies, and published guidance (Rantz et al. 1982; Oberg et al. 2005; Mueller and Wagner 2009). Estimates of measurement uncertainty, internally calculated by the ADV using a statistical technique developed by the USGS, were also recorded.

After the field data were collected, the net difference in flow between each measurement site was computed to determine gains and losses:

$$Net\ seepage\ gain/loss\ =\ Q_d - Q_u$$

In this formula, Q_d is the instantaneous streamflow measured at the downstream end of a stream reach and Q_u is the instantaneous streamflow measured at the upstream end of the stream reach (note that any tributary inflows to the stream reach or outflows from the stream reach were considered negligible for the purposes of this analysis). Plan views of the stream system depicting these net gains or losses were then developed, and stream reaches with disproportionately large gains were identified as potentially influenced by leak water. Since specific conductivities and water temperatures tend to differ between non-leak water (which is generally higher in mineral content and more variable with respect to temperature) and leak water (which is lower in mineral content and typically cooler and more stable with respect to temperature), these data were used to supplement the analysis.

Step 3: Assess Potential Impacts to Surface Water

The final step of the surface water assessment was to estimate potential impacts to the quantity and quality of surface water from leak cessation due to decommissioning, based on the results from Step 2.

Assess Potential Impacts to Surface Water Quantity

Since the amount of pressure variation observed in the RWBT over the monitoring period was too little to have a considerable effect on leak flow rates, leak contributions were assumed to be constant (although variable between monitoring stations). These leak contributions were then subtracted from measured baseflow hydrographs to develop baseflow hydrographs under projected, non-leak conditions. Streamflow hydrographs under projected, non-leak conditions were developed by adding the projected baseflow hydrographs to the observed quickflow hydrographs since quickflow would not change as a result of decommissioning. Using the flow rating curves described earlier, the projected baseflow and streamflow hydrographs were converted into time series of stream stages, and the ranges and distributions of stream stages were plotted on stream segment cross-sections alongside those for baseline conditions. Changes in water depths were evaluated on both an annual basis and independently for the growing and non-growing seasons.

Assess Potential Impacts to Surface Water Quality

For stream segments suspected to be influenced by leaks, changes to surface water quality were qualitatively assessed by comparing water quality observations to segments likely uninfluenced by leaks based on previous monitoring, observations, and calculations. Assessments were conducted for specific conductivity and temperature, the two water quality parameters observed by the long-term monitoring network.

11.9.5.4 Wetlands – Impact Analysis Methodology

The wetlands analysis consisted of evaluating the potential for cessation of leaks to result in changes to wetlands in the natural resources study area. In particular, because of their hydraulic connection to wetlands, the potential for changes to shallow groundwater levels were assessed to determine whether they would affect wetland extent and vegetation composition. The analysis of the potential for impacts from decommissioning to shallow groundwater and wetlands was completed using the following step-wise approach, and described in more detail below.

- ***Step 1: Establish Baseline Shallow Groundwater and Wetlands Conditions***. Baseline shallow groundwater and wetlands conditions were established based on desktop review of available information, field delineation of the wetlands in the natural resources study area, and compiling and analyzing DEP’s shallow groundwater monitoring data and wetlands soil pH data.

- ***Step 2: Develop a Wetlands Water Budget.*** A wetland water budget was developed for delineated wetlands within the Natural Resources Study Area to account for wetland inflows and outflows (including from natural groundwater and RWBT leak) that would influence shallow groundwater levels in wetlands.

- ***Step 3: Assess Potential Impacts to Wetlands.*** Using the results of the wetland water budget, the change in shallow groundwater level as a result of decommissioning that would remove leak discharges to wetlands was estimated. Estimates of average lowered shallow groundwater levels during the growing season were then used to estimate the potential change to wetland extent and vegetation composition.

The analysis conducted for each of these steps is described further below.

Step 1: Establish Baseline Shallow Groundwater and Wetlands Conditions

Shallow Groundwater Monitoring

As described in Section 11.9.5.3, "Surface Water – Methodology," a surface water monitoring network consisting of 15 surface water monitoring locations was installed in the stream segments to monitor streamflow and surface water quality from 2013 through 2014. Seven shallow groundwater monitoring wells (less than 10 feet deep) were installed in wetlands to continuously monitor shallow groundwater water levels. Because shallow groundwater is hydraulically linked to the wetlands in the Natural Resources Study Area, the seven shallow groundwater monitoring wells were installed in accessible wetland areas, and located adjacent to surface water monitoring locations. The shallow groundwater monitoring wells were each equipped with a water level meter that was programmed to record water level measurements at 10-minute intervals. Shallow groundwater levels were measured manually and recorded when the automated data was downloaded quarterly.

These shallow groundwater monitoring stations are shown on **Figure 11.9-13** and listed in **Table 11.9-4**, which summarizes the stream segment, monitoring location, station ID number, and associated wetland (see also **Figure 11.9-10**) for each shallow groundwater monitoring location.

Table 11.9-4: Natural Resources Study Area Shallow Groundwater Monitoring Locations and Wetlands

Stream Segment	Location	Station ID	Wetland
Segment 1	Upstream end	S1-GW-01	Wetland I
Segment 1	Middle	S1-GW-02	Wetland I
Segment 2	Downstream end	S2-GW-01	Wetland G
Segment 3A	Upstream end	S3-GW-01	Wetland C
Segment 3	Above confluence with 3A	S3-GW-02	Wetland A
Segment 3B	Above confluence with 3	S3-GW-03	Wetland B
Segment 3	Above confluence with 3B	S3-GW-04	Wetland D

Note:
GW: Shallow groundwater well

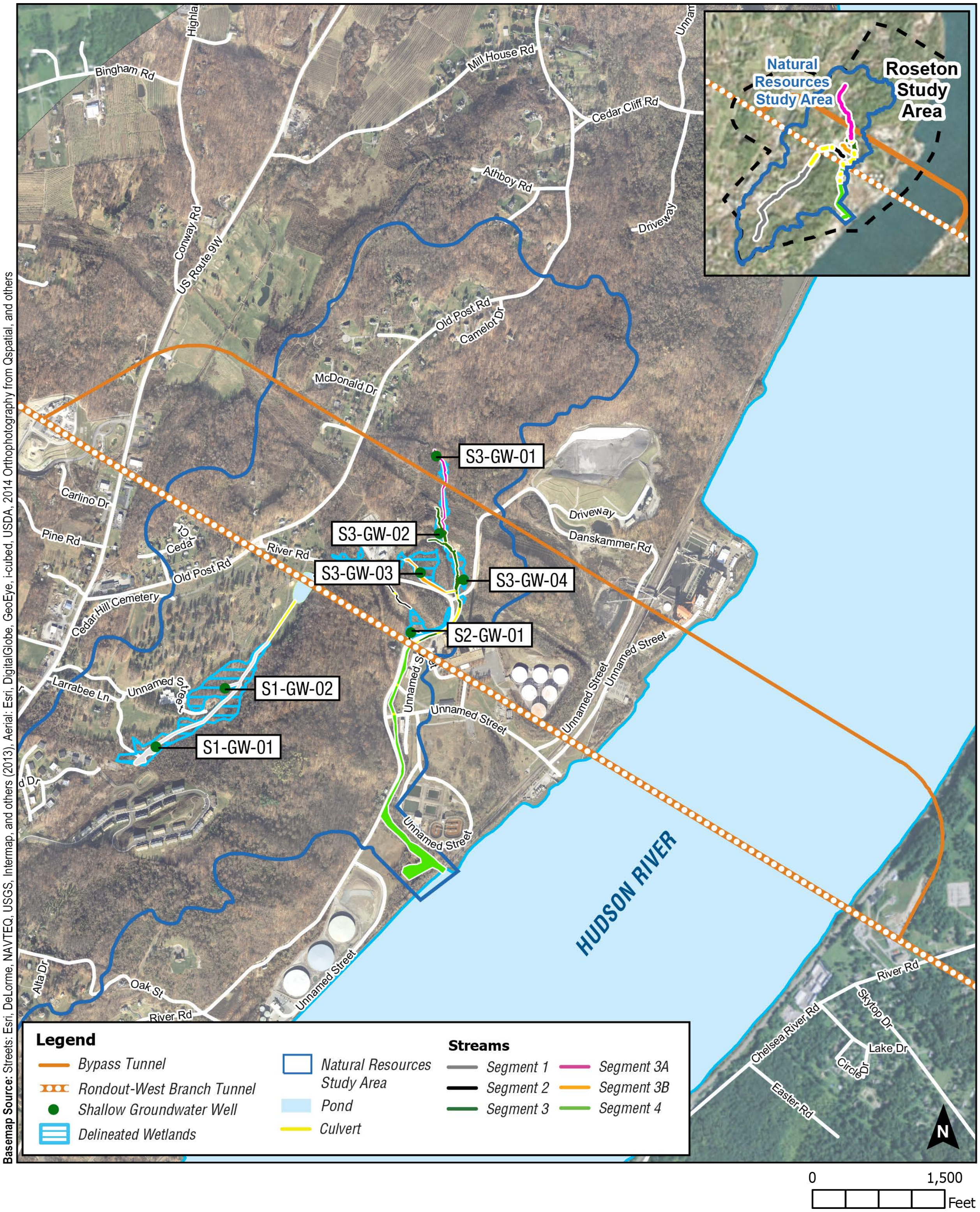


Figure 11.9-13: Shallow Groundwater Monitoring Locations – Natural Resources Study Area

In addition to shallow groundwater monitoring data, a local weather station, RWBT flow, and HGL data were used to estimate baseline shallow groundwater conditions, as described further below:

- *Local Weather Station Data:* DEP installed a local weather station in the Roseton Study Area that records precipitation for comparison to monitored changes in groundwater and surface water levels. The annual, monthly, growing season, and non-growing seasonal precipitation totals for the 2013 and 2014 monitoring period were summarized and compared to the long-term average annual, average monthly, average growing season, and average non-growing season precipitation recorded at the Dutchess County Airport from 1949 to 2014. This analysis was completed to assess whether the precipitation during the shallow groundwater monitoring period was representative of the long-term precipitation averages.

- *Pressure Monitoring in the RWBT:* The RWBT's pressure profile, referred to as the HGL, is controlled by water levels in the reservoirs. Greater pressure results in higher flow rates through the RWBT. These flow rates vary based on water supply needs. Changes in flow can influence the leaks, the amount of water discharged to surface water expressions and their contribution to the shallow groundwater elevation. Higher flows result in greater pressure that increases the discharge to the shallow groundwater and increases the water level. Whereas lower flows result in lower pressure and have a smaller influence on the shallow groundwater. RWBT flow rates are measured by a Venturi meter and HGL data are collected by a pressure transducer, both at 15-minute intervals. DEP reports that summarize these data were used in the analysis.

- *RWBT Depressurization Monitoring:* Groundwater levels in shallow monitoring wells in the Natural Resources Study Area and the flows and HGL in the RWBT were measured and recorded during depressurizations. During the October 2014 RWBT depressurization, changes in the shallow groundwater level was monitored and recorded to assess and relate these changes to changing RWBT flow and HGL. The analysis was completed with a review of shallow groundwater, RWBT flow, and HGL data (a way of depicting the distribution and variability of a dataset), to visually determine if a relationship existed between changing RWBT operations and shallow groundwater level.

Wetlands Delineation

Baseline wetlands conditions were established based on an ArcGIS review of available information on the wetlands in the Natural Resources Study Area, field delineations and compiling and analyzing DEP's wetland, surface water and shallow groundwater monitoring data from previous and existing observations and monitoring. Prior to conducting the field wetland delineation, an ArcGIS review was conducted of the following sources (see **Figure 11.9-10)**:

- NYSDEC Freshwater Wetlands Map;
- USFWS National Wetlands Inventory (NWI) Map; and
- USDA Hydric Soils Map.

A general survey, including field documentation of wetlands and watercourses in the Natural Resources Study Area was conducted between October 1 and 4, 2012, and on October 19, 2012. While the field surveys were conducted at the end of the growing season, the vegetation did not appear to have been exposed to a killing frost prior to the survey. Vegetation was readily identifiable; however, some species of spring flowering herbaceous plants may not have been evident at the time of the survey. Therefore, return visits were made to the wetlands and watercourses during June and August 2013 to verify observations from 2012, and to complete wetland and watercourse delineations following U.S. Army Corps of Engineers (USACE) procedures. The surveys generally followed contiguous wetlands associated with Stream Segments 1, 2, 3, 3A, 3B, and 4 (see **Figure 11.9-6**). The boundaries of the wetlands in these areas were delineated on October 1, 4, and 19, 2012, on June 6, 2013, and between August 13 and 14, 2013.

Wetlands within the Natural Resources Study Area identified above were delineated in accordance with the "Field Guide for Wetland Delineation – 1987 Corps of Engineers Manual" prepared by the Wetland Training Institute (Wetland Training Institute 1995), as well as the "Regional Supplement to the Corps of Engineers Wetland Delineation Manual: North Central and Northeast Region (Version 2.0)" issued January 2012. Sequentially numbered flags were placed to delineate the boundaries of wetlands within the Natural Resources Study Area. The flag locations were recorded using a Trimble DGPS unit (GeoXH 2008 Explorer series or Pro 6T series), and the data were post-processed into Environmental Systems Research Institute ArcGIS to prepare delineation figures.

Potential wetland areas were surveyed for the presence of all three wetland indicators: hydrophytic vegetation, appropriate hydrology, and hydric soils. Paired observation points (e.g., upland and wetland) were established for each delineated wetland. A USACE wetland delineation datasheet was completed for each observation point to document the observed vegetation, soils, and hydrology.

Wetlands Soil pH Testing

Wetlands characteristics are influenced by many factors, including the pH of the water and soils. Unique wetland communities can be established where elevated pH levels exist as a result of groundwater or surface water interaction with calcareous (calcium – containing) geologic formations, and these are called calcareous wetlands. These types of wetland communities can contain a unique diversity of vegetation communities, habitats, and associated biota. As the Natural Resources Study Area contains calcareous geologic formations, and because there could be a change in the quality of the wetland source water due to cessation of leaks, wetland soil pH testing was completed in June 2015 to document any elevated pH levels (greater than 7.4) and cation exchange capacity (CEC) potentially indicative of unique calcareous wetland communities.

Prior to the soil sampling, the wetland delineation results and site observations were used to assess which wetland communities featured plant species indicative of calcareous conditions. The plant species that were documented in the Natural Resources Study Area were compared to the list of plant species that are documented in the following ecological communities (from Edinger et al. 2014): Inland Calcareous Lake Shore, Calcareous shoreline outcrop, Calcareous cliff community, Calcareous pavement woodland, Calcareous red cedar barrens, Calcareous talus slope woodland, Rich shrub fen, Rich graminoid fen, Rich sloping fen, and red maple-hardwood swamp. The locations of the documented plant species that exist within these ecological communities were used to guide the selection of field monitoring locations, with final locations determined in the field.

A soil auger was used to excavate sampling pits up to 20 inches deep in one or two representative locations within each wetland. Soil samples were collected from the mid-point of the upper soil horizon below the top organic layer. Soil samples were allowed to dry over the course of a week before they were shipped to the Soil Testing Laboratory at the Rutgers Agricultural Experiment Station for analysis of pH and CEC. During the field survey water quality (pH, specific conductivity, and temperature) measurements were also collected in Stream Segments 1, 2, 3, 3A, and 4.

The results of the soil pH and CEC testing were used in conjunction with documented plant species to determine whether calcareous wetland communities are present in the Natural Resources Study Area. The locations of soil pH values greater than 7.4 were flagged as potentially calcareous, and the plant species documented at these locations were reviewed for consistency with ecological communities as documented by Edinger et al. (2014). A qualitative assessment was then completed to determine if unique calcareous wetland communities existed within the Natural Resources Study Area, and if so, the potential for impacts that may result from decommissioning impacts to shallow groundwater levels and soil quality (i.e., soil pH).

Step 2: Develop a Wetlands Water Budget (Including Shallow Groundwater)

In general terms, a water budget is used to develop the relationship between inputs of water (i.e., precipitation, surface water inflow, and groundwater inflow) and outputs of water (i.e., surface water runoff, groundwater outflow, and evapotranspiration) to determine the change in storage in a wetland. Once baseline wetland conditions were established, wetland water budgets were developed to identify the potential for changes in wetland water storage that may result from cessation of leaks associated with decommissioning. The wetland water budgets and estimated wetland water levels were developed based on the approach outlined in "Planning Hydrology for Constructed Wetlands" by Gary J. Pierce (Pierce 1993), and used the following equation:

$$\Delta S = \left(P + Q_{s,i} + Q_{g,i} + B_i\right) - \left(ET + Q_{s,o} + Q_{g,o} + B_o\right)$$

In this formula, ΔS is the daily change in wetland storage, P is precipitation falling on the wetland area, $Q_{s,i}$ is the sum of surface water inflows from precipitation falling on the wetland drainage area, $Q_{g,i}$ is the sum of groundwater inflows from adjacent uplands, B_i is the sum of stream baseflow inflow, ET is evapotranspiration from the wetland area, $Q_{s,o}$ is the sum of surface water outflows from the wetland area, $Q_{g,o}$ is the sum of groundwater recharge to the groundwater aquifer, and B_o is the sum of wetland outflow to stream baseflow. All formula parameters were calculated with units of depth for estimation of depth to shallow groundwater. These values were then converted to units of storage volume by multiplying by the wetland area.

The stream baseflow inflow and stream baseflow outflow parameters were added to the wetland water budget to account for the contribution of leak water from surface expressions to stream segments. Based on observations during prior depressurizations, this water has a relatively quick travel time from the RWBT to the ground surface where it feeds the stream segments that interact with adjacent wetlands. This process is considered separate from natural groundwater inflow and outflow to wetlands.

Water budgets were prepared for Wetlands A, B, C, D, E, G, and I for the growing season period from April 23, 2014 to September 30, 2014. Wetlands A, D, and E were analyzed with a single lumped water budget due to their adjacency, location of monitoring stations, and location relative to Stream Segment 3. Water budgets were not created for Wetlands F, K, and KA as field observations of wetland hydrology indicated these wetlands are naturally occurring with no observed surface expressions or known connection to the RWBT leak. While Wetland F is in close proximity to Stream Segment 3, the wetland is at a considerably higher elevation than the stream, and the source of wetland hydrology is water draining from the adjacent hillslope. The daily change in wetland storage was used to develop an estimated depth to groundwater time series for each wetland. The change in wetland water level on a given day can be estimated by accounting for the net daily inflow or outflow with respect to the conditions estimated for the previous day.

Wetland water budget parameters were developed using the following approach:

- Daily precipitation (P) was represented by data collected at the weather station in the Roseton Study Area and at the nearby National Weather Service weather station at Dutchess County Airport, Poughkeepsie, New York [(KPOU) 41-38N 073-53W 46M].

- The surface water inflow ($Q_{s,i}$) and outflow ($Q_{s,o}$) for each wetland was calculated using the Natural Resources Conservation Service (NRCS) Curve Number method to estimate rainfall-runoff from daily precipitation events.

- Wetland groundwater inflow ($Q_{g,i}$) from adjacent uplands and outflow to aquifer recharge ($Q_{g,o}$) was calculated using Dupuit's equation (an equation for steady-state flow in an unconfined aquifer) and the continuously monitored shallow groundwater data within each wetland.

- As the existing wetlands are located adjacent to the stream segments that are influenced by surface expressions, the wetland water budgets were prepared to include the baseflow inflow (B_i) and outflow (B_o) parameters to represent the interaction between wetland hydrology and surface expressions. The daily baseflow inflow (B_i) and outflow (B_o) is represented by the measured baseflow at each of the surface water monitoring stations. The flow condition into or out of the wetland was determined based on a comparison of the measured stream water elevation to adjacent measured shallow groundwater elevation to determine when a gaining stream (baseflow outflow from wetland) or losing stream (baseflow inflow to wetland) condition existed. If water elevation in the stream was higher than the groundwater elevation in the adjacent wetland then a losing stream situation was assumed, and water was calculated as flowing into the wetland from the stream. If water elevation in the stream was lower than the groundwater elevation in the adjacent wetland then a gaining stream situation was assumed, and water was calculated as flowing out of the wetland to the stream. The addition of the baseflow inflow (B_i) and outflow (B_o) parameters to the water budget allowed for the estimation of potential changes to wetland shallow groundwater level, with the assumption that these parameters would change for some wetlands following decommissioning.

- Estimates of daily potential evapotranspiration (*ET*) data were obtained from the Northeast Climate Data Center located at Cornell University.

- Once water budget inflows and outflows were calculated, then the change in wetland water level on a given day was estimated by accounting for the net daily inflow or outflow with respect to the conditions estimated for the previous day, and depth to groundwater time series plots were created for each wetland. Water budget input parameters (related to conductivity, and watershed and soils characteristics) were determined for each wetland by comparing the estimated to the nearest measured shallow groundwater level at a monitoring station. Final water budget parameters were selected that visually provided the best comparison between estimated and measured shallow groundwater levels for each wetland for the 2014 growing season.

- Once the wetland water budgets were finalized, the estimated change in average shallow groundwater level during the growing season that may result from cessation of leaks associated with decommissioning was calculated by assuming the removal of the baseflow (inflow) to wetlands. As further described in Section 11.9.5.17, "Geology and Soils – Baseline Conditions," due to the complex geology of the study area, the hydraulic connectivity of shallow overburden soils to the leaks could only generally be described. Therefore, groundwater inflow and outflow from decommissioning was assumed to remain the same. The percentage of time during the 2014 growing season that groundwater level was observed to be within 1 foot of the soil surface was calculated and compared to the percentage of time estimated to be within 1 foot after cessation of the leaks. This metric was assumed to be representative of conditions for suitable wetland hydrology and was compared to the USACE regulatory wetland definition which indicates that the root zone (within 1 foot of ground surface) must be seasonally saturated or inundated for more than 12.5 percent of the growing season to provide suitable conditions for establishment of wetland vegetation and anaerobic soil conditions (Environmental Laboratory 1987; USACE 1992).

- The analysis also considered the results of the groundwater flow model that was used to estimate groundwater level changes in the bedrock and unconsolidated aquifers that could result from cessation of the leaks. A spatial comparison was made to confirm that the area of the modeled Estimated Unconsolidated Aquifer Groundwater Influence Area was consistent with the wetlands that have the potential to be affected by changes to shallow groundwater, as identified with the water budget analysis.

Step 3: Assess Potential Impacts to Wetlands

Finally, potential impacts to shallow groundwater from decommissioning were evaluated based on the change to the average shallow groundwater level during the growing season for each wetland area using the results of the wetland water budget described in Step 2 above. The estimated change in shallow groundwater level was used to estimate changes to wetland extent using the following approach:

- Using the mean shallow groundwater elevation during the growing season from shallow groundwater monitoring in wetlands, a shallow groundwater elevation grid was estimated for 2014 using GIS. Spot measurements of depth to shallow groundwater completed in June 2015 were used to check the 2014 groundwater elevation grid and to establish the depth to shallow groundwater at the wetland boundary. Prior to use, the spot measurements were reviewed for consistency with average depth to shallow groundwater recorded during the monitoring period, and these were confirmed to be representative and appropriate for the analysis. The grid represents the average shallow groundwater elevation of individual wetlands during the 2014 growing season, under the condition of the leaking RWBT.

- An additional shallow groundwater elevation grid was prepared for the lower groundwater elevation following decommissioning as estimated during Step 2.

- The estimated shallow groundwater elevation grid was then used in GIS to estimate the potential loss of wetland area by identifying existing delineated wetland areas where the estimated mean depth to shallow groundwater could exceed 1 foot from cessation of leaks. Ground surface elevation data used in the analysis was developed from a LiDAR (Light Detection and Ranging) survey of the Roseton Study Area conducted in November 2014 when weather conditions were favorable (e.g., clear, leaf off conditions with relatively cool ground temperatures).

- A summary of potential changes to wetland area from decommissioning was prepared.

The potential change to shallow groundwater hydrology has the potential to impact both the wetland extent and vegetation composition. The estimated change to wetland extent and shallow groundwater levels were used in conjunction with species data collected during the field wetland delineations to qualitatively assess potential impacts to wetland vegetative composition. The analysis of impacts to shallow groundwater levels, wetland extent, and wetland vegetation communities is presented in Section 11.9.5.28, “Wetlands – Probable Impacts With Decommissioning.”

11.9.5.5 Floodplains – Impact Analysis Methodology

The floodplain analysis consisted of evaluating the potential for decommissioning to result in changes to regulated floodplain resources in the Natural Resources Study Area. In particular, the potential for changes to water levels were qualitatively assessed to determine whether they would affect mapped floodplains. For this assessment, Federal Emergency Management Agency (FEMA) 2010 floodplain maps were referenced to determine flood zones in and around the Natural Resources Study Area, mapped floodplains existing adjacent to leak-influenced stream segments were identified, and a qualitative assessment of potential affects to floodplains following decommissioning was completed.

11.9.5.6 Aquatic and Benthic Resources – Impact Analysis Methodology

The aquatic and benthic resources analysis consisted of evaluating the potential for decommissioning to result in changes to aquatic and benthic resources in the Natural Resources Study Area. In particular, because of their dependence on habitat, the potential for changes to surface water levels and water quality of streams in the study area were assessed (see Section 11.9.5.27, “Surface Water – Probable Impacts With Decommissioning,” for further detail) were used to determine whether these changes would affect aquatic and benthic resources. The analysis of the potential for impacts from decommissioning to shallow aquatic and benthic resources was completed using the following approach.

<u>Establish Baseline Conditions</u>

Baseline conditions for aquatic and benthic resources within the study areas were summarized from a combination of desktop reviews and field data collection, described below.

- ***Desktop Reference Data Was Reviewed and Evaluated***. Information was obtained from governmental and nongovernmental agencies and reviewed, such as the FEMA flood insurance rate maps; NRCS National List of Hydric Soils and Web Soil Survey; data from U.S. Geological Survey (USGS) streamgauge 01372058—Hudson River Below Poughkeepsie, New York; data from NYSDEC monitoring Station 13010077—Hudson River (Lower) in Poughkeepsie; USFWS NWI maps and federally listed threatened or endangered species for Orange and Dutchess counties, New York; NYSDEC tidal and freshwater wetlands maps; National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Essential Fish Habitat (EFH) designations; Ecological Communities of New York State (Edinger et al. 2014); NYSDEC Bureau of Fisheries; and aerial photography.

- ***Resource Agency Data Was Reviewed.*** Correspondence with the New York State Natural Heritage Program (NYNHP), NYSDEC Regional Offices, and USFWS were used to determine whether rare species of fish or benthic life or unique habitats were reported as occurring on or adjacent to the Natural Resources Study Area.

- ***On-Site Field Surveys Were Conducted.*** Habitat assessments and surveys were completed during 2012, 2013, and 2015 for fish and benthic invertebrate species. The objective of the field surveys was to document baseline conditions of aquatic resources within five stream segments. Species-specific studies for Odonates (dragonfly and damselfly) were conducted in watercourses and wetlands in 2015. The following field surveys were conducted by aquatic scientists who also documented existing ecological communities and recorded ancillary observations of bird, herpetile, and mammalian species.

    - <u>Odonate Survey:</u> A May 2015 survey was undertaken to assess the presence/absence of, and collect and identify Odonate (dragonfly and damselfly) nymphs in specific habitats not sampled during the 2012 and 2013 benthic invertebrate surveys conducted for the previous EIS. Prior to the survey, a desktop review (using April 2010 NYSDEC dragonfly and damselfly survey results for Ulster and Orange counties as an information source) was conducted to identify potential rare Odonate species that might be present in the Natural Resources Study Area. Samples were collected using kick nets, field sorted, preserved and sent to Watershed Assessment Associates, LLC for identification. Other invertebrates, reptile species, and amphibians observed during the survey were recorded. While no rare species of Odonates were found, the survey provided more detailed information on the invertebrate community in the Natural Resources Study Area.

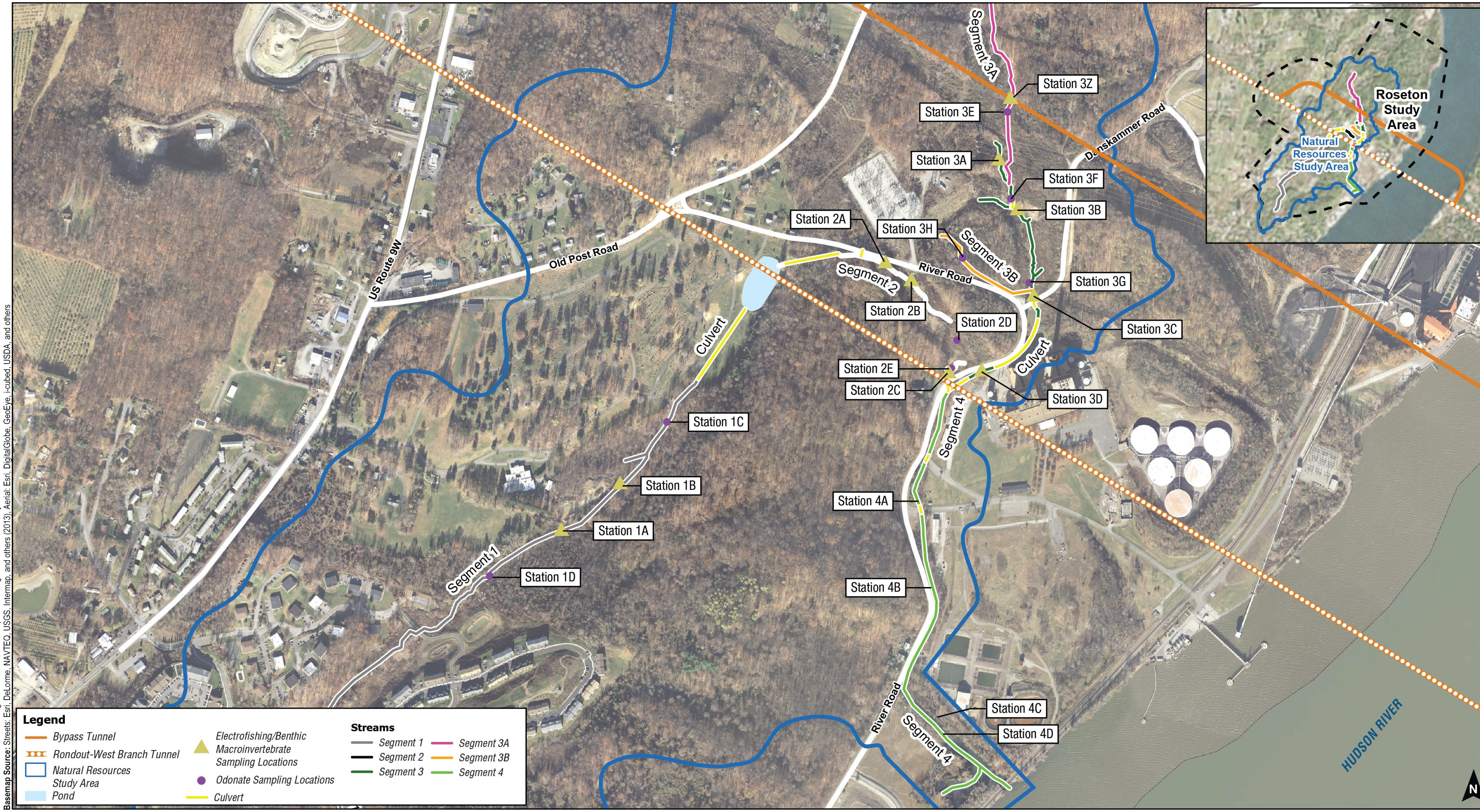
- Fish and Benthic Macroinvertebrate Surveys: Fish were sampled by electrofishing and benthic macroinvertebrates were sampled using a rectangular-frame dip net, in accordance with the EPA's Rapid Bioassessment Protocols "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers" (Barbour et al. 1999) within five of the six stream segments identified on **Figure 11.9-14**. Segment 3B was not sampled because this watercourse had insufficient flow and depth for kick-net sampling (Odonate sampling in May 2015 did include sampling this segment). See **Table 11.9-5** below for fish and benthic surveys.

Table 11.9-5: Summary of Fish and Benthic Field Surveys Conducted within the Natural Resources Study Area

Location	Date	Field Survey
Stream Segments 1,2, 3, 3A, 4	October 2012 May 2013 August 2013	Electrofishing, Benthic Macroinvertebrate collection
Tidal Inlet (Segment 4)	April 2015	Boat Electrofishing survey
Watercourses and Wetlands along Segments 1, 2, 3, 3A, 3B	May 2015	Odonate Survey

The objective of the field surveys was to document baseline conditions of aquatic resources within the stream segments. During this sampling, water quality parameters such as temperature, conductivity, dissolved oxygen, and pH were measured and recorded. Electrofishing was conducted at 14 stations along five of the six designated stream segments. Segment 3B was not sampled due to shallow water depths unsuitable for sampling.

The collected fish species, total number of fish collected, and fish length range was summarized by stream segment and by sampling event. In addition, the number of fish collected per minute of electrofishing (catch per unit effort [CPUE]) was calculated by dividing the number of fish collected by the total time the reach was sampled. Manual measurements of stream widths and length were recorded in the field to determine area sampled.



GIS Data Sources: Stream Segments - AKRF, NWI - http://www.fws.gov/lands/305.html, Hydric Soils - NRCS
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

0 600 Feet

NYC Environmental Protection

Figure 11.9-14: Electrofishing and Benthic Monitoring Locations – Natural Resources Study Area

Standard benthic macroinvertebrate community metrics were calculated to characterize and compare benthic macroinvertebrate assemblages among the stream segments. These metrics consisted of the following:

- *Family Richness* – the total number of macroinvertebrate families found in a kick-net sample.

- *Family Ephemeroptera, Plecoptera, Trichoptera (EPT) Assemblage* – EPT denotes the cumulative number of mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) families present within a sample.

- *Percent Model Affinity (PMA)* – PMA is a measure of the level of similarity of a given sampled community to a model or "ideal" non-impacted community based on the percent abundance of seven major groups (Novak and Bode 1992). Novak and Bode (1992) established an "ideal" community composition based on reference stream samples collected from freshwater streams in the State. The ideal community consists of 40 percent Ephemeroptera, 5 percent Plecoptera, 10 percent Trichoptera, 10 percent Coleoptera, 20 percent Chironomidae, 5 percent Oligochaeta, and 10 percent other groups. The PMA value is the degree to which the sampled community is similar to the ideal community.

- *Hilsenhoff's Biotic Index (HBI)* – HBI is a measure of the tolerance of the macroinvertebrates in a sample to organic pollution (e.g., sewage inputs, animal wastes) and low dissolved oxygen levels (Hilsenhoff 1988).

- *Designated Functional Feeding Group Assemblage* – Functional feeding groups were assigned to all individuals collected based on NYSDEC standard protocols (NYSDEC 2012).[4] These classes include gathering collectors, filtering collectors, predators, shredders, and scrapers.

Additional sampling for Odonate (dragonfly and damselfly) nymphs was conducted on May 13 and 20, 2015. Samples were collected by kick net, field sorted, preserved in 70 percent ethyl alcohol in labeled containers, and sent under chain-of-custody protocol to Watershed Assessment Associates, LLC for identification. Six primary locations (see **Figure 11.9-14**) in the Roseton Natural Resource Study Area were sampled; two microhabitats (a flooded reed grass community in Wetland G and remnants of a beaver pond within Wetland I) were also sampled. Sampling consisted of using the kick net to probe sediments, undercut banks, submerged woody and plant debris, fallen leaves, and aquatic vegetation. Three sweeps with the kick net were collected at each sampled location; the debris was examined in a shallow plastic container for Odonates and other aquatic organisms. Any Odonate nymphs were removed and preserved; the remainder of the sample was returned to the watercourse/waterbody at the collection point. Water quality was recorded at each sampling location. Parameters included dissolved oxygen, temperature, pH, and specific conductance.

[4] Functional Feeding Groups – feeding categories assigned to macroinvertebrates by the NYSDEC based on main sources of food. Feeding groups consist of generalist feeders such as gathering collectors, filtering collectors and predators, while specialized feeders consisted of scrapers and shredders.

Various habitats present in each segment were sampled, including riffles, runs, pools, underbank habitat, and woody debris. All fish collected were released back into the stream.

Assess the Future Without Decommissioning

The existing aquatic and benthic resources were evaluated with any proposed development plans in the Natural Resources Study Area to estimate what, if any, changes to the aquatic and benthic biota might take place without decommissioning. The methodology also assumed that the existing leaks would continue to flow in the same locations and volume as under baseline conditions.

Assess the Probable Impacts With Decommissioning

Baseline water quality data and the results of the surface water analysis were used as a primary basis to determine the potential for impacts to the aquatic biota and habitats with the potential to be influenced once the bypassed section of the RWBT is decommissioned (see Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning," for further detail). The following methodology was used to evaluate the potential for changes to aquatic and benthic resources:

- Aquatic biota and habitats ("ecological communities") that are suspected to be influenced by the leaks and observed surface expressions were compared to "reference" ecological communities in the same watershed that have no influence from leaks and surface expressions. The reference ecological communities used for comparison were assumed to be representative of the future surface water levels and conditions of the ecological communities that would exist following decommissioning.

- A qualitative evaluation of potential changes to stream biotic resources (i.e., benthic and fish) within segments potentially affected by cessation of leaks was prepared based on results of the surface water analysis of the potential for impacts to streamflow and water quality and review of applicable data and literature related to those changes.

- All available benthic macroinvertebrate sample results since 2010 were compiled. Sampling locations, sampling dates, field methods, and laboratory methods were reviewed to document data comparability. The benthic macroinvertebrate species-abundance data was compared among potentially impacted segments and reference segments. Community composition was compared in terms of cumulative percent composition, sorted by the most abundant taxa. Taxonomic lists were compared among stream segments, identified by order for insects, and as appropriate for non-insects. This comparison resulted in identification of benthic macroinvertebrate habitat preferences and requirements analyzed by stream segment.

- Benthic macroinvertebrate community metrics were calculated to describe the benthic community structure along the stream segments. Community composition metrics are described in terms of the percentage of pollution-sensitive and tolerant taxa (e.g., Ephemeroptera, Plecoptera, and Trichoptera) and species that dominate the assemblage based on feeding group and habitat/behavior classifications. Benthic macroinvertebrate communities were also compared among segments in terms of habit (e.g., clingers, burrowers, swimmers) and feeding strategy (e.g., collector/gatherer, scraper, predator). Differences in benthic macroinvertebrate community metrics were discussed in terms of hydrologic and habitat conditions among leak-affected segments and those that are not suspected to be influenced by the leak. Potential changes to hydrologic and habitat conditions, and associated potential changes to the benthic macroinvertebrate communities from cessation of leaks were assessed.

- A qualitative evaluation of potential changes in fish community structure within the evaluated stream segments, including the tidally influenced mixing area at the Roseton Brook confluence with the Hudson River (NYSDEC Class A stream segment), was prepared. This analysis was based on estimated streamflow and water quality characteristics during the RWBT depressurization(s), and on data and literature review for the potentially impacted species documented in the stream segments.

11.9.5.7 Terrestrial Resources – Impact Analysis Methodology

The terrestrial resources analysis consisted of evaluating the potential for decommissioning to result in changes to ecological communities, habitat and wildlife resources in the Natural Resources Study Area. In particular, because of their dependence on habitat, terrestrial resources were assessed relative to potential changes in surface water levels and water quality of streams and wetlands in the study area (see Section 11.9.5.27, “Surface Water – Probable Impacts With Decommissioning,” and Section 11.9.5.28, “Wetlands – Probable Impacts With Decommissioning”). The analysis of the potential for impacts from decommissioning to ecological communities and wildlife was completed using the approach described below.

Ecological Communities

Establish the Baseline Conditions

Baseline conditions for ecological communities within the Natural Resources Study Area were summarized from the following sources:

- ***Desktop Reference Data Was Reviewed and Evaluated***. Information was obtained from governmental and nongovernmental agencies and reviewed, such as the FEMA flood insurance rate maps; NRCS National List of Hydric Soils and Web Soil Survey; data from USGS streamgauge 01372058—Hudson River Below Poughkeepsie, New York; data from NYSDEC monitoring Station 13010077—Hudson River (Lower) in Poughkeepsie; USFWS NWI maps and federally listed threatened or endangered species for Orange and Dutchess counties, New York (Information for Planning and Conservation System); NYSDEC tidal and freshwater wetlands maps; NYSDEC 2000-2005 New York State Breeding Bird Atlas; NYSDEC Amphibian and Reptile Atlas Project (Herp Atlas) Data; Ecological Communities of New York State (Edinger et al. 2014); the Orange County Water Authority; and aerial photography.
- ***Resource Agency Data Was Reviewed.*** Correspondence with the NYNHP, NYSDEC Regional Offices, and USFWS was used to determine whether rare species of plants and wildlife or unique habitats were reported as occurring on or adjacent to the Natural Resources Study Area.

- ***On-Site Field Surveys Were Conducted.*** Habitat assessments and surveys were completed during 2012 and 2013 for wildlife species. Species-specific studies were conducted for turtles and their ecological communities were defined. The field surveys were conducted by terrestrial scientists who also documented and classified existing ecological communities based on Edinger et al. (2014) and recorded ancillary observations of bird, herpetile, and mammalian species. Additionally, the following surveys were conducted for special status species:

  - Bog Turtle (*Clemmys [=Glyptemys] muhlenbergii*) Surveys – Phase I, Phase II, and Phase III bog turtle surveys were conducted following methodologies described in USFWS "Bog Turtle (*Clemmys [=Glyptemys] muhlenbergii*), Northern Population, Recovery Plan" (dated May 2001, updated by USFWS April 2006). The Phase I, II, and III surveys indicate that the wetlands in the Natural Resources Study Area do not support bog turtles.

  - Spotted turtle (*Clemmys guttata*) and wood turtle (*Glyptemys insculpta*) survey - this survey was undertaken in spring 2015 to assess the presence or absence of these two State Special Concern Species reported in the Herp Atlas. Suitable riparian and wetland habitats were searched. No specimens of either species were observed during this or any of the other site surveys.

Assess the Future Without Decommissioning

Existing terrestrial resources were evaluated with any proposed development plans in the Natural Resources Study Area to estimate what, if any, changes to the terrestrial biota might take place without decommissioning. The methodology also assumed that the existing leaks would continue to flow in the same locations and volume as under baseline conditions.

Assess the Probable Impacts With Decommissioning

The results of the desktop and field surveys and the surface water and wetland analysis were used as a primary basis to determine the potential for impacts due to decommissioning (see Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning," for further detail). To evaluate the potential for changes to terrestrial resources and terrestrial habitats, ecological communities that are suspected to be influenced by the leaks and observed surface expressions were compared to reference ecological communities in the same watershed that would be expected to have no influence from leaks and surface expressions from the RWBT. The reference ecological communities used for comparison were assumed to be representative of the future surface water levels and conditions that could occur, and the ecological communities that would exist and/or be influenced by these water levels after cessation of the leaks.

Wildlife

The wildlife analysis consisted of evaluating the potential for decommissioning to result in changes to wildlife in the Natural Resources Study Area. In particular, because of their dependence on habitat, the potential for changes to stream flow (surface water levels and water quality) and wetlands in the study area were assessed (see Section 11.9.5.27 "Surface Water –

Probable Impacts With Decommissioning" and Section 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning") to determine whether these changes would affect wildlife. The analysis of the potential for impacts from decommissioning to wildlife was completed using approach described below.

Establish Baseline Conditions

Baseline conditions for ecological communities within the Natural Resources Study Area were summarized from the following sources:

- ***Desktop Reference Data Was Reviewed and Evaluated***. Potential wildlife occurring within the Natural Resources Study Area was identified by consulting the 2000-2005 New York State Breeding Bird Atlas, the New York State Amphibian and Reptile Atlas Project (Herp Atlas), and the NYSDEC Nature Explorer. Additional information was obtained and reviewed, such as the NRCS National List of Hydric Soils and Web Soil Survey; USFWS NWI maps; NYSDEC tidal and freshwater wetlands maps; federally listed threatened or endangered species for Orange and Dutchess counties, New York; Ecological Communities of New York State (Edinger et al. 2014); and aerial photographs.

- ***Resource Agency Data Was Reviewed.*** Correspondence from the NYNHP, NYSDEC Regional Offices, and USFWS were used to determine what wildlife species and/or unique habitats were reported as occurring on or adjacent to the Natural Resources Study Area.

- ***On-Site Field Surveys Were Conducted.*** Habitat assessments and general wildlife surveys were completed during 2012, 2013 and 2015. The surveys documented existing habitats and the wildlife species using and having the potential to use them. The field surveys were conducted by wildlife scientists who also documented existing ecological communities and recorded ancillary observations of bird, amphibian, reptile, and mammalian species.

Assess the Future Without Decommissioning

Existing wildlife resources were evaluated with any proposed development plans in the Natural Resources Study Area to estimate what, if any, changes to the wildlife resources and their habitats that might take place without decommissioning. The methodology also assumed that the existing leaks would continue to flow in the same locations and volume as under baseline conditions.

Assess the Probable Impacts With Decommissioning

The results of the desktop and field surveys were used as a primary basis to determine the potential for impacts to the wildlife species and their habitats due to cessation of leaks. To evaluate the potential for changes to wildlife species and their habitats, wildlife species that are suspected to be influenced by the leaks and observed surface expressions were compared to reference ecological communities in the same watershed that would be expected to have no influence from leaks and surface expressions from the RWBT. The reference ecological communities used for comparison are assumed to be representative of the future surface water levels and conditions that could occur, and the wildlife species that would exist and/or be influenced by these water levels after cessation of the leaks.

11.9.5.8 Federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and Unlisted Rare and Vulnerable Species – Impact Analysis Methodology

This section presents the analysis of the potential for decommissioning to result in impacts to federal/State Threatened, Endangered, and Candidate Species, Species of Special Concern, and unlisted rare and vulnerable species within the Natural Resources Study Area. The analysis of the potential for impacts from decommissioning was completed using the approach described below.

Establish Baseline Conditions

Federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species with the potential to occur in the Natural Resources Study Area were identified based on consultation with the State and federal agencies, as well as desktop evaluations using the “Desktop Reference Data” described under “Wildlife,” and on-site field surveys. The desktop and on-site field evaluations were also used to identify habitat for these species within the Natural Resources Study Area.

NYNHP provided database query results that identified the species and/or habitats with State, heritage and global rankings based on species rarity, population trends, and threats, along with other information related to the species, on January 14, 2011, February 19, 2013, and October 15, 2015.

The USFWS Information for Planning and Conservation (IPaC) database was queried for an official species list (OSL) of federally listed Endangered, Threatened, Candidate, or Proposed for listing species known to exist within the Natural Resources Study Area dated February 27, 2013 (Tracking Number: 05E1NY00-2013-SLI-0326). The OSL was submitted to USFWS for initial project consultation on April 3, 2013. The OSL was updated through the IPaC site on July 20, 2016, with no change to the species list. Additionally, a desktop evaluation was also used to identify broad habitat characteristics of the Natural Resources Study Area. Species provided protection under the Migratory Bird Treaty Act of 1918 (MBTA), and other protective legislation such as the Bald and Golden Eagle Protection Act (BGPA), were evaluated if documented to occur within the Natural Resources Study Area. The assessments for federal Threatened and Endangered Species determine whether the proposed project activities have the potential to affect or result in a take of a species. Section 7 of the Endangered Species Act requires a federal agency to consult with USFWS when a federal action (or a project with a federal nexus) has the potential to affect a threatened or endangered species.

A project’s impacts to protected species are designated as one of the following: “no effects,” “may affect but is not likely to adversely affect,” and “may affect and is likely to adversely affect.” A finding of “no effect” means there will be no impacts, positive or negative, to protected resources. A finding of “may affect but is not likely to adversely affect” means that project impacts will either be beneficial, insignificant or discountable, or otherwise unable to be evaluated. A finding of "may affect and is likely to adversely affect" means an adverse effect (more than insignificant or discountable) to a listed species may occur as a direct or indirect result of the project. Take of an endangered species is not allowed without an exception or permit under Section 10 of the Endangered Species Act. Take is defined in the Endangered Species Act as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" and "harm" includes actions that result in significant habitat modification.

On September 2, 2015, DEP requested additional information on EFH and threatened and endangered species under the jurisdiction of NMFS, and concurrence that no further EFH and threatened and endangered species consultations would be required because the project would have no adverse effect to EFH or species under NMFS jurisdiction.

While the NYNHP consultation returned no known extant or historic populations of bog turtles within 1 mile of the study area, the USFWS OSLs identified bog turtle presence within Orange County where the study area is located and the Herp Atlas identified bog turtle presence within the USGS Topographic Quadrangle map which included the study area. Therefore, the potential for bog turtles to occur within the Natural Resources Study Area was evaluated by conducting Phase I, Phase II, and Phase III bog turtle surveys following methodologies described in USFWS "Bog Turtle (*Clemmys [=Glyptemys] muhlenbergii*), Northern Population, Recovery Plan" (dated May 2001, updated by USFWS April 2006). The results of the surveys were used to determine the potential for impacts to bog turtles and their habitat associated with decommissioning, which are evaluated in Section 11.9.5.31, "Terrestrial Resources – Probable Impacts With Decommissioning."

Assess the Future Without Decommissioning

Existing federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species were evaluated with any proposed development plans in the Natural Resources Study Area to estimate what, if any, changes to the rare species or their habitat might take place without decommissioning. The methodology also assumed that the existing leaks would continue to flow in the same locations and volume as under baseline conditions.

Assess the Probable Impacts With Decommissioning

The results of the federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species desktop evaluations and field surveys were used as a primary basis to determine the potential rare species and their habitats with the potential to be influenced once the bypassed section of the RWBT is decommissioned. Species with the potential to be located in habitats in the Natural Resources Study Area that may be affected by potential changes to surface water, shallow groundwater, and wetlands as a result of cessation of leaks associated with decommissioning were further evaluated in the impact analysis. To evaluate the potential for changes to rare species and their habitats, federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species that are suspected to be influenced by the leaks and observed surface expressions were compared to "reference" ecological communities in the same watershed that would be expected to have no influence from leaks and surface expressions from the RWBT. The reference ecological communities used for comparison are assumed to be representative of the future surface water levels and conditions that could occur, and the federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and unlisted rare and vulnerable species that would exist and/or be influenced by these water levels following decommissioning.

11.9.5.9 Geology and Soils – Impact Analysis Methodology

The analysis of geology and soils consisted of evaluating the potential for the temporary shutdown and decommissioning to result in changes to these resources in the Roseton Study Area. In particular, the evaluation was conducted to assess the potential for changes in ground surface elevation and subsurface conditions from lower groundwater levels due to cessation of leaks. Section 11.9.5.26, “Groundwater – Probable Impacts With Decommissioning,” further describes the anticipated decline in groundwater levels.

The geology and soils analysis focused on evaluating the potential effect changes to water levels could have on geology and soils within the Roseton Study Area.

The potential for impacts to geology and soils from the changes to groundwater levels during the temporary shutdown and over the long term after decommissioning in the Roseton Study Area was completed using the following approach:

- ***Step 1: Establish Baseline Geology and Settlement Mechanisms.*** Baseline conditions were established based on a desktop assessment of available information on the geology and soils, infrastructure, and the RWBT leaks that occur at the ground surface (surface expressions) in the Roseton Study Area. These baseline conditions were used to identify potential settlement mechanisms.

- ***Step 2: Establish Unconsolidated Aquifer Groundwater Influence Area.*** The groundwater flow model described in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology,” was used to establish the area where the groundwater level could be lowered (at the bedrock/unconsolidated aquifer interface) in the unconsolidated aquifer during the temporary shutdown and over the long term after decommissioning (referred to as the Estimated Unconsolidated Aquifer Groundwater Influence Area). The lower water levels in this area could potentially cause settlement in the cohesive soils in the unconsolidated aquifer.

- ***Step 3: Complete a Geotechnical Field Investigation.*** Based on the desktop assessment and estimated changes in groundwater levels in the unconsolidated aquifer, a geotechnical field investigation was completed to collect additional information on geology and soils in the unconsolidated aquifer close to structures in or near the Estimated Unconsolidated Aquifer Groundwater Influence Area.

- ***Step 4: Identify Areas that Could be Subject to Settlement.*** The water level data collected during the geotechnical investigation, supplemented with groundwater modeling data, were used with the physical properties of the soils from Step 3 to identify areas that could be subject to settlement in the cohesive soils in the unconsolidated aquifer during the temporary shutdown and over the long term after decommissioning.

Each of these steps is described in further detail below.

Step 1: Establish Baseline Geology and Settlement Mechanisms

The first step in evaluating the potential for impacts to geology and soils was to establish baseline geologic conditions in the Roseton Study Area. In order to establish these conditions, the following were determined:

- Existing geology;
- Infrastructure/structures currently present; and
- Presence of surface expressions of the RWBT leak.

Available information (e.g., design drawings, boring logs, and construction notes) from construction of the RWBT and design of the bypass tunnel, existing reports on geology within the Roseton Study Area, and information obtained for this FDEIS were reviewed and used to establish baseline conditions (see Section 11.9.5.17, "Geology and Soils – Baseline Conditions). The existing inventory of the known surface expressions in the Roseton Study Area was updated and confirmed by field reconnaissance.

Initial field investigations were then completed within the Roseton Study Area to observe surface expressions, collect remote sensing data sets, and conduct a geophysical survey. The remote data included completing a LiDAR survey with true-color (or near-infrared) orthoimagery (high-resolution photo-imagery) and thermal imagery (November 2014). A geophysical survey was completed using ground penetrating radar (December 2014). The LiDAR survey was used to create a high-resolution digital elevation map that was checked and confirmed through field surveying of structures or features. LiDAR data were collected to provide a baseline topographic dataset and for the purpose of comparison with LiDAR data collected by others in 2012.

The remote sensing data also included thermal infrared imagery that was acquired to identify subtle temperature differences on the ground surface or in surface water expressions. Detailed aerial photographs using orthoimagery were also collected to supplement LiDAR and thermal imagery results. The digital elevation map was used to established baseline ground surface conditions. Results from the ground penetrating radar survey conducted in December 2014 were compared with the 2009 ground penetrating radar survey results to determine if changes in geology could be observed between the two data sets.

The four mechanisms that could potentially cause settlement and changes to geology and soils during the temporary shutdown and over the long term after decommissioning are:

- Effective stress increase resulting from lowering groundwater levels;
- Migration of fine soil particles in small localized areas around existing surface expressions that are currently discharging leak water, or in areas of thin soil overburden where new surface expressions could form before the temporary shutdown;

- Sloughing of destabilized areas at the ponded surface water expression, where the sides are being stabilized by pressure exerted by the elevated groundwater levels; and
- Collapse of subsurface voids or the decommissioned section of the RWBT.

Potential settlement resulting from the first mechanism, effective stress due to the lowering of the groundwater level, is the focus of this analysis. The other three mechanisms can only be qualitatively assessed as potentially occurring in areas with specific features including: surficial water expressions, the ponded surface water expression, and areas of subsurface voids. These four mechanisms were considered with results from Steps 2-4 below to estimate the areas that could be subject to settlement.

Step 2: Establish Estimated Unconsolidated Aquifer Groundwater Influence Area

Lowering the water level in the bedrock could cause settlement in the unconsolidated aquifer. The groundwater flow model was used to establish the area where the water level could be lowered during the temporary shutdown and long term due to decommissioning. This area is called the Estimated Groundwater Influence Area.

A description of the groundwater model and the process used to establish the Estimated Groundwater Influence Area is provided in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology.”

Step 3: Complete a Geotechnical Field Investigation

A field investigation was conducted to collect geotechnical data within or near the Estimated Unconsolidated Aquifer Groundwater Influence Area. The data were used to identify areas where potential settlement could occur resulting from the lowering of groundwater levels. The geotechnical investigation was focused around structures and infrastructure in the area, including the two power plants and associated utilities, railroad tracks, River Road, and a church. The geotechnical investigation (see **Figure 11.9-15**) included:

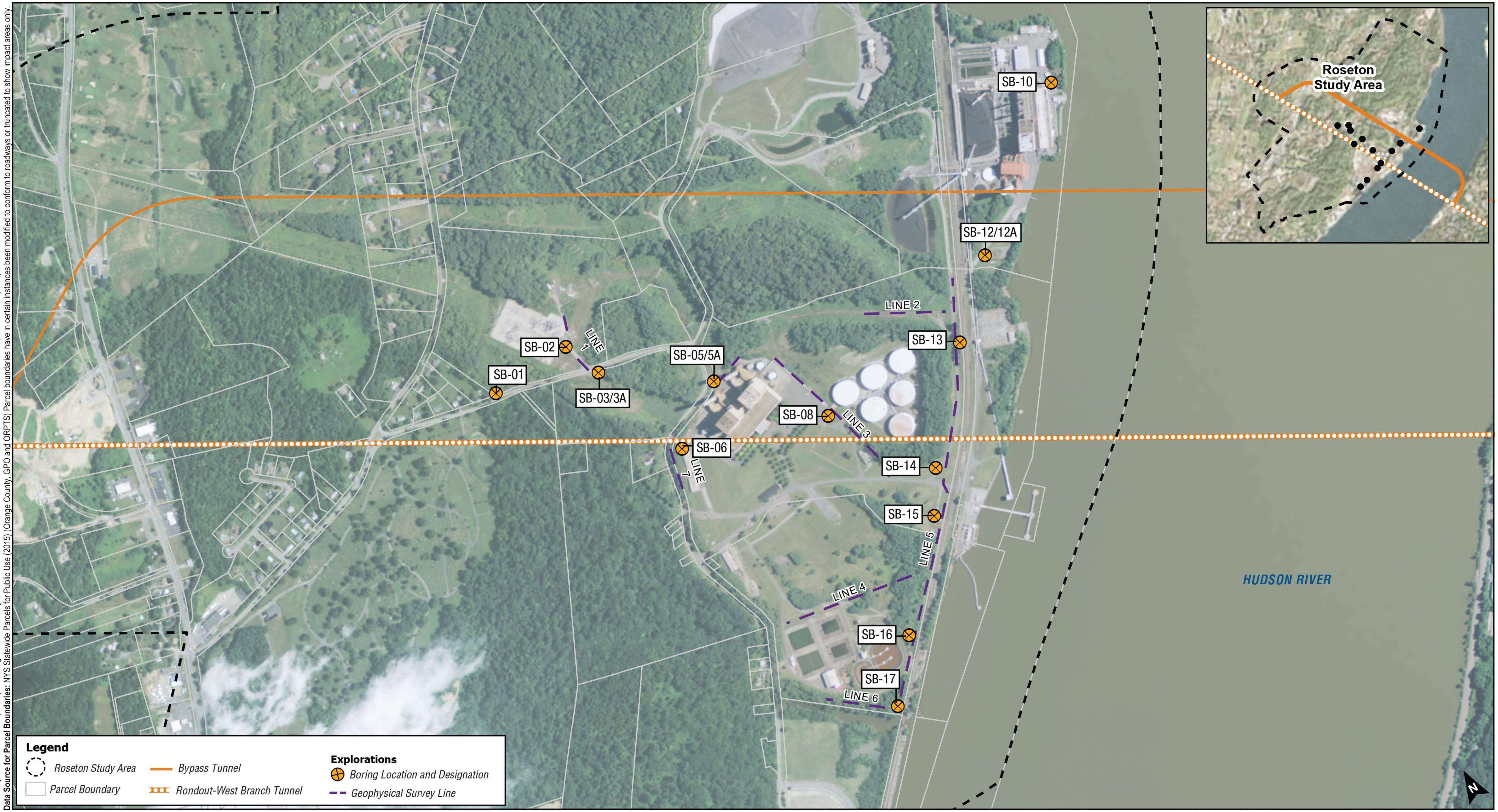
- Seven geophysical survey lines to characterize the depth to rock and potentially identify any soft soils or subsurface anomalies; and
- Sixteen test borings (with piezometers installed in each at various depths) to obtain soil samples and groundwater levels.

Geotechnical laboratory testing of the soil samples, included:

- Soil index (moisture content, Atterberg limits and particle size analysis);
- Moisture content;
- Organic content; and
- Constant rate of strain consolidation.

These results were used to identify areas with the potential for settlement in geology and soils during the temporary shutdown and over the long term after decommissioning.

Basemap Source: World Topo Map: Esri, DigitalGlobe, GeoEye, i-cubed, USDA and others Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)
Data Source for Parcel Boundaries: NYS Statewide Parcels for Public Use (2015) (Orange County, GPO and ORPTS) Parcel boundaries have in certain instances been modified to conform to roadways or truncated to show impact areas only.



0 675 Feet

NYC Environmental Protection

Figure 11.9-15: Geotechnical Field Investigation

Step 4: Identify Areas that Could be Subject to Settlement

To assess potential settlement related to the lowering of groundwater levels, several geologic and soil characteristics were considered: the thickness of the compressible layer, preconsolidation pressure, compression ratio, and recompression ratio, coefficient of consolidation, current effective stress, and final effective stress values.

The results of the investigation (Steps 1 to 3) and the parameters identified above were used to estimate potential settlement at each geotechnical boring during the temporary shutdown and over the long term after decommissioning. The time rate of settlement of soils after decommissioning was also considered based on these parameters. The areas that could be subject to settlement were identified from these results by taking into consideration the types of structures and infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area.

11.9.5.10 Groundwater – Baseline Conditions

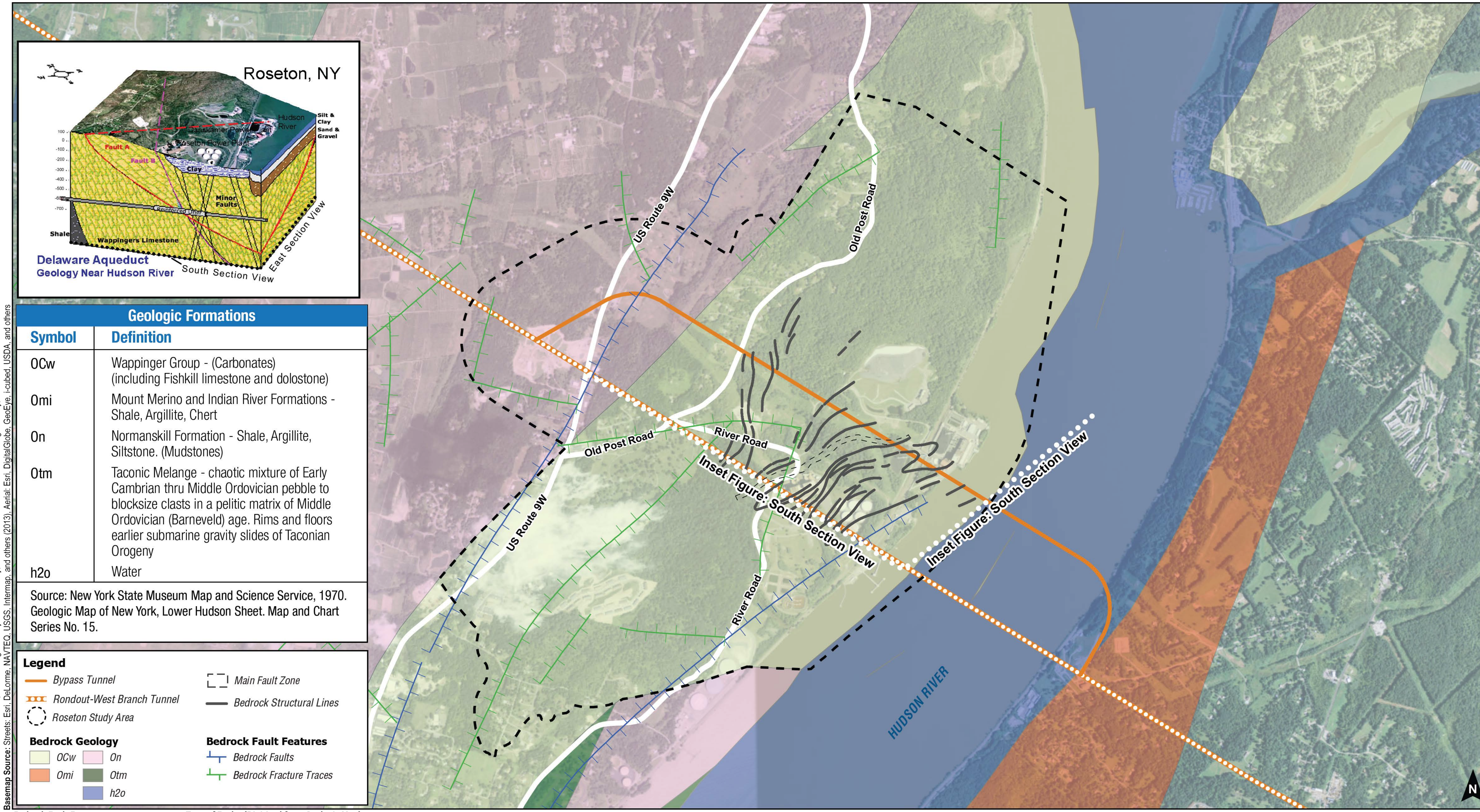
As described in Section 11.9.5.2, "Groundwater – Impact Analysis Methodology," decommissioning has the potential to affect groundwater resources in the Roseton Study Area. Therefore, baseline groundwater conditions within the Roseton Study Area were developed based on the methodology described in Section 11.9.5.2, "Groundwater – Impact Analysis Methodology," and are described below.

Geology

The Roseton Study Area is located in the Hudson-Mohawk Lowlands between the Hudson Valley Fold-Thrust Belt to the west and the Hudson Highlands to the east. The bedrock units found in this province are composed of upper Cambrian to middle Ordovician aged strata (500 to 450 million years before present) (Marshak 1989).

The bedrock formations in the Roseton Study Area include the Normanskill Formation and the Wappinger Group (see **Figure 11.9-16**). Bedrock formations east of the Roseton Study Area include the Mount Merino and Indian River Formations and the Tectonic Melange. DEP investigations and RWBT construction records show bedrock formations are heavily deformed in the region with one major fault zone intersecting the RWBT (Roseton Fault) and several other smaller fault zones intersecting the tunnel just east of the Roseton Fault.

The unconsolidated formations in the Roseton Study Area were deposited by glaciers. A large glacial lake (Lake Albany) formed in the Hudson River Valley as glacial deposits blocked water from draining out of the Hudson Valley to the south. Lake Albany extended from approximately Glens Falls to Newburgh, New York. A thick layer of lacustrine clays, silts, and sands ranging from approximately 75 to 85 feet formed at the bottom of Lake Albany in the Roseton Study Area. These lacustrine clays, silts, and sands exist within the low-lying elevations (0 to 60 feet above mean sea level) of the Roseton Study Area. At higher elevations along the uplands, these lacustrine deposits grade into glacial till.



Symbol	Definition
OCw	Wappinger Group - (Carbonates) (including Fishkill limestone and dolostone)
Omi	Mount Merino and Indian River Formations - Shale, Argillite, Chert
On	Normanskill Formation - Shale, Argillite, Siltstone. (Mudstones)
Otm	Taconic Melange - chaotic mixture of Early Cambrian thru Middle Ordovician pebble to blocksize clasts in a pelitic matrix of Middle Ordovician (Barneveld) age. Rims and floors earlier submarine gravity slides of Taconian Orogeny
h2o	Water

Source: New York State Museum Map and Science Service, 1970. Geologic Map of New York, Lower Hudson Sheet. Map and Chart Series No. 15.

Bedrock Fault Features
Source: Orange County Water Authority. 1995. Groundwater Resources of Orange County, New York, Orange County Water Authority, Goshen, New York, prepared by Leggette, Brashears, & Graham, Inc., 1995.

Type of Faults (Digitized from Geologic Map)
Source: Golder Associates, 2010. Preliminary Geologic Interpretation: Roseton By-Pass Tunnel Facility Planning Phase, NYCDEP Contract CDA-FP1.

0 2,000 Feet

NYC Environmental Protection

Figure 11.9-16: Bedrock Geology – Roseton Study Area

Figure 11.9-17 presents the surficial geology based on the Surficial Geology Map of New York (New York State Museum 1989). It should be noted that the glacial lake deposits were not mapped in the Roseton Study Area by the New York State Museum but historical records and geotechnical boring logs show that the glacial lake lacustrine clay is present at the Roseton Study Area. Section also Section 11.9.5.17, "Geology and Soils – Baseline Conditions" for a further description of geology and soils.

Rondout-West Branch Tunnel

The RWBT underlies the central part of the Roseton Study Area at an average depth of 600-700 feet below ground surface. Sections of bedrock have been mechanically broken up into crush zones that contain multiple bedrock faults. Steel reinforcements were required to stabilize these areas of the tunnel in the Roseton Study Area.

DEP deployed an Autonomous Underwater Vehicle (AUV) through the Rondout - West Branch Tunnel in November 2014, as described further in Section 11.2.1, "Overview of Rondout-West Branch Tunnel Leaks." The AUV passed through the RWBT between Shafts 5A and 6 located in the vicinity of Roseton. A numerical analysis of the data collected by the AUV indicated a distinct drop in velocity of tunnel water equivalent to the loss of approximately 15 mgd between Shafts 5A and 6 in Roseton.

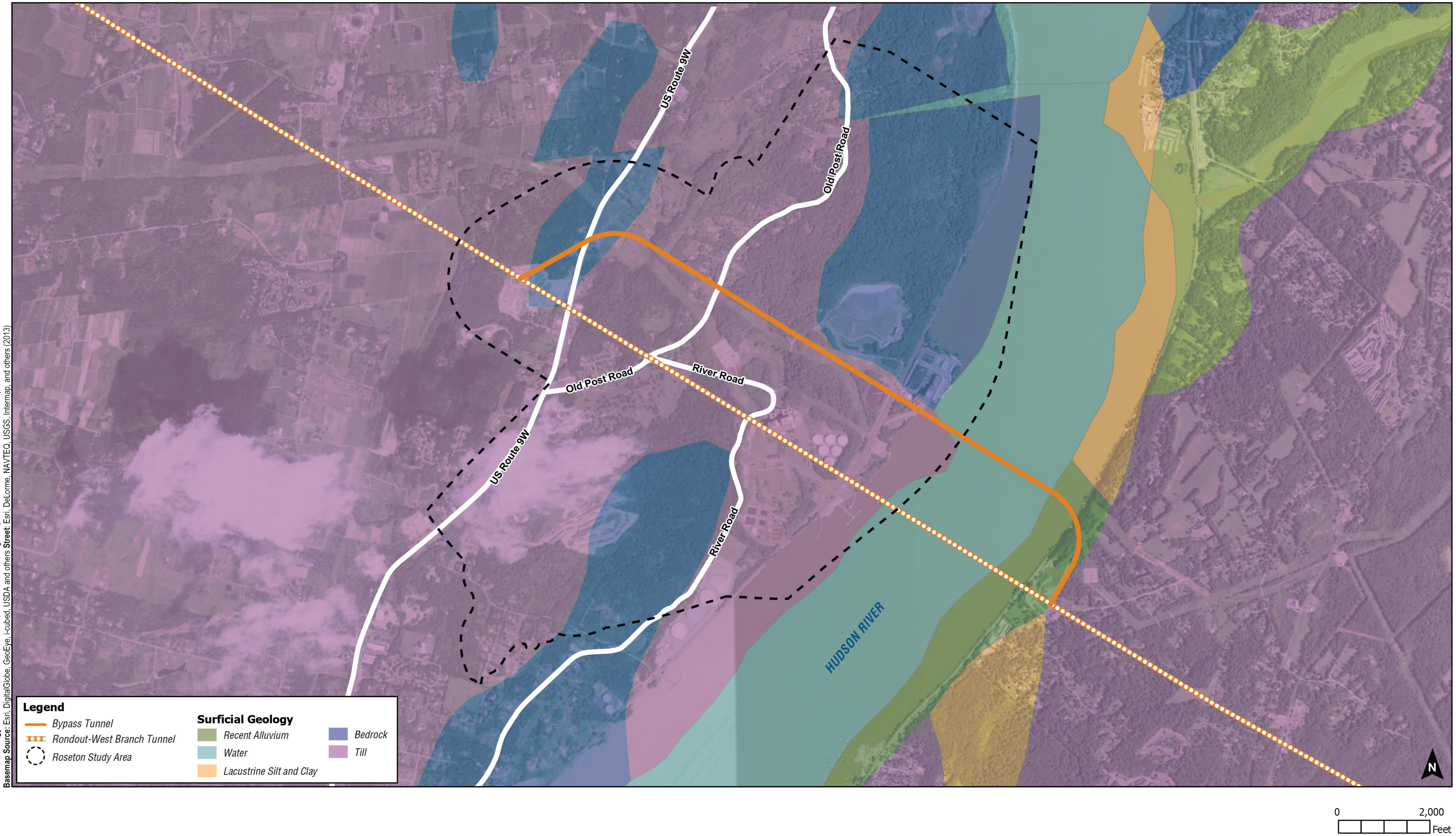
Groundwater Background

Groundwater occurs in the unconsolidated glacial soils and bedrock. Groundwater starts as precipitation. Precipitation falls on ground surface and infiltrates into the small voids between grains of sand, silt, and clay (called the unconsolidated aquifer) in the glacial deposits, ultimately filling up the void spaces to create groundwater as shown on **Figure 11.9-18**.

The surface of the water that fills up the void spaces between the sand grains is called the water table (see **Figure 11.9-19**). Sometimes the water table is called a phreatic or piezometric surface. The shallow unconsolidated aquifer is called an unconfined aquifer because the top of the aquifer can (water table, phreatic, or piezometric surface) freely move up and down filling and draining void spaces between grains of soil. Groundwater moves downhill, from higher water elevations to lower water elevations as groundwater infiltrates into the unconsolidated aquifer at higher elevations, migrates through the aquifer, and ultimately discharges to surface water (see **Figure 11.9-20**), like the Hudson River in the study area.

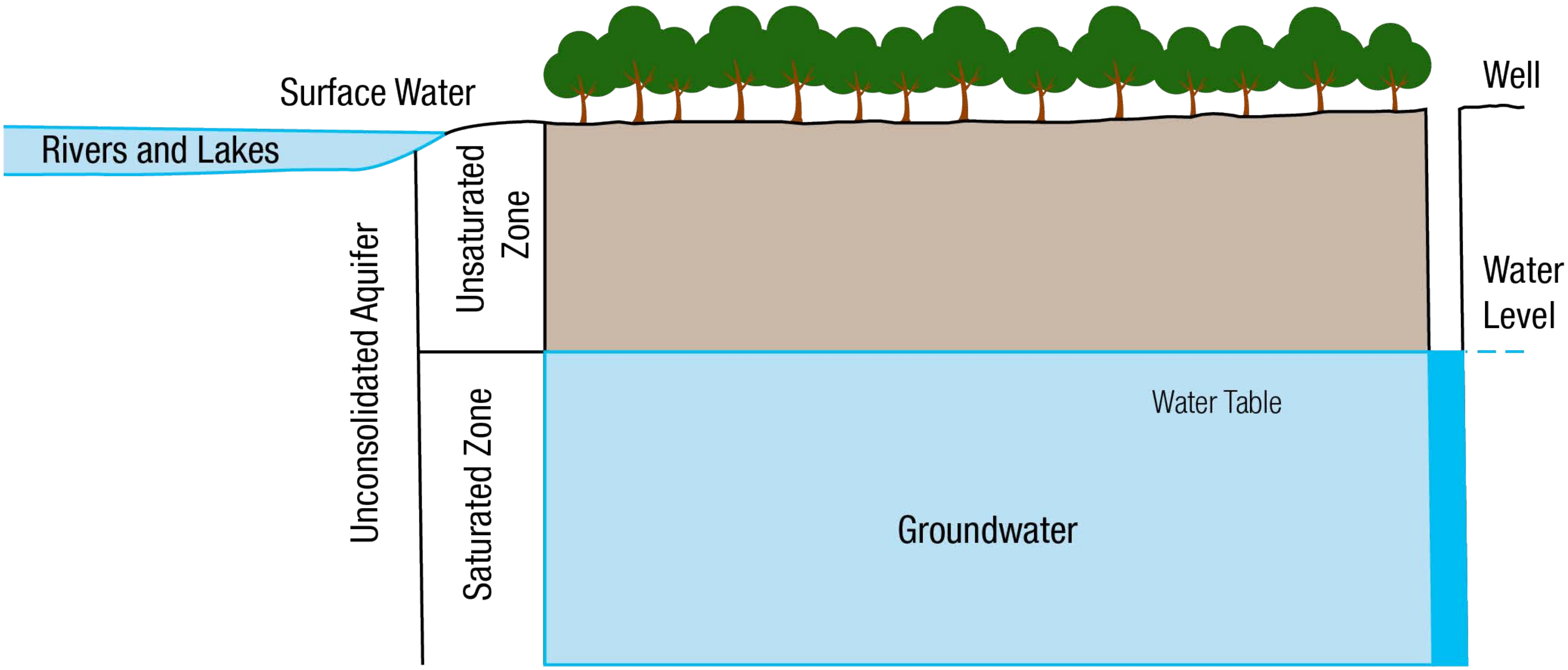
Unconsolidated Aquifers

Groundwater in the unconsolidated aquifer occurs and moves in the same manner as described above. Precipitation falls on the unconsolidated aquifer filling the void spaces between the soil grains creating a water table. The water table is largely in lacustrine deposits of clays, silts, and sands that generally exist within the low-lying elevations (0 to 60 feet above mean sea level) in close proximity to the Hudson River, or within the mixture of clay, silt, and sand of the glacial tills. The lacustrine and glacial tills typically have a very low permeability and are considered a poor aquifer due to low well yields even for private use (Frimpter 1972). The porosity, or the percent of void spaces between soil in the unconsolidated aquifer that can store water, can range from 28 to 42 percent (Todd 1980).



Surficial Geology Source: New York State Museum, 1989, Surficial Geologic Map of New York: Lower Hudson Sheet, Map and Chart Series No. 40
Basemap Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA and others **Street:** Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)

Figure 11.9-17: Surficial Geology – Roseton Study Area



Source: USGS - Basic Groundwater Hydrology

Figure 11.9-18: Illustration of How Groundwater Saturates Soil

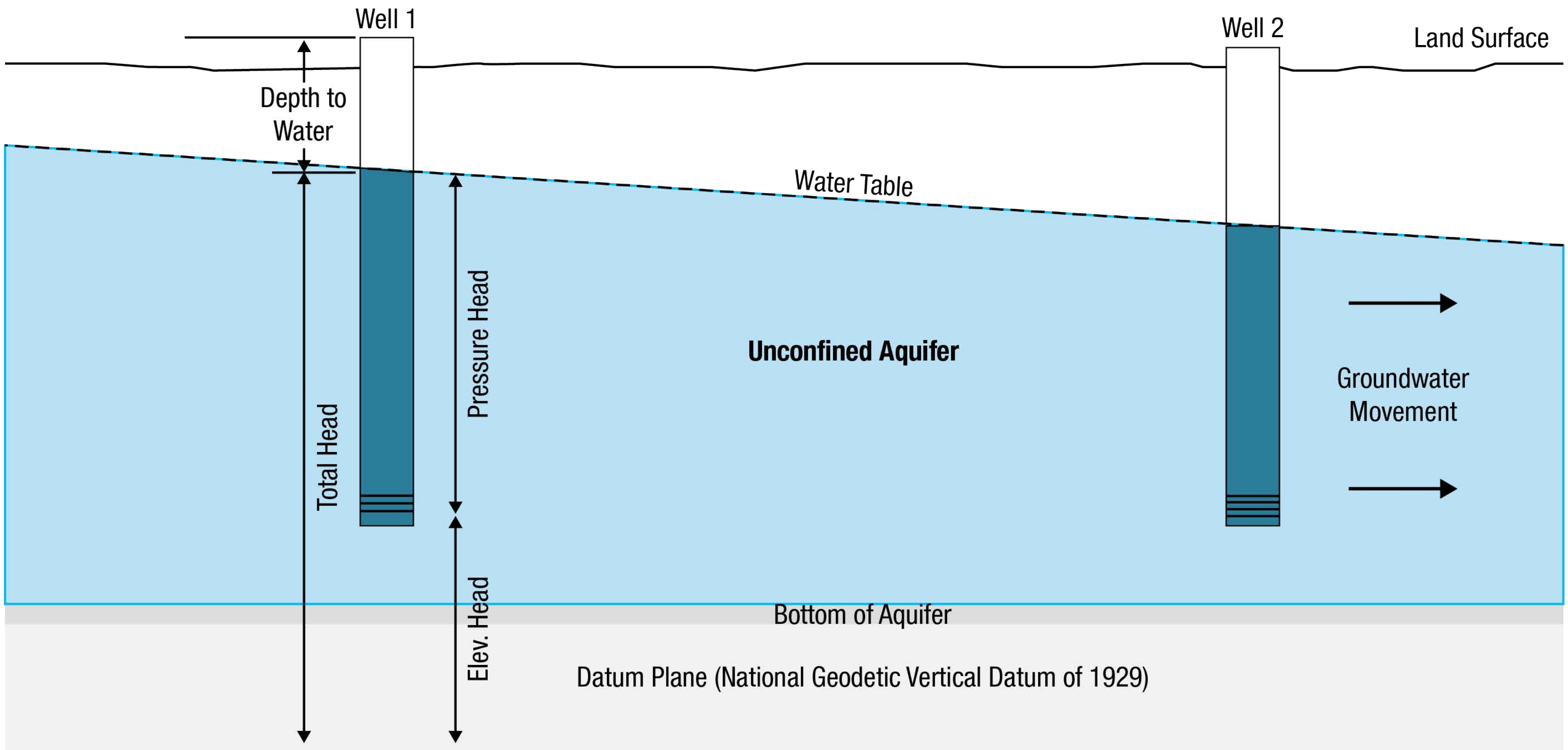


Figure 11.9-19: Illustration of the Water Table

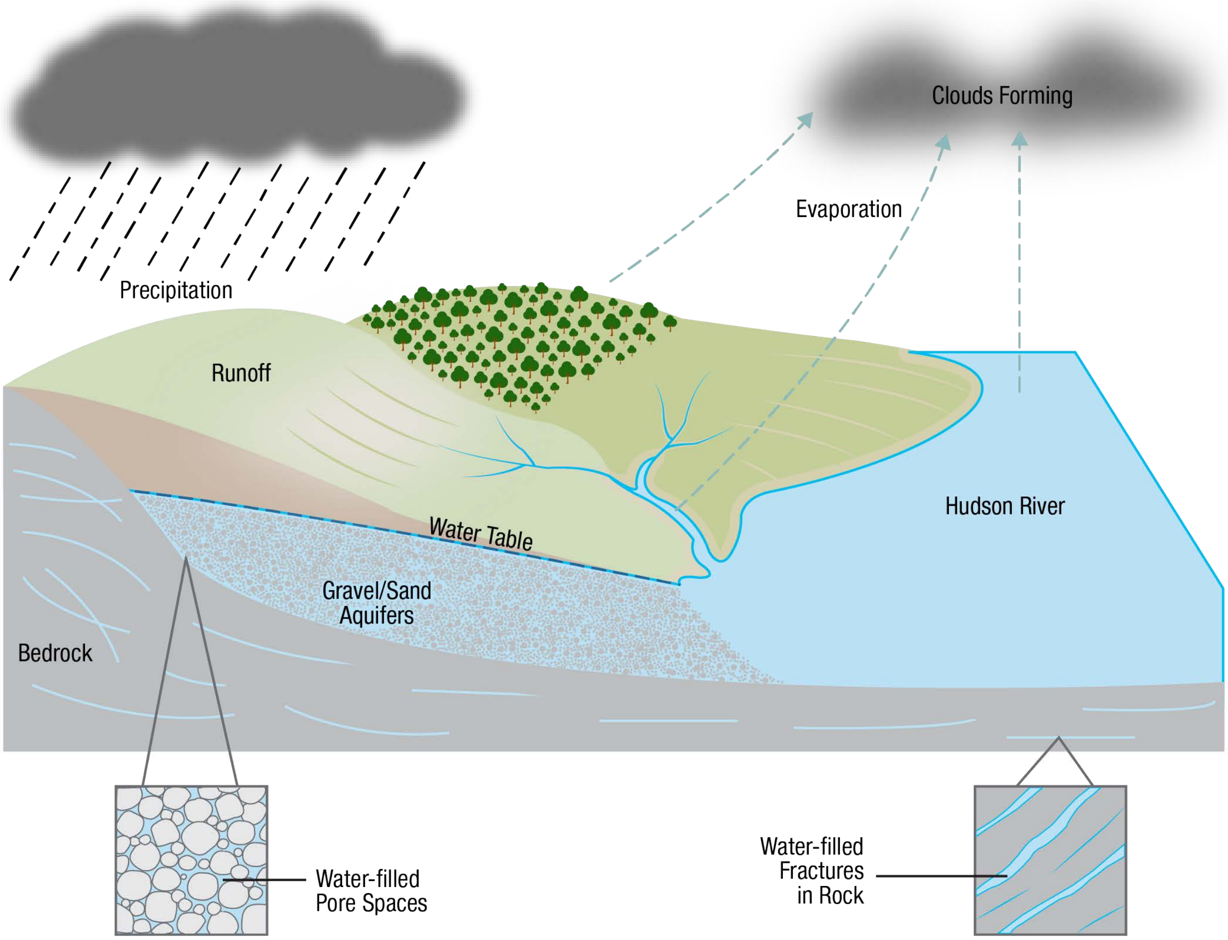


Figure 11.9-20: Illustration of Regional Groundwater Flow

Bedrock Aquifers

The unconsolidated soils containing sand, silts, and clays are underlain by bedrock that forms a deeper aquifer in the Roseton Study Area. The bedrock aquifer consists of shale and limestone. Groundwater migrating through bedrock does not migrate in void spaces between sand, silt, and clay (primary openings) as it does in unconsolidated aquifers. These bedrock aquifers contain a series of fractures, weathered segments, fault lines, and geologic beds that function as a connected but irregular network for groundwater movement (secondary openings) in the rock (see **Figure 11.9-21**).

Groundwater will move much easier along this network of secondary openings, than it will within the primary openings of the rock. Like the unconsolidated aquifer, groundwater generally moves downhill from higher water elevation to lower water elevation as groundwater infiltrates into the bedrock at higher elevations, migrates through the aquifer, and ultimately discharges to the unconsolidated aquifer and eventually to the Hudson River.

The bedrock aquifer that underlies the unconsolidated aquifers in the Roseton Study Area is called a confined aquifer. This aquifer is confined because the overlying unconsolidated aquifer will not allow the water in the deeper bedrock aquifer to freely move up and down filling and draining void spaces. In the Roseton Study Area, the void spaces in bedrock are completely filled and stay completely filled with water beneath the unconsolidated aquifer where the unconsolidated soils are present. Groundwater in this confined aquifer is under pressure. In this case, the water level in a well installed in a confined aquifer will rise above the top of the aquifer (see **Figure 11.9-22**). This is often called artesian pressure. The difference between the water level in an unconfined aquifer (water table) and the water level in a confined aquifer (potentiometric surface) is that the water table would be visible in a hole in the ground but the potentiometric surface would not be visible unless a well was installed in the confined aquifer.

Groundwater in the bedrock aquifer starts as precipitation falling on the ground surface where bedrock is near ground surface such as the upland areas of Roseton. Groundwater could also enter the bedrock aquifer from the overlying unconsolidated unconfined aquifer. The depth to the potentiometric water level in bedrock monitoring wells ranges from a few feet above ground surface (where artesian pressure raises the potentiometric surface above ground surface causing water to flow out of the well) to a few feet below ground surface in the Roseton Study Area.

Groundwater flows from higher water level elevation west of the Roseton Study Area to lower water level elevation as water in the bedrock aquifer discharges to the Hudson River (see **Figure 11.9-23**). The average groundwater elevations in the wells monitored as part of the monitoring network ranged between approximately 5 and 203 feet above mean sea level with seasonal fluctuation averaging approximately 15 feet (and up to as much as 40 feet). The porosity or the percent of void spaces in the fractures, weathered segments, fault lines, and geologic beds in bedrock is much smaller than between sand, silts, and clays in the unconsolidated aquifer. The porosity of bedrock can range from 0.05 to 0.10 (Freeze and Cherry 1979). These data show that bedrock aquifers store a much smaller volume of water than unconsolidated aquifers.

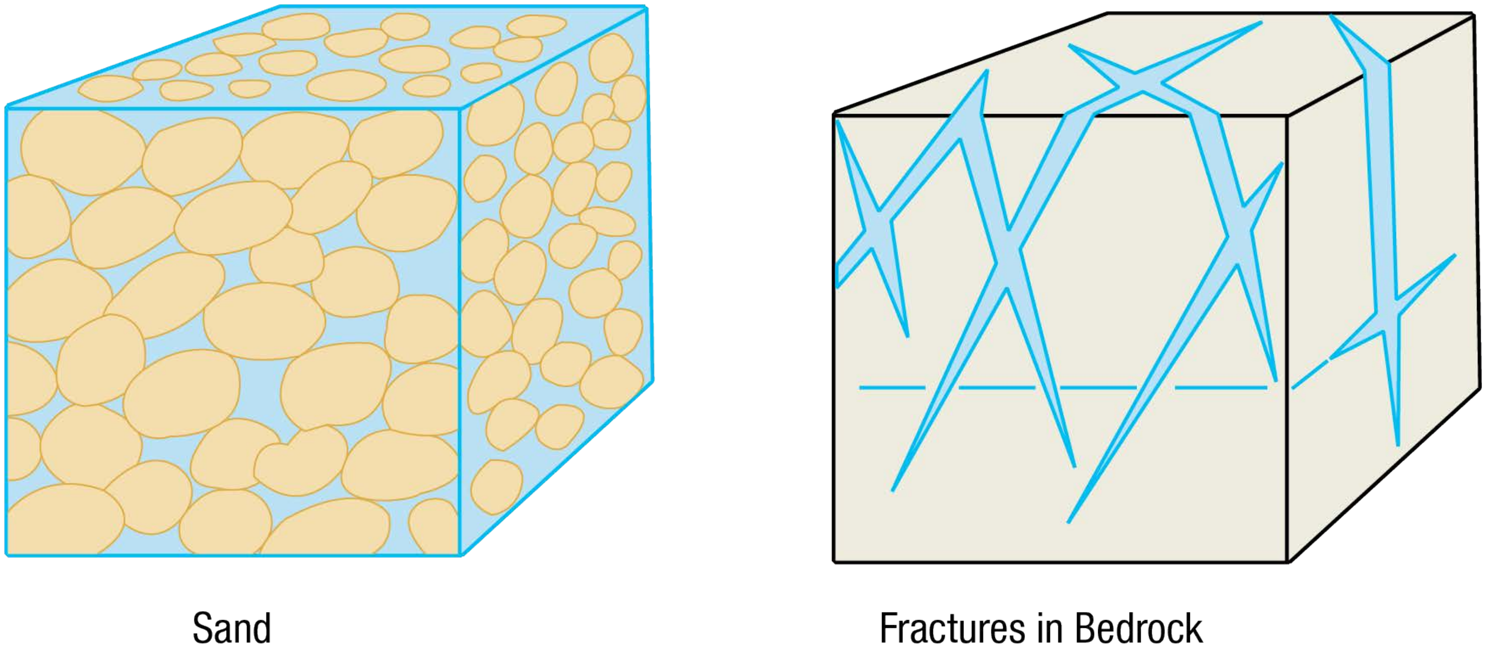


Figure 11.9-21: Illustration of Openings in Unconsolidated Soils and Bedrock

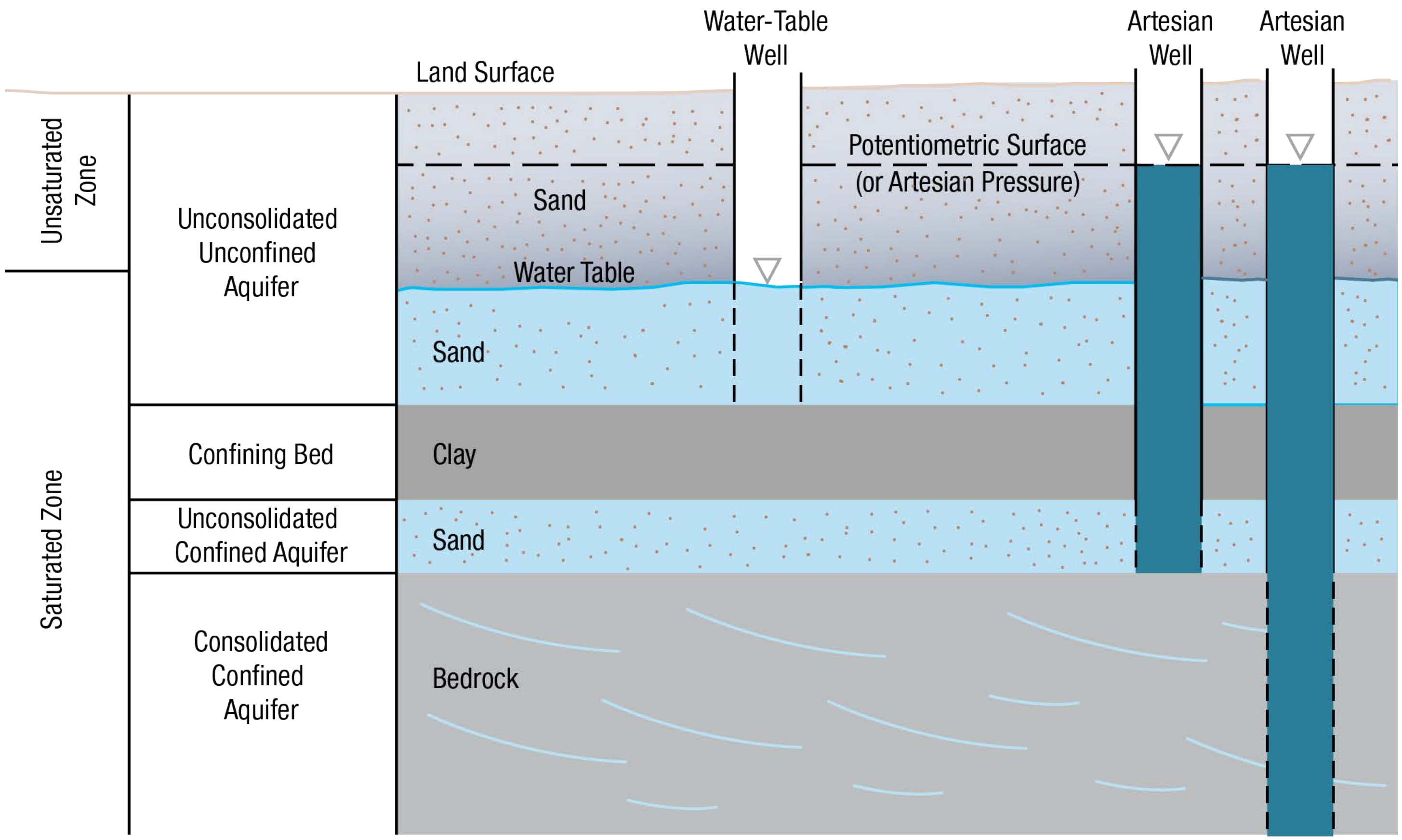
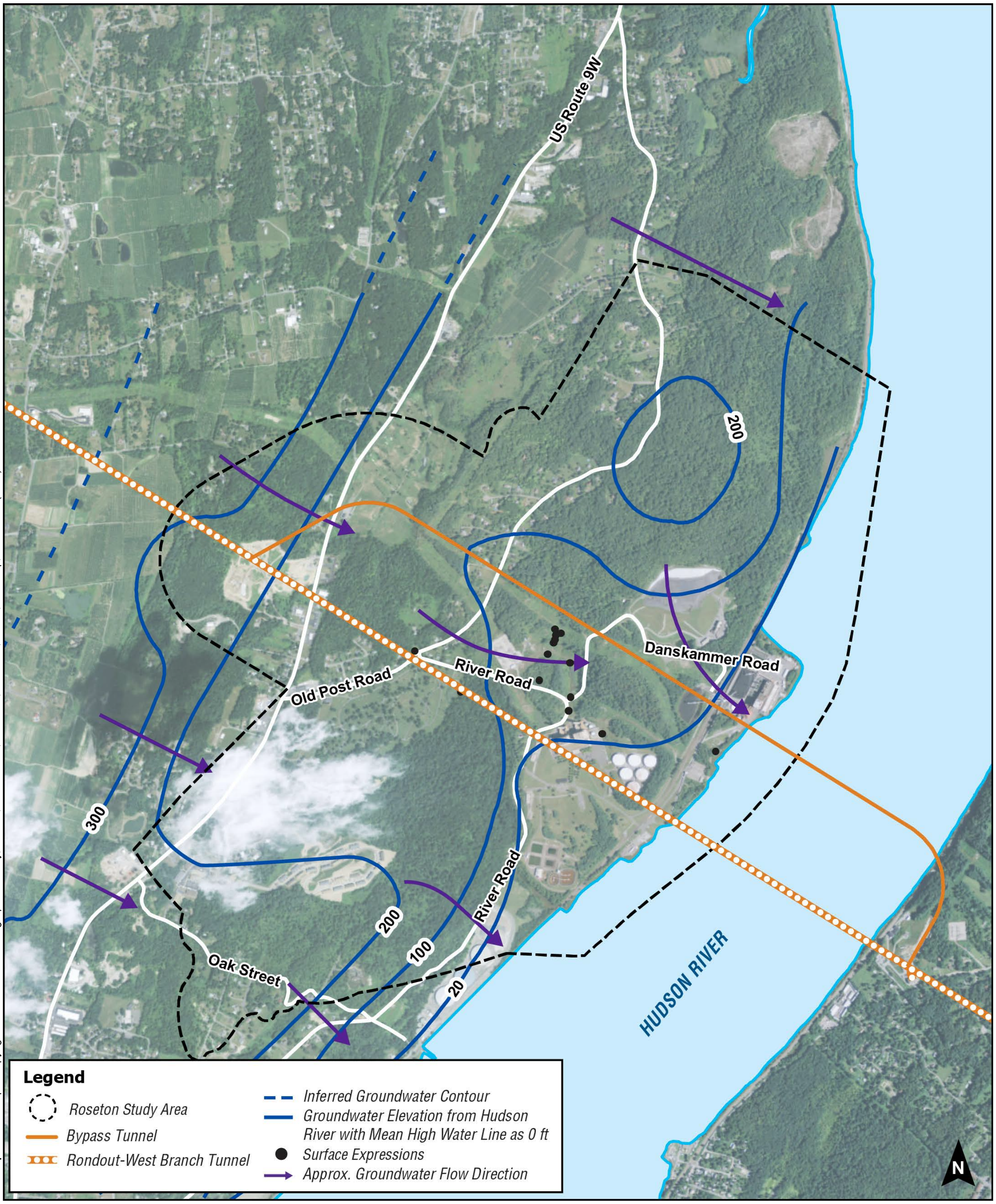


Figure 11.9-22: Illustration of Confined Aquifer, Potentiometric Surface, and Artesian Pressure



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, Swisstopo, and the GIS User Community
Basemap Source: Topo: Copyright: ©2013 National Geographic Society, i-cubed, Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)

Note: 100 ft Contour Interval. 20 ft Contour (Shown for reference). Hudson River assumed 0 ft elevation. Groundwater contours based on average groundwater elevations from July 2013 – December 2014 in Roseton Study Area.

Figure 11.9-23: Regional Groundwater Flow – Roseton Study Area

Groundwater Use

Two water districts are near the Roseton Study Area (see **Figure 11.9-24**). The Town of Marlborough water district is north of the Roseton Study Area. The Town of Newburgh water district is south of the Roseton Study Area. A more detailed description of the groundwater use and the potential impacts to users in the Roseton Study Area is in Section 11.9.13, "Water and Sewer Infrastructure." As further described in Section 11.9.13, "Water and Sewer Infrastructure," results of the groundwater impact analysis show there are 27 parcels within the Estimated Bedrock Aquifer Groundwater Influence Area with known, potential or future potential private drinking water supply wells in the unconsolidated and bedrock aquifers. One parcel (Cedar Hill Cemetery) has two existing wells bring the total number of known, potential, or future potential private supply wells to 28.

Aquifer Recharge

Groundwater recharge is dependent on the infiltration of precipitation through the ground surface into the underlying unconsolidated and bedrock aquifers. Groundwater recharge is dependent on the amount and rate of precipitation, permeability of the soils, and ground surface or bedrock surface slope. The recharge to the bedrock aquifer can be evaluated using published values of precipitation, permeability, and bedrock surface slope.

A study completed in the Beacon-Fishkill area shows that the average precipitation at Fishkill is 45 inches per year. Of this total, only 8 inches of water recharge a bedrock aquifer covered by till (Snavely 1980). These hydrogeologic conditions are very similar to the hydrogeologic conditions at Roseton.

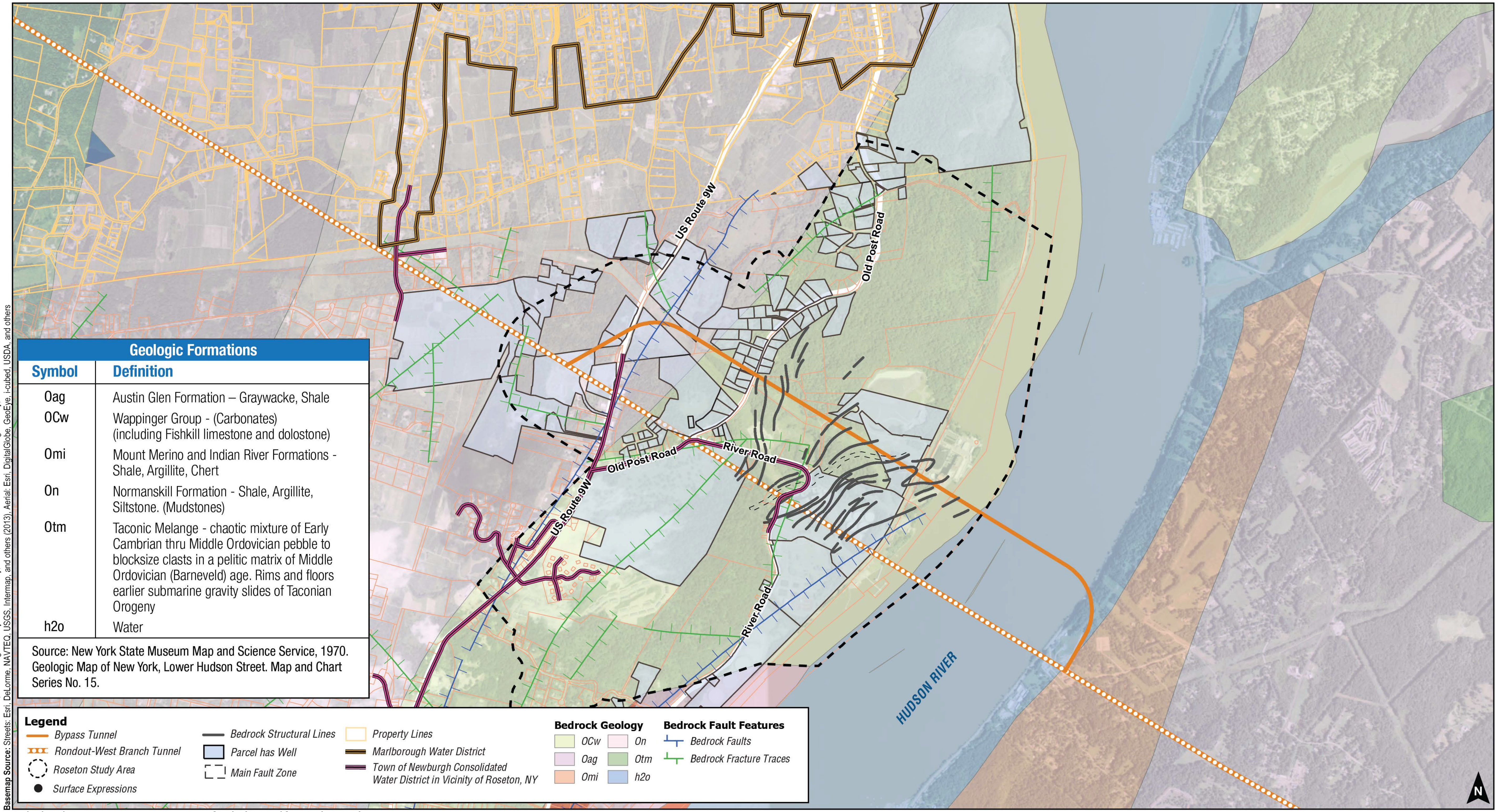
The recharge to the bedrock aquifer was calculated using these data and the fact that residential properties surrounding Roseton Study Area have a minimum of one acre of land.[5] This calculation shows that approximately 600 gallons per day (gpd) of groundwater can recharge the bedrock aquifer on each one-acre residential property during an average precipitation year.

Roseton Study Area Groundwater Data

Water levels measured in monitoring wells during the regional characterization of groundwater conditions in the Roseton Study Area were used to evaluate the following:

- Groundwater level variations due to seasonal variations in aquifer recharge, groundwater use, and aquifer discharge;
- Groundwater temperature variations due to changes in the RWBT leak influence as represented by the HGL; and
- Groundwater level fluctuations due to changes in the RWBT water pressure and water level as represented by the HGL.

[5] The recharge estimates were calculated as follows: 8 inches (0.67 feet) or 5 inches (0.42 feet) of recharge per year x 43,560 square feet per x 7.48 gallons per cubic foot /365 days per year = 595 gallons per day.



Other Source: Golder Associates, 2010. Orange County Water Authority, 1995. Groundwater Resources of Orange County, New York.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Bedrock Fault Features
Source: Orange County Water Authority. 1995. Groundwater Resources of Orange County, New York, Orange County Water Authority, Goshen, New York, prepared by Leggette, Brashears, & Graham, Inc., 1995.

Type of Faults (Digitized from Geologic Map)
Source: Golder Associates, 2010. Preliminary Geologic Interpretation: Roseton By-Pass Tunnel Facility Planning Phase, NYCDEP Contract CDA-FP1.

Note: Hourly Average Data for Pre-shutdown (10/10/14 to 10/17/14), Shutdown (10/17/14 to 10/20/14), and Post-shutdown (10/20/14 to 10/27/14) Town of Newburgh Consolidated Water District public water service area in the vicinity of the Roseton Study Area. The consolidated water district also provides public drinking water to areas further to the south outside of Roseton.

0 1,800 Feet

Figure 11.9-24: Groundwater Use in the Roseton Study Area

NYC Environmental Protection

Seasonal Groundwater Level Variations

Water levels measured in three GWP wells (Groundwater Point Wells) that are: (1) not residential wells (therefore, the water level does not fluctuate as a result of the well use); or (2) near or affected by residential wells were plotted to show the seasonal variation of the water level as a result of seasonal variations in aquifer recharge, groundwater use, and aquifer discharge (see **Figure 11.9-7**). The results show seasonal water level variation of 5.5 feet in bedrock well (GWP-8) (see **Figure 11.9-25**). The seasonal water level variation in the unconsolidated aquifer was 4.5 feet (GWP-12). However, this is conservative, as this well may have been slightly affected by nearby pumping.

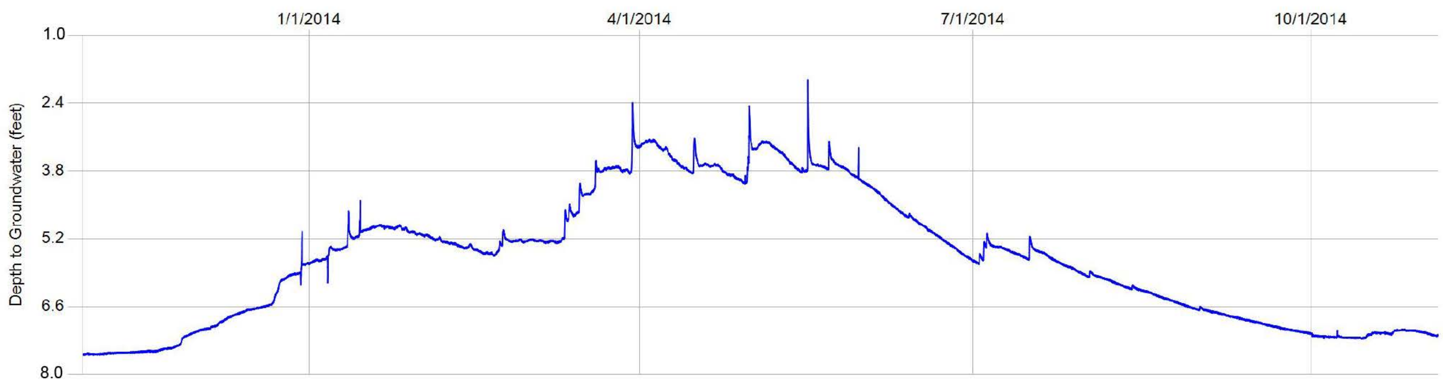
Seasonal Groundwater Temperature Variations

Groundwater temperature was monitored at the GWP locations to assess if temperature fluctuations or trends in groundwater measured in monitoring wells might be indicative of water leaking from the RWBT as native groundwater temperature does not seasonally fluctuate (see **Figure 11.9-26**, Sheets 1 and 2). The results show wells located furthest from the RWBT exhibited the least temperature fluctuation while those closest to the existing RWBT exhibited a temperature fluctuation indicative of influence from the RWBT. This temperature fluctuation is seasonal and correlates to the temperature of the surface water in Rondout Reservoir which is generally warmer in the summer and colder in the winter than the groundwater. Analysis of bedrock groundwater temperature data from the GWP locations indicate that groundwater temperature in the bedrock varies seasonally by up to approximately 4 °C (7.2°F). Greater groundwater temperature variation was measured in wells closest to the RWBT (GWP-5, GWP-14, and GWP-22) indicating a possible hydraulic connection to the RWBT. Less groundwater temperature variation was measured in wells GWP-07, GWP-09, GWP-18, and GWP-12.

Depressurizations

As described further in Section 11.9.2, “Description of Rondout-West Branch Tunnel Decommissioning,” water levels were measured in monitoring wells during the depressurizations. During a depressurization of the RWBT, DEP depressurizes the tunnel and releases water in the tunnel through a “blow-off” valve at Shaft 6 in the Town of Wappinger, New York, but does not completely empty the tunnel of water. Once the depressurization event has been completed, the blow-off valve is closed and flow is gradual restored re-pressurizing the tunnel. A description of the water levels measured in monitoring wells during each depressurization event is described below.

Location: Roseton GWP-08



Location: Roseton GWP-12

Figure 11.9-25: Seasonal Groundwater Level Variations in Roseton Monitoring Wells

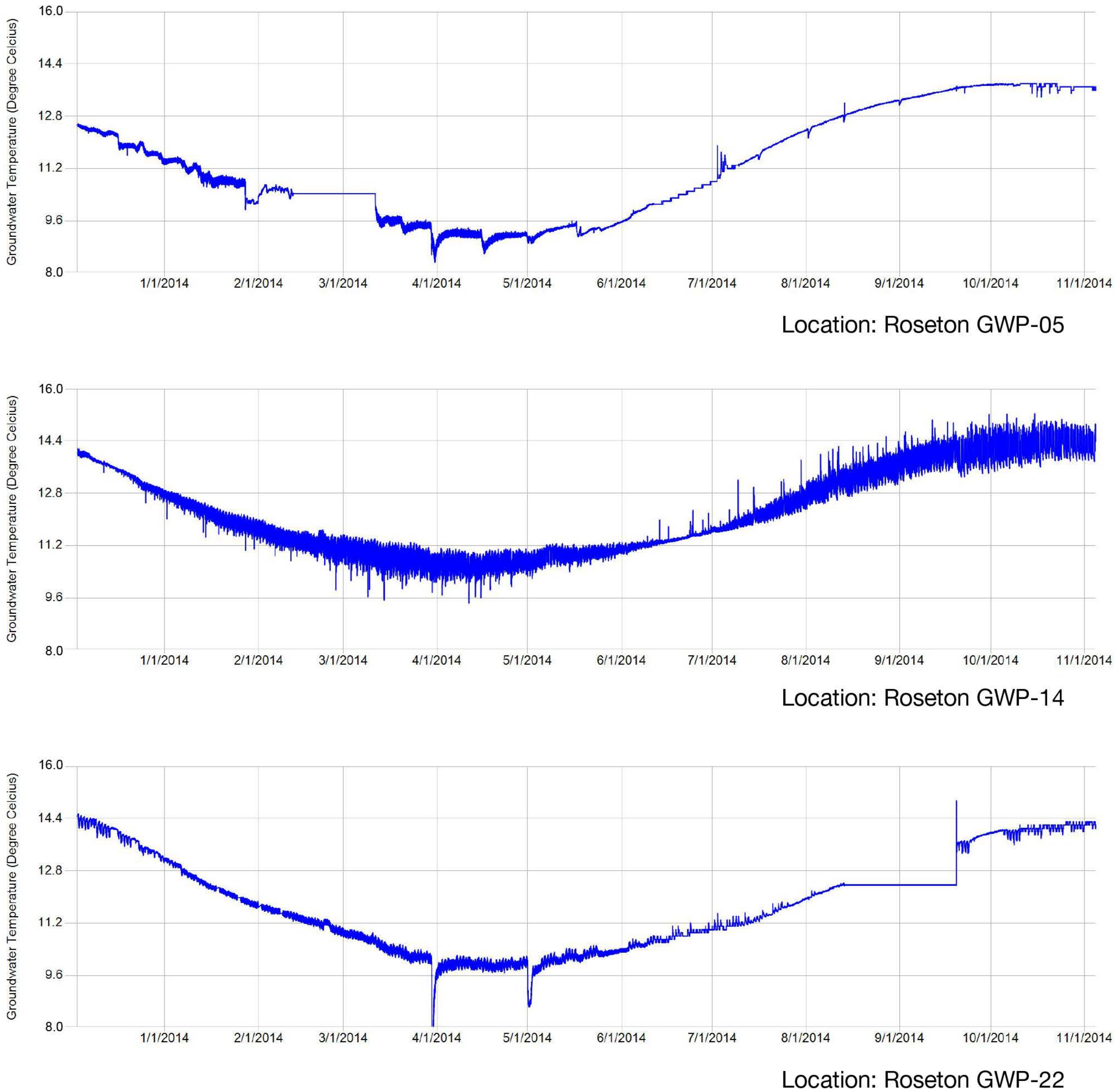


Figure 11.9-26: Seasonal Groundwater Temperature Variations in Roseton Monitoring Wells (Sheet 1)

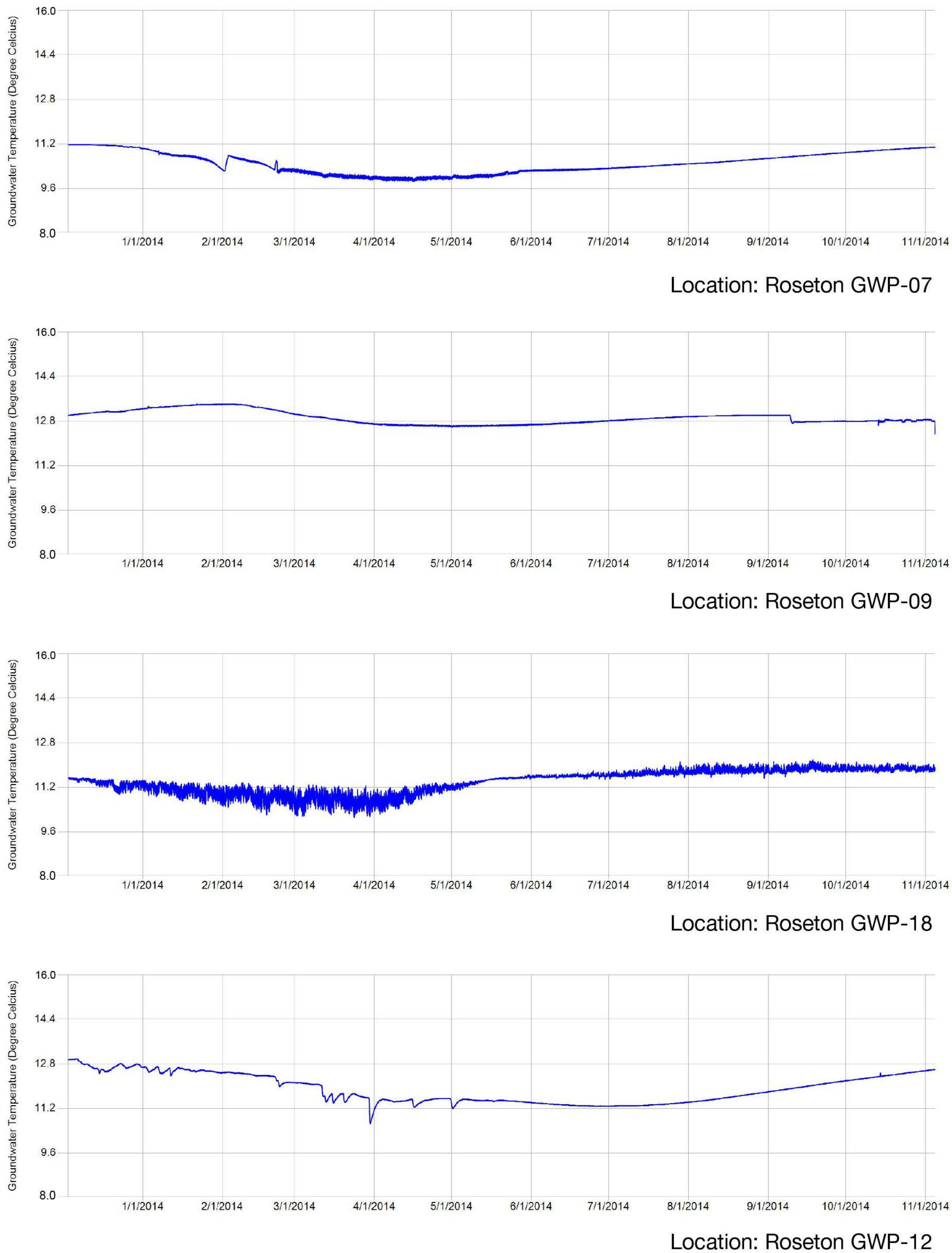


Figure 11.9-26: Seasonal Groundwater Temperature Variations in Roseton Monitoring Wells (Sheet 2)

February to March 2008 Depressurization of the RWBT

DEP depressurized the RWBT reducing the HGL at Shaft 6 from a maximum of 585 to a minimum of 75 feet (510 feet) between February 18 and March 3, 2008 (14 Days). Water levels were measured in eight wells during the depressurization. The water level in five wells (wells DW-2R, DW-3R, DW-7R, DW-8R, and DW-9R) decreased as a result of the depressurization. The water level in three other wells (MW-1R, MW-5R, and MW-6R) did not decrease as a result of the depressurization (see **Figure 11.9-27**).

October to November 2008 Depressurization of the RWBT

DEP depressurized the RWBT reducing the HGL at Shaft 6 from a maximum of 596 to a minimum of 90 feet (roughly 510 feet) between October 25 and November 26, 2008 (32 Days). The water level in the two bedrock wells (DW-6R and DW-7R) monitored during the depressurization did not decrease during the depressurization (**see Figure 11.9-28**).

November 2009 to January 2010 Depressurizations of the RWBT

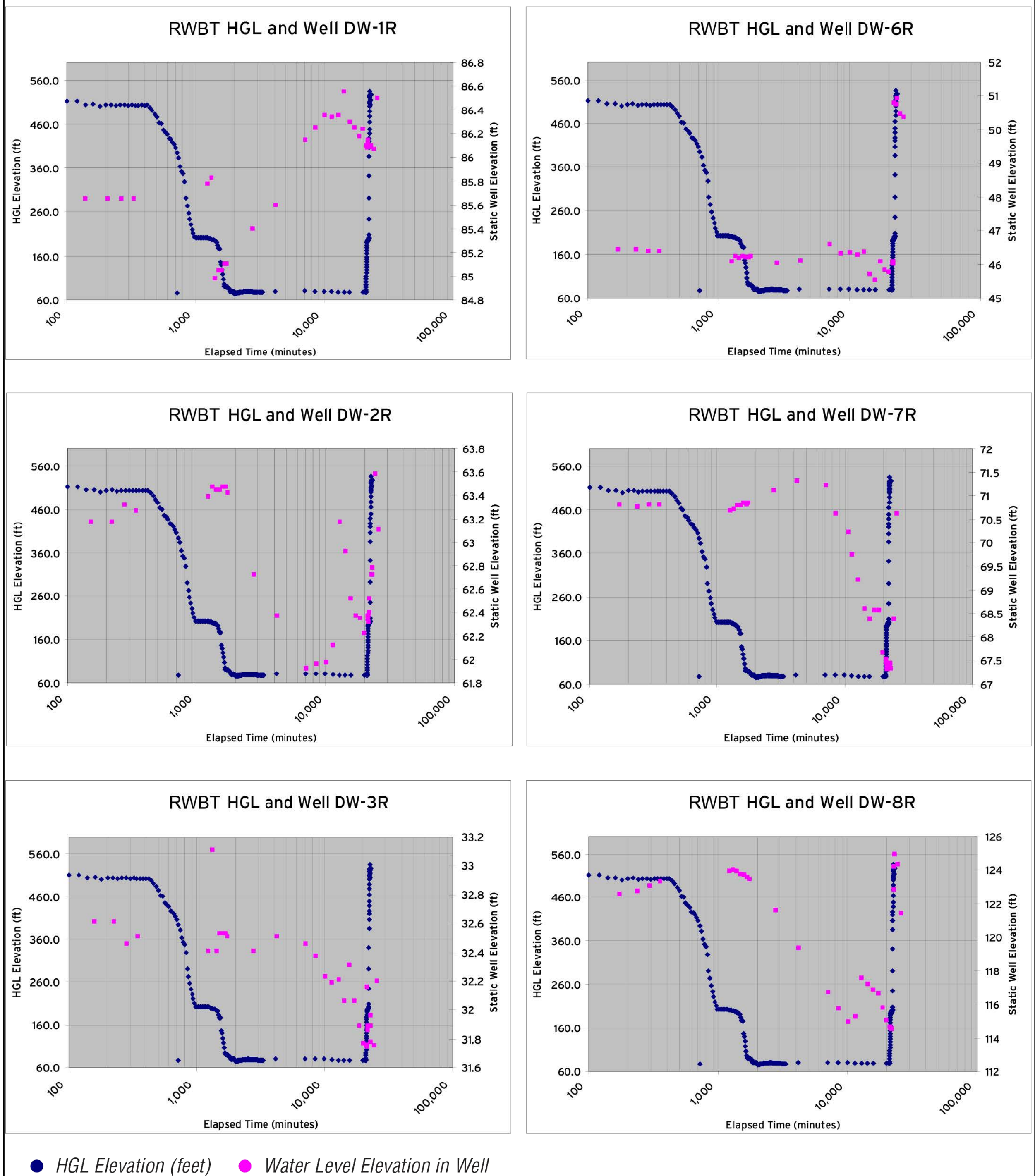
Three depressurizations events were completed from November 2009 to January 2010. The first depressurization occurred from November 5 to November 15, 2009. The second depressurization occurred from December 4 to December 16, 2009. The final depressurization occurred from January 13 to January 26, 2010. The HGL in the RWBT was lowered approximately 510 feet during each depressurization event. Water levels were measured in six monitoring wells (RW-1, RW-2, RW-3, RW-4, DW-6R, and DW-7R) during these depressurization events. The results show that the water level in unconsolidated wells RW-1, RW-2, RW-3, and RW-4 did not change as a result of depressurizing the RWBT. The results also show the water level in bedrock wells DW-6R and DW-7R did not change as a result of the depressurization (see **Figure 11.9-29**).

October 2014 Depressurization of the RWBT

DEP depressurized the RWBT, reducing the HGL at Shaft 6 by 120 feet between October 17 and October 20, 2014 (6 Days). Water levels were measured in 15 wells and three piezometers (one location with piezometers at three depths) during the depressurization. The results show water levels changed in two wells (GWP-7 and GWP-9) and two piezometers (RB-1-Middle and RB-1-Deep) as a result of the depressurization (see **Table 11.9-6**).

Summary

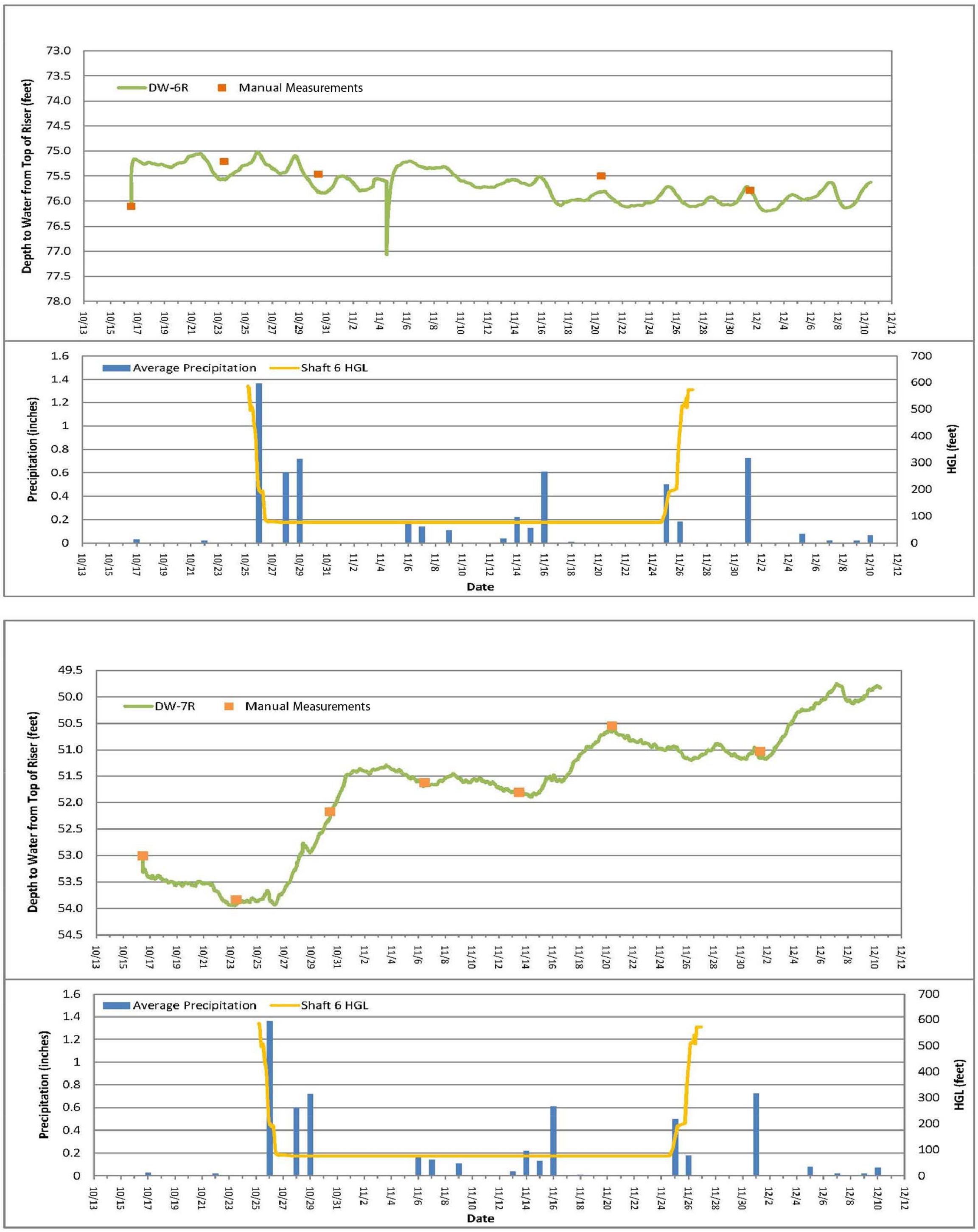
Water levels were measured in monitoring wells during the six depressurizations between 2008 and 2014. The water level in unconsolidated wells (RW-1 through RW-4) did not drawdown as a result of the three depressurizations completed between November 2009 and January 2010. The water level did drawdown in bedrock monitoring wells during depressurizations. The water level in bedrock wells DW-2R, DW-3R, DW-7R DW-8R, and DW-9R did drawdown as a result of the February to March 2008 depressurization. However, the water level in bedrock wells DW-6R and DW-7R did not drawdown during the October to November 2008 depressurization, or during the three depressurization from November 2009 and January 2010 that were completed with similar HGL changes and similar durations. Bedrock wells DW-2R, DW-3R, DW-6R, DW-7R DW-8R, and DW-9R are located over 2,000 feet to the north of RWBT.



Note: HGL = Hydraulic Grade Line
Depressurization Occurred in February and March 2008

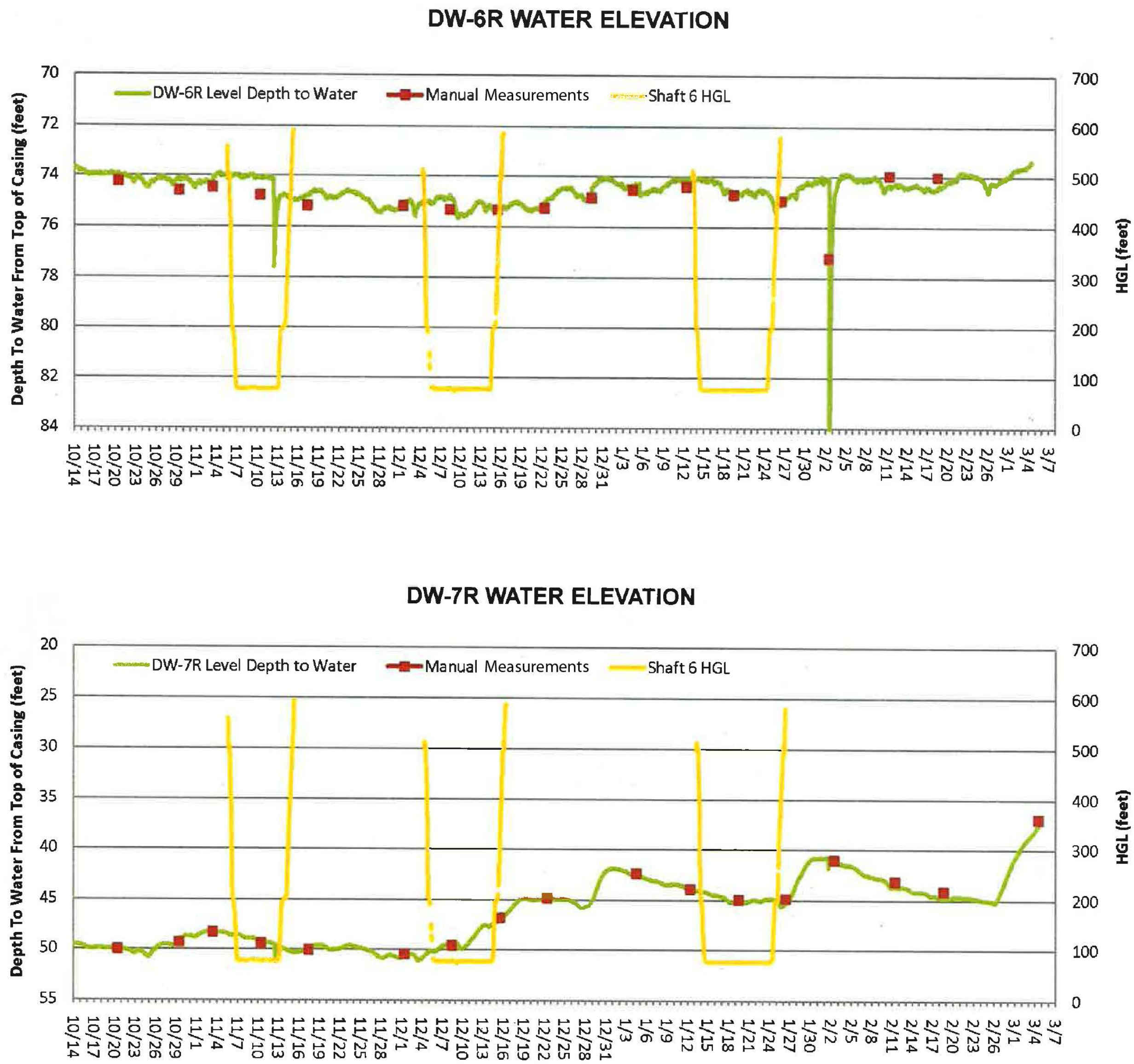
Note: the water level data and charts were not available for wells DW-5R and DW-9R.

Figure 11.9-27: Water Levels Measured during the February/March 2008 Depressurization



Note: HGL = Hydraulic Grade Line
Depressurization Occurred in October and November 2008

Figure 11.9-28: Water Levels Measured during the October/November 2008 Depressurization



Note: HGL = Hydraulic Grade Line
Depressurizations Occurred in Nov '09, Dec '09, and Jan '10

Figure 11.9-29: Water Levels Measured during the November 2009 to January 2010 Depressurization

Environmental Protection

Table 11.9-6: Groundwater Study Area Depressurization Response in Groundwater and Boring Monitoring Locations

Station ID	October 2014 Depressurization Response (Feet Drawdown)	Station ID	October 2014 Depressurization Response (Feet Drawdown)
GWP-2	NR	RB-2-Shallow	0.28
GWP-5	NR	RB-2-Middle	0.34
GWP-6	NR	RB-2-Deep	0.13
GWP-7	0.66	RB-3-Shallow	NA
GWP-8	NR	RB-3-Middle	NA
GWP-9	2.26	RB-3-Deep	NA
GWP-12	NR	RB-5-Shallow	Probable Delayed Response
GWP-13	NR	RB-5-Middle	Probable Delayed Response
GWP-14	NR	RB-5-Deep	Probable Delayed Response
GWP-17	NR	RB-6-Shallow	0.15
GWP-18	NR	RB-6-Middle	0.35
GWP-19[1]	NR	RB-6-Deep	0.44
GWP-20	NR	RB-7-Shallow	NR
GWP-21	NR	RB-7-Middle	NR
GWP-22	NR	RB-7-Deep	NR
RB-1-Shallow	NR	RB-15-Shallow	NR
RB-1-Middle	1.09	RB-15-Middle	NR
RB-1-Deep	12.24	RB-15-Deep	NR

Notes:
NA: Incomplete data set
NR: No Response

The water level in two wells (GWP-7 and GWP-9) and two piezometers (RB-1-Middle and RB-1-Deep) did drawdown during the October 2014 depressurization. GWP-7 is roughly 1,500 feet south of RWBT, and GWP-9 is roughly 1,600 feet south of RWBT. These wells encounter fractures or faults that are hydraulically connected with the RWBT. The remaining wells (where there was no water level response due to the depressurizations), either did not encounter fractures hydraulically connected to RWBT, or the duration of the depressurization was insufficient for the potential water level effects to be transmitted to these wells. The locations of the wells that responded to the changes in the RWBT HGL show how groundwater flow is controlled by the presence, location, and distribution of fractures and faults in the bedrock.

11.9.5.11 Surface Water – Baseline Conditions

Baseline conditions of surface water within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.3, "Surface Water – Methodology." The Natural Resources Study Area includes wetland communities that are associated with six watercourses (Stream Segments 1, 2, 3, 3A, 3B, and 4), which together comprise a perennial tributary to the Hudson River known as Roseton Brook. These watercourses are identified by

NYSDEC as Class C, perennial, non-trout streams, except for the tidal segment of Stream Segment 4 at its confluence with the Hudson River, which is identified as Class A (see **Figure 11.9-6**). Class C water quality standards are presented in **Table 11.9-7**.

Table 11.9-7: NYSDEC Class C Water Quality Standards

Parameter	Standard
Taste-, color-, and odor-producing, toxic, and other deleterious substances	None in amounts that will adversely affect the taste, color, or odor thereof, or impair the waters for their best usages.
Turbidity	No increase that will cause a substantial visible contrast to natural conditions.
Suspended, colloidal, and settleable solids	None from sewage, industrial wastes, or other wastes that will cause deposition or impair the waters for their best usages.
Oil and floating substances	No residue attributable to sewage, industrial wastes, or other wastes, nor visible oil film nor globules of grease.
Phosphorus and nitrogen	None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages.
Thermal discharges	For trout waters (T or TS): (i) No discharge at temperatures over 70 degrees Fahrenheit shall be permitted at any time to streams classified for trout. (ii) From June through September, no discharge shall be permitted that will raise the temperature of the stream more than 2 degrees Fahrenheit over that which existed before the addition of heat of artificial origin. (iii) From October through May, no discharge shall be permitted that will raise the temperature of the stream more than 5 degrees Fahrenheit over that which existed before the addition of heat of artificial origin or to a maximum of 50 degrees Fahrenheit whichever is less. (iv) From June through September, no discharge shall be permitted that will lower the temperature of the stream more than 2 degrees Fahrenheit from that which existed immediately prior to such lowering.
Flow	No alteration that will impair the waters for their best usages.
pH	Shall not be less than 6.5 or more than 8.5.
Dissolved oxygen (DO)	For trout spawning waters (TS), the DO concentration shall not be less than 7.0 mg/L from other than natural conditions. For trout waters (T), the minimum daily average shall not be less than 6.0 mg/L, and at no time shall the concentration be less than 5.0 mg/L. For non-trout waters, the minimum daily average shall not be less than 5.0 mg/L, and at no time shall the DO concentration be less than 4.0 mg/L.
Dissolved solids	Shall be kept as low as practicable to maintain the best usage of waters, but in no case shall it exceed 500 mg/L.
Total coliforms (number per 100 ml)	The monthly median value and more than 20% of the samples, from a minimum of five examinations, shall not exceed 2,400 and 5,000, respectively.
Fecal coliforms (number per 100 ml)	The monthly geometric mean, from a minimum of five examinations, shall not exceed 200.
Source: Title 6 of the NYSDEC New York State Codes, Rules and Regulations, Part 703 (6 NYCRR §703).	

Watercourses

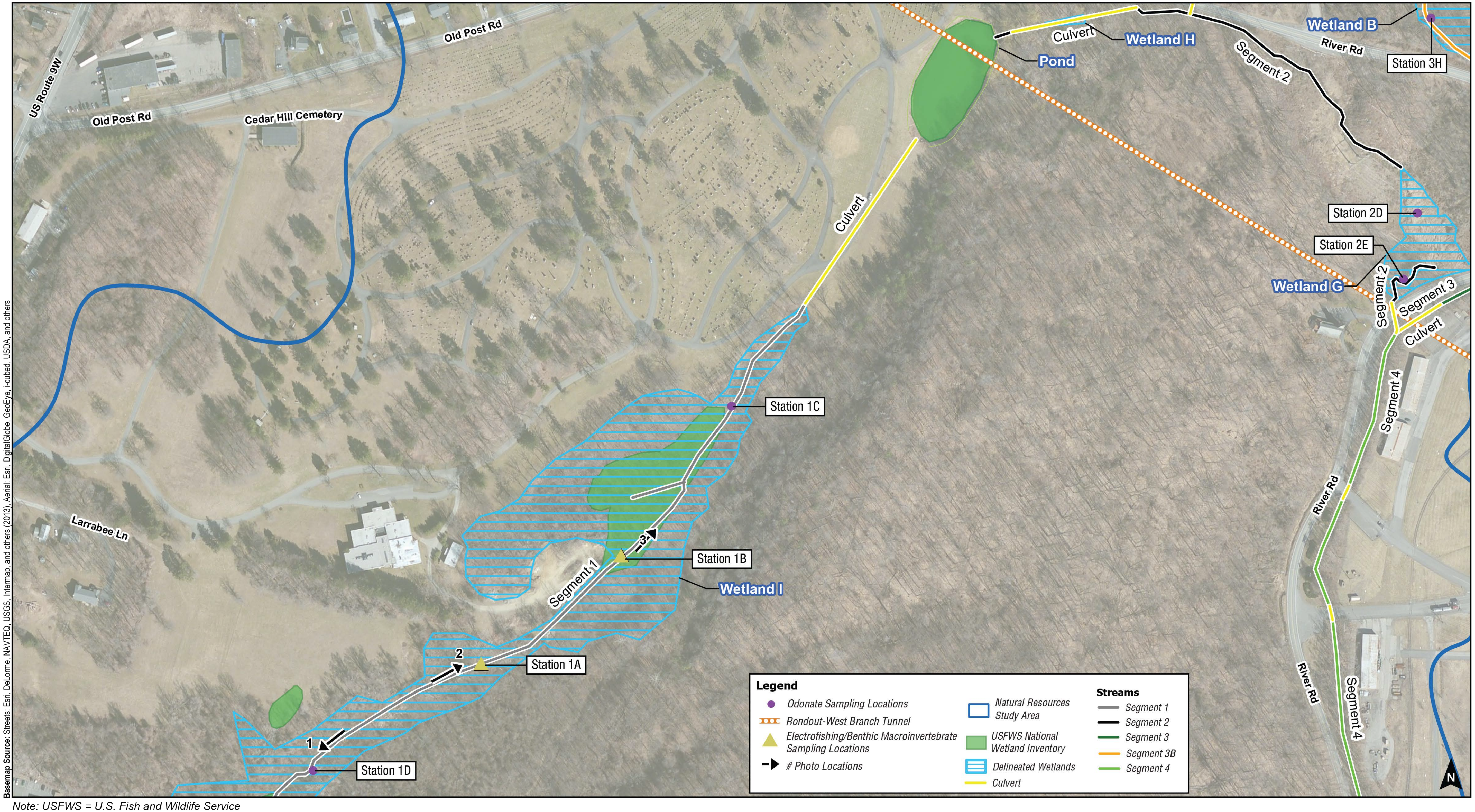
Field surveys were conducted to characterize the six watercourses in the Natural Resources Study Area. During delineations, particular attention was given to the source of water to the watercourses, and whether other sources of water (such as a culvert that conveys stormwater runoff) were apparent. Each watercourse was assigned a community classification, referred to as a Cowardin Classification, based on the habitat descriptions in Cowardin et al. (Cowardin et al. 1979). The watercourse segment, length, area, and classifications are summarized in **Table 11.9-8**.

Table 11.9-8: Stream Segments and Cowardin Classifications in the Natural Resources Study Area

Stream Segment	Length (Feet)	Area (Acres)	Cowardin Classification
Segment 1	2,656	0.47	Riverine, lower perennial, streambed, mud, permanently flooded (R2SB5H)
Segment 2	1,582	0.25	Upstream: riverine, upper perennial, streambed, cobble gravel, permanently flooded, partially drained/ditched (R3SB3Hd) Downstream: riverine, lower perennial, streambed, mud, permanently flooded (R2SB5H)
Segment 3A	981	0.13	Riverine, lower perennial, streambed, mud, permanently flooded (R2SB5H)
Segment 3	2,190	0.45	Riverine, upper perennial, streambed, cobble gravel/sand, permanently flooded (R3SB3/4H)
Segment 3B	738	0.16	Riverine, lower perennial, streambed, sand/cobble gravel, permanently flooded (R2SB3/4H)
Segment 4	3,262	2.68	Upstream: riverine, upper perennial, streambed, cobble gravel/sand, permanently flooded (R3SB3/4H) Downstream: riverine, tidal, streambed, mud, permanent-tidal (R1SB5V)

Stream Segment 1

Stream Segment 1 is located in the southwesterly portion of the Natural Resources Study Area. This stream segment is approximately 2,660 feet in length, approximately 570 feet of which is within a culvert draining north from Wetland I to the cemetery pond (see **Figure 11.9-30**). It is classified as riverine, lower perennial, streambed, mud, and permanently flooded. The average depth is approximately 10 to 12 inches and the width of flow within the stream generally varies from approximately 3 to 6 feet. However, the upstream portion of Stream Segment 1 contains beaver dams, which subsequently have flooded the area, widening the stream to approximately 40 feet. The pond at the terminus of Stream Segment 1 forms the headwaters of Stream Segment 2. The substrate of Stream Segment 1 is dominated by muddy, sandy silt, with sparsely situated cobbles, gravel, and large woody debris. The larger particles and woody debris have created several small pools and riffles. This watercourse is contiguous with Wetland I. Photographs 1 and 2 on **Figure 11.9-31** and Photograph 3 on **Figure 11.9-32** depict typical conditions at Stream Segment 1. No surface expressions were located during field surveys completed from 2012 to 2015 in the vicinity of Stream Segment 1.



Note: USFWS = U.S. Fish and Wildlife Service

Figure 11.9-30: Stream Segments, Photograph Locations, Electrofishing and Benthic Monitoring Stations – Natural Resources Study Area

Photograph 1: View southwest, upstream along Stream Segment 1

Photograph 2: View northeast, upstream along Stream Segment 1

Figure 11.9-31: Photographs – Stream Segment 1

Photograph 3: View northeast, downstream along Stream Segment 1

Figure 11.9-32: Photographs – Stream Segment 1

Stream Segment 2

Stream Segment 2 is located in the central part of the Natural Resources Study Area and originates from the man-made pond at the cemetery. From the pond, the stream flows into a culvert, daylights along River Road, flows within an overhead transmission line right-of-way and through Wetland G, and drains through a culvert beneath River Road into Stream Segment 4 (see **Figure 11.9-33**). This stream segment is approximately 1,580 feet in length.

The upper portion of Stream Segment 2 along River Road is classified as riverine, upper perennial, streambed, cobble gravel, permanently flooded, and partially drained/ditched. After flowing south for approximately 400 feet within the transmission line right-of-way, the water moves through a culvert that is approximately 40 feet in length. Within the transmission line right-of-way, the stream reaches a rock outcrop north of Wetland G and forms a waterfall that plunges rapidly, dropping approximately 90 feet in elevation over a horizontal distance of approximately 470 feet. This segment is also shallow (less than 4 inches deep) and narrow (less than 3 feet in width). The stream drains into Wetland G, where the flow is diffuse with no discernible channel. Near the southern boundary of Wetland G, Stream Segment 2 channelizes to a width of approximately 3 feet, widening to approximately 6 feet further downstream. This lower reach of Segment 2 is classified as riverine, lower perennial, mud substrate, and permanently flooded. The average water depth in the lower reach of Stream Segment 2 is approximately 1 foot. Flowing from Wetland G, water exits through a partially blocked underground culvert, approximately 75 feet long, below River Road and into Stream Segment 4. Photographs 4 and 5 on **Figure 11.9-34** are typical of the conditions at Stream Segment 2.

The substrate in the upstream portion of Stream Segment 2 (before the waterfall) consists of well-sorted particles ranging from fine sand to cobbles. Downstream, once the stream re-channelizes, a soft silt/mud substrate provides evidence of sediment deposition. No surface expressions were located during field surveys completed from 2012 to 2015 in the vicinity of Stream Segment 2.

Stream Segment 3A

Stream Segment 3A is located in the northerly portion of the Natural Resources Study Area and originates north of Stream Segment 3. It is classified as riverine, lower perennial, mud substrate, and permanently flooded. This stream segment is approximately 980 feet in length and flows south through Wetland C, with typical palustrine emergent wetland vegetation occurring along both stream banks (see **Figure 11.9-35**). The upstream portion of this segment (approximately 300 feet in length) is a low-gradient watercourse flowing through a forested area. Flow increases as the elevation drops in the lower portion of the segment (approximately 650 feet in length), which is heavily vegetated with common reed (*Phragmites australis*). Stream Segment 3A ends as it converges with the northern portion of Stream Segment 3 near Wetland A and Wetland C. The watercourse ranges from approximately 5 to 8 feet in width and averages approximately 6 inches in depth. Substrate consists of mostly silts and mud with small areas of gravel. Photographs 6 and 7 on **Figure 11.9-36** are typical of the conditions at Stream Segment 3A. No surface expressions were located during field surveys completed from 2012 to 2015 in the vicinity of Stream Segment 3A.

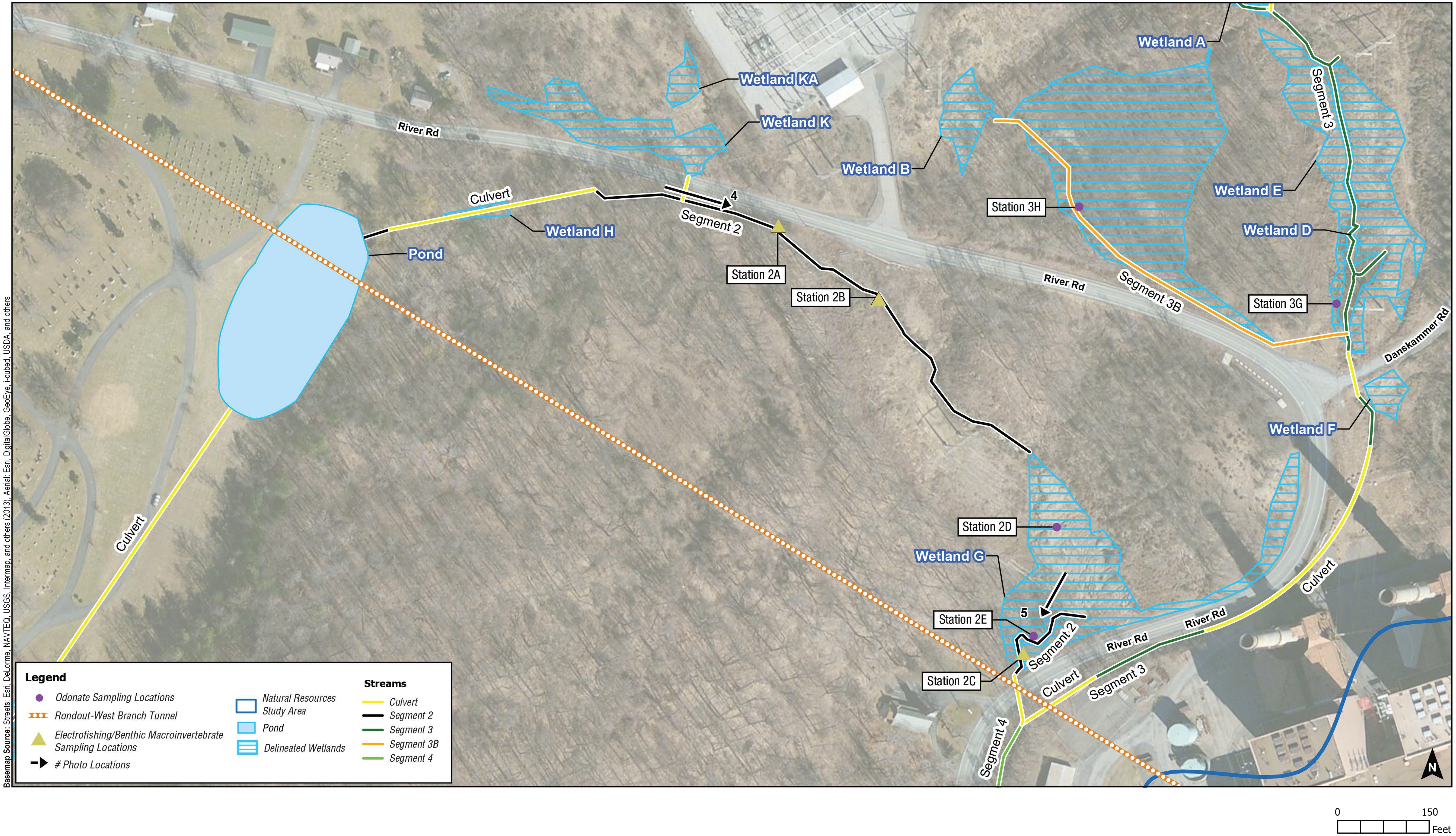
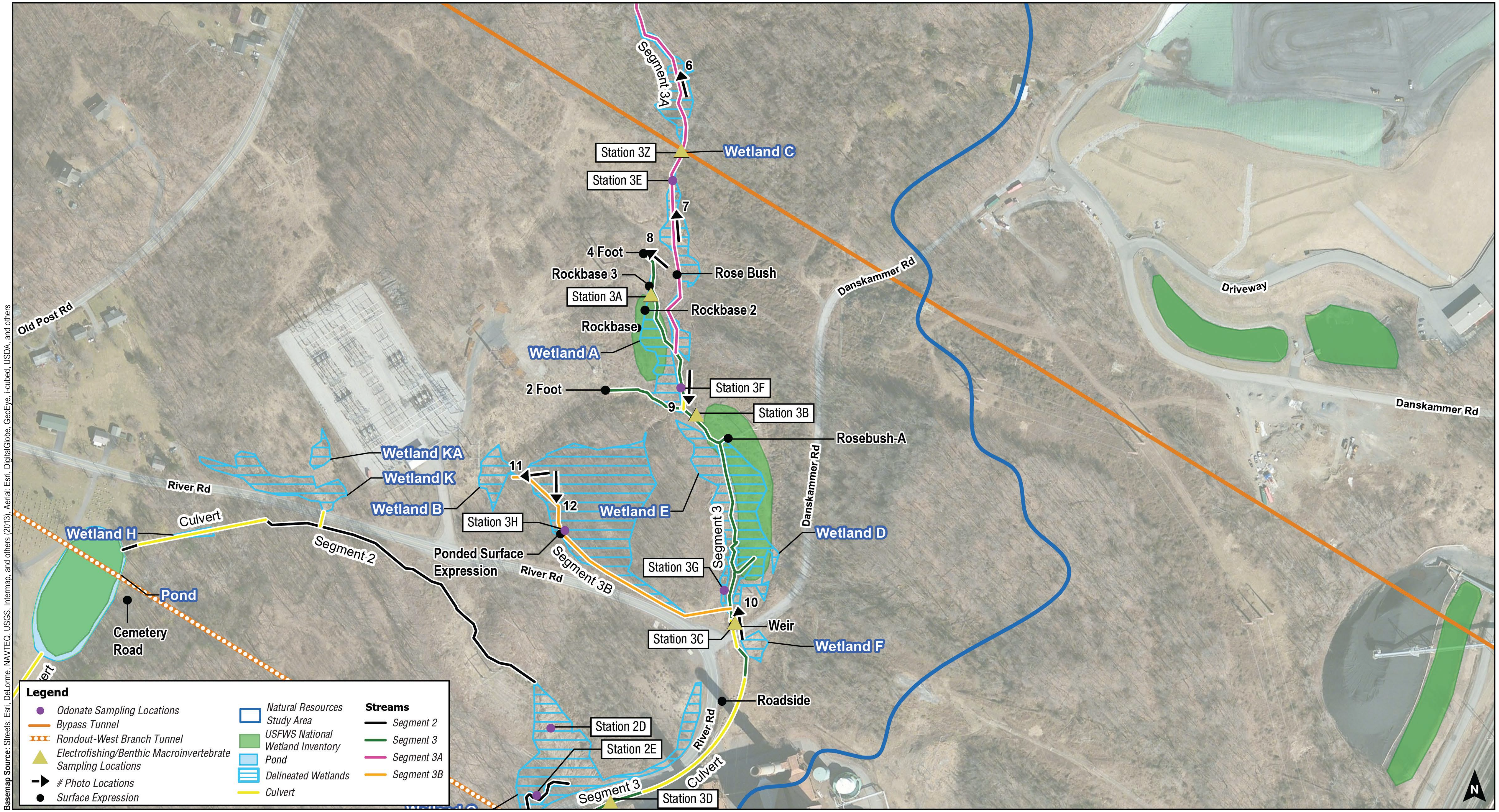


Figure 11.9-33: Stream Segments, Photograph Locations, Electrofishing and Benthic Monitoring Stations – Natural Resources Study Area

Photograph 4: View east, upstream of Stream Segment 2 along River Road

Photograph 5: View south at culvert under River Road, at downstream end of Stream Segment 2

Figure 11.9-34: Photographs – Stream Segment 2



Note: USFWS = U.S. Fish and Wildlife Service

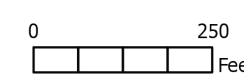


Figure 11.9-35: Stream Segments, Photograph Locations, Electrofishing and Benthic Monitoring Stations – Natural Resources Study Area

Photograph 6: View north towards the upstream forested portion of Stream Segment 3A

Photograph 7: View north towards the downstream portion of Stream Segment 3A and Wetland C

Figure 11.9-36: Photographs – Stream Segment 3A

NYC Environmental Protection

Stream Segment 3

Stream Segment 3 is located in the north-central portion of the Natural Resources Study Area and originates from a surface expression flowing from a rock face at the base of a steep, forested bank north of Wetland A. It is classified as riverine, upper perennial, streambed, cobble gravel/sand, and permanently flooded. This stream segment is approximately 2,190 feet in length and travels above ground through Wetlands A, C, D, E and F (see **Figure 11.9-35**). The stream runs south where it widens to approximately 13 feet. Portions of the stream in this area are greater than 3 feet deep. Approximately 300 feet from its origin, the stream flows through a short culvert on the utility company's property. Several smaller surface expressions also feed Stream Segment 3 in this location. The water is clear, and the bottom substrate includes cobble, sand, brick, and terracotta rubble, with mud occurring upstream of woody snags. The channel of Stream Segment 3 is somewhat incised. However, emergent wetland vegetation also occurs along both stream banks (i.e., in the floodplain) and in association with various minor surface expressions. Stream Segment 3 ultimately drains over a weir and into an underground culvert for approximately 300 feet. Approximately 300 feet south of this point Stream Segment 3 meets Stream Segment 4 (see **Figure 11.9-33)**. Photographs 8 and 9 on **Figure 11.9-37** and Photograph 10 on **Figure 11.9-38** are typical of the conditions at Stream Segment 3.

Stream Segment 3B

Stream Segment 3B is located in the central portion of the Natural Resources Study Area and is approximately 740 feet in length. It originates north of River Road in Wetland B from a very large ponded surface expression, which is approximately 25 feet in diameter with an undetermined depth. From this surface expression, Stream Segment 3B flows east where it ends at its confluence with Stream Segment 3, just upstream of the weir at the intersection of River and Danskammer Roads (see **Figure 11.9-35**). This watercourse ranges from approximately 4 to 6 feet wide, is an average of 5 inches in depth, and has relatively low flows. Based on field observations, the segment is classified as riverine, lower perennial, streambed, sand/cobble gravel, and permanently flooded. Photographs 11 and 12 on **Figure 11.9-39** are typical of the conditions at Stream Segment 3B.

Stream Segment 4

Stream Segment 4 is located in the easterly and southern portions of the Natural Resources Study Area and is approximately 3,260 feet in length. It originates at the confluence of Stream Segments 2 and 3 and flows southwest, parallel to River Road, before turning southeast and draining into a tidal inlet on the Hudson River (see **Figure 11.9-40**). There are several active New York State Pollutant Discharge Elimination System (SPDES) point source industrial wastewater discharges from the adjacent power plant into the reach of the stream along River Road, including several with posted SPDES permit signs. Most of the streamcourse along River Road is channelized. The lower, tidal portion of this segment is classified as riverine, tidal, streambed, mud, permanent-tidal. The lower portion of Stream Segment 4 is best described as a tidal creek with mudflats near its confluence with the Hudson River.

Photograph 8: View northwest looking at surface expression from rocky outcrop at origin of Stream Segment 3

Photograph 9: View south at culvert in the middle of Stream Segment 3

Figure 11.9-37: Photographs – Stream Segment 3

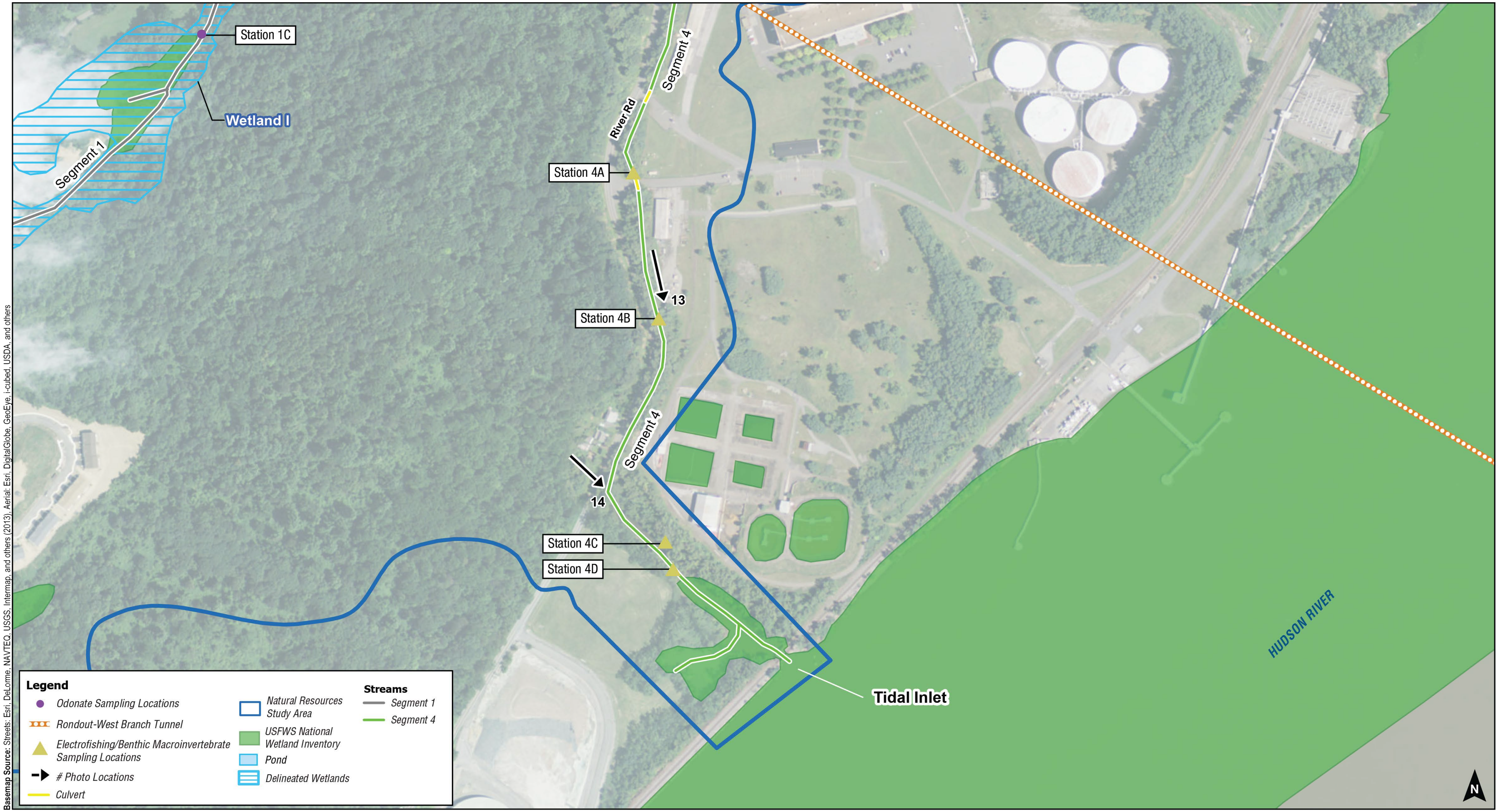
Photograph 23: View north towards weir (center bottom), adjacent to intersection of River and Danskammer Roads

Figure 11.9-38: Photographs – Weir

Photograph 11: View west, looking at ponded surface expression from which Stream Segment 3B originates

Photograph 12: View south at Stream Segment 3B

Figure 11.9-39: Photographs – Stream Segment 3B



Note: USFWS = U.S. Fish and Wildlife Service

Figure 11.9-40: Stream Segments, Photograph Locations, Electrofishing and Benthic Monitoring Stations – Natural Resources Study Area

The upper reach of Stream Segment 4 is relatively narrow (approximately 3 to 7 feet wide) and flows for approximately 1,000 feet with a substantial velocity. The bottom substrate is bedrock, cobble, or gravel. Both banks are vegetated with large trees, and portions of the streambed contain beds of watercress. Adjacent to River Road, the stream becomes more incised, the substrate changes to larger sized particles, and velocity increases. Once the stream turns southeast, the slope of the streambed decreases and Stream Segment 4 becomes tidally influenced by the Hudson River. The banks widen to approximately 40 feet, and the substrate consists of silt and sand with gravel and a few cobbles as the stream turns southeast. The tidal portion is much wider than the upper reach of this segment and exhibits variable depth based on tide stage. The mean tidal fluctuation in this portion of the Hudson River is approximately 3 feet (NOAA Tidal Benchmark Data Sheet for Newburgh, New York, Station ID: 8518935). The bottom substrate of the tidal portion of Segment 4 transitions to a mixture of mud and silt substrate as it approaches the connection to the Hudson River. Stream banks typically consist of palustrine emergent and forested wetlands. However, substantial portions of the banks in this section are lined with wooden cribbing or abandoned wooden barge hulls. Stream Segment 4 terminates at the Hudson River, immediately east of the freight railroad trestle. Photographs 13 and 14 on **Figure 11.9-41** are typical of the conditions at Stream Segment 4.

11.9.5.12 Wetlands – Baseline Conditions

Surface water in the Natural Resources Study Area includes USFWS NWI-mapped wetlands, Class A and Class C NYSDEC watercourses, and a tidal inlet on the Hudson River (see **Figure 11.9-6**). The Natural Resources Study Area also includes ten field delineated wetlands (identified as Wetlands A, B, C, D, E, F, G, I, K, and KA, and an additional wetland identified during the ArcGIS review at the confluence of Stream Segment 4 with the Hudson River (see **Figure 11.9-6**). The wetland communities are associated with six watercourses (Stream Segments 1, 2, 3, 3A, 3B, and 4), which together become a perennial tributary to the Hudson River known as Roseton Brook.

An understanding of the contributing sources to wetland hydrology is critical to assessing the potential for wetland impacts when hydrologic contributions may be altered. As described in Section 11.9.5.4, “Wetlands – Impact Analysis Methodology,” because of their hydraulic connection to wetlands, the potential for changes to shallow groundwater levels were assessed to determine whether they could affect wetland extent and vegetation composition. Decommissioning has the potential to lower shallow groundwater and thus wetland extent and character; therefore, the baseline conditions of these resources were identified together.

The baseline conditions of wetlands and associated shallow groundwater within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.4, “Wetlands – Impact Analysis Methodology,” and are described further below.

Shallow Groundwater

Shallow groundwater and surface water are hydraulically connected in areas where the unconfined aquifer is near surface waterbodies (i.e., streams, wetlands, and ponds). In the Natural Resources Study Area, this interaction between the surface water and shallow groundwater sustains the baseflow of stream segments and the shallow groundwater level necessary to support wetlands.

Photograph 13: View south at upstream portion of Stream Segment 4, River Road is to the right

Photograph 14: View of tidal inlet at downstream end of Stream Segment 4, looking northwest at low tide

Figure 11.9-41: Photographs – Stream Segment 4

The discharge of leak water through surface expressions into stream segments affects this interaction between the surface water and shallow groundwater interaction and wetland hydrology.

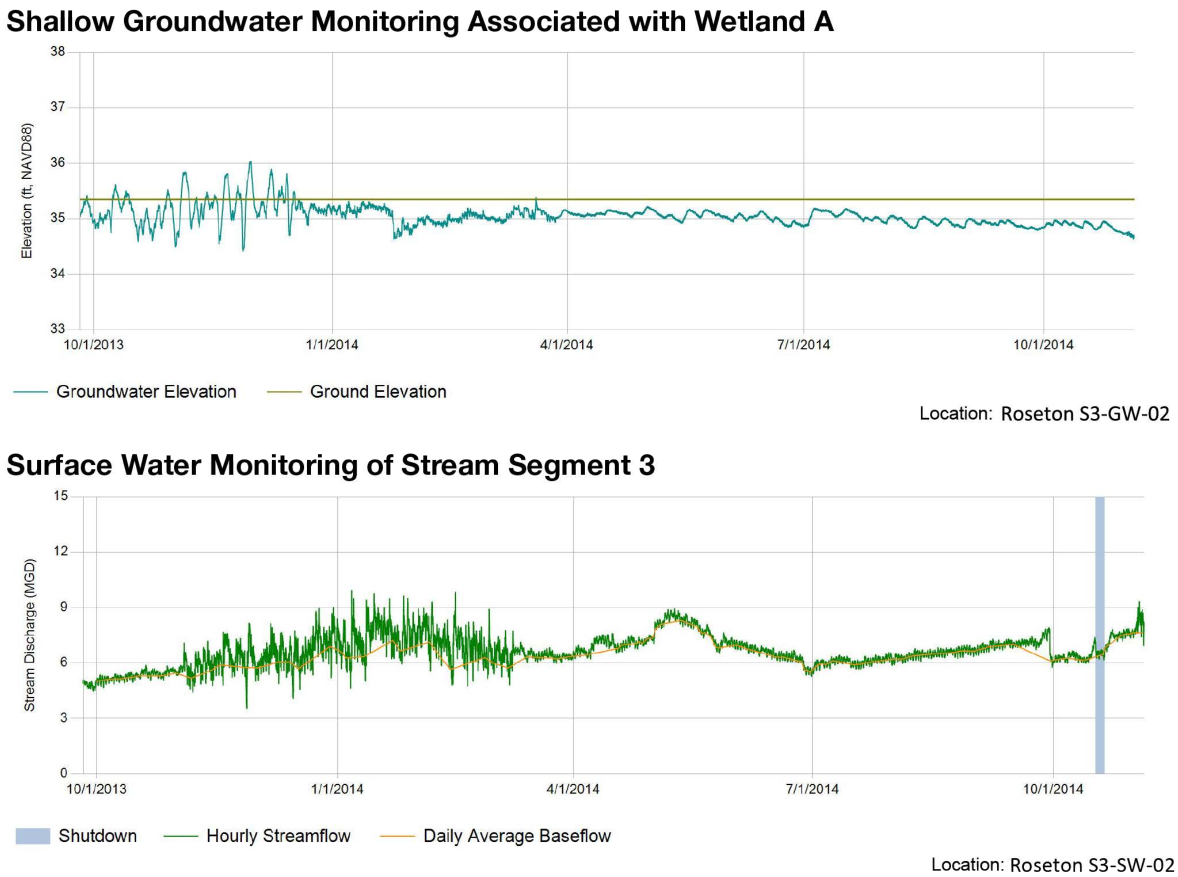
For some wetlands in the Natural Resources Study Area, this baseflow inflow – and consequently leak water for those segments that are affected – is the major contributing source of wetland hydrology. As an example, the shallow groundwater and surface water monitoring data collected within Wetland A (S3-GW-02) and at the adjacent head of Stream Segment 3 (S3-SW-02) illustrates the relationship between shallow groundwater and surface water in a wetland (see **Figure 11.9-42**). The monitoring data collected at these locations illustrates the typical leak-influenced condition that supports a constant baseflow and shallow groundwater elevation with limited variability.

To support the assessment of baseline conditions and potential connection to the leaks, shallow groundwater levels were monitored from 2013 to 2014 (Water Year 2014) in Wetlands A, B, C, D, G, and I. Depth to shallow groundwater is important because, it is assumed that suitable wetland hydrology is supported when shallow groundwater depths are within 1 foot of the ground surface (root zone) for at least 12.5 percent of the growing season (Environmental Laboratory; USACE 1992).

A summary box plot of shallow groundwater levels (depth to shallow groundwater from ground surface) during the full water year, growing season, and non-growing is presented in **Figure 11.9-43**. The median depth to shallow groundwater from the ground surface for all monitoring stations was approximately 1.5 feet or less, with the full set of observations ranging from ponded surface water (S1-GW-01) to a groundwater depth from ground surface of over 4 feet (S3-GW-03).

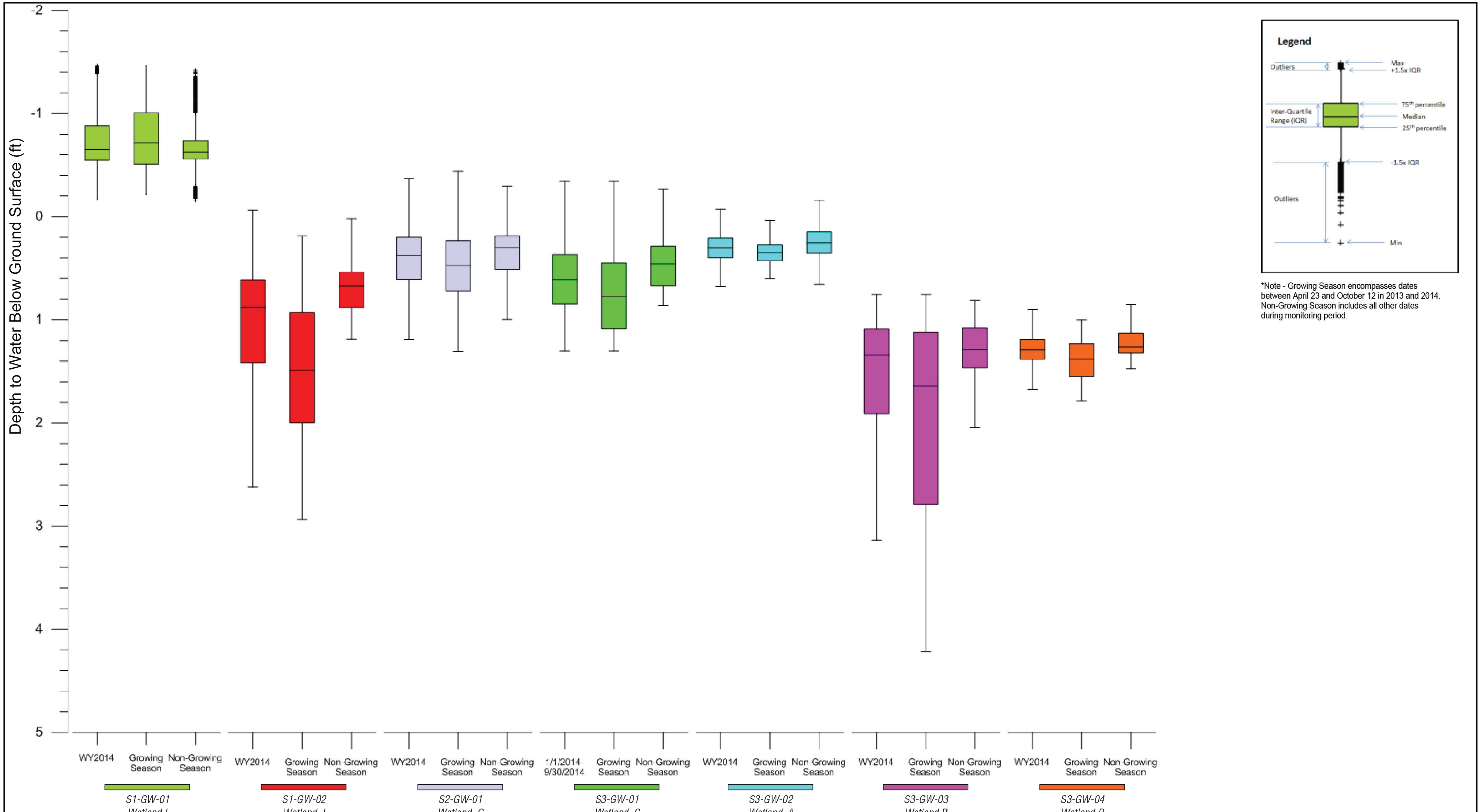
Table 11.9-9 shows the observed average shallow groundwater levels at wetlands located in the Natural Resources Study Area from April 23, 2014 to September 30, 2014, as well as the percentage of the 2014 growing season that shallow groundwater was within 1 foot of the ground surface.

Median shallow groundwater elevation, at all but one location (S1-GW-01), was higher during the non-growing season than the growing season. Peak elevations occurred around the month of April, as is characteristic for the region. For S3-GW-01 (Wetland C) adjacent to Stream Segment 3A, S1-GW-01 and S1-GW-02 (Wetland I) both adjacent to Stream Segment 1, and S3-GW-03 (Wetland B) adjacent to Stream Segment 3B, the data exhibit greater variability during the growing season than the non-growing season. This suggests a hydrologic regime, under which shallow groundwater tables are more active during the growing season as they respond to precipitation, dry periods, and plant uptake. Albeit to a somewhat lesser extent, a similar pattern is apparent at S2-GW-01 (Wetland G) adjacent to Stream Segment 2.



Note: all elevations are in NAVD88 feet

Figure 11.9-42: Example of Shallow Groundwater and Surface Water Monitoring, Water Year 2014 – Natural Resources Study Area



Note: Hourly average data from October 1, 2013 to September 30, 2014, for all stations except for S3-GW-01 which is January 1, 2014 to September 30, 2014

Figure 11.9-43: Shallow Groundwater Monitoring Box Plot for Water Year 2014, Growing Season, and Non-Growing Season – Natural Resources Study Area

Table 11.9-9: Average Shallow Groundwater Levels at Wetlands in the Natural Resources Study Area[1]

Wetland ID	Shallow Groundwater Monitoring Station ID	Average Depth Below Ground Surface to Shallow Groundwater during the 2014 Growing Season (Feet)	Percentage of the 2014 Growing Season that Shallow Groundwater was within 1 Foot of Ground Surface
Wetland A	S3-GW-02	0.4	100
Wetland B	S3-GW-03	2.0	14
Wetland C	S3-GW-01	0.7	69
Wetland D	S3-GW-04	1.2	0
Wetland G	S2-GW-01	0.5	98
Wetland I	S1-GW-01	-0.7	100
Wetland I	S1-GW-02	1.5	27

Note:
[1] Based on April 23 to September 30, 2014 water level monitoring data.

No surface expressions were documented in stream segments or wetlands near monitoring stations S1-GW-01 (Wetland I), S1-GW-02 (Wetland I), S2-GW-01 (Wetland G), and S3-GW-01 (Wetland C), suggesting that the variability of shallow groundwater levels during the growing season at these locations are representative of natural conditions for the region. Monitoring Station S3-GW-03 (Wetland B) also exhibited variability in shallow groundwater levels during the growing season, with values ranging from within approximately 1 foot to greater than approximately 4 feet from the ground surface. This monitoring station is located in Wetland B near the ponded surface expression, suggesting that portions of wetland B have a hydrologic connection to the surface expression. However, this connection does not provide enough shallow groundwater inflow to supplement wetland hydrology during dry periods and periods of increased transpiration from the portion of Wetland B that is a forested wetland community.

In comparison to the above shallow groundwater monitoring stations, less variability in depth to shallow groundwater from the ground surface can be seen at S3-GW-02 (Wetland A) near the head of Stream Segment 3, and downstream at S3-GW-04 (Wetland D) adjacent to Stream Segment 3. This suggests a greater influence of surface expressions, which could act as a stabilizing influence on shallow groundwater table fluctuations at these locations.

Based on the assumption that shallow groundwater depths are within one foot of the ground surface (root zone) for at least 12.5 percent of the growing season, shallow groundwater depths at some monitoring stations were on the threshold of providing suitable conditions for establishing and maintaining wetland vegetation, while the depths at other stations were not during the 2014 growing season (see **Table 11.9-9**). These locations include shallow groundwater monitoring Station S3-GW-03 (Wetland B) with shallow groundwater levels within 1 foot of ground surface for approximately 14 percent of the 2014 growing season and monitoring Station S3-GW-04 (Wetland D) with shallow groundwater levels within 1 foot of ground surface for zero percent of the 2014 growing season. This baseline information was used to support the qualitative analysis of potential changes to wetland vegetation composition that may result from the lowering shallow groundwater elevations due to cessation of leaks associated with decommissioning.

Results from surface water monitoring during a depressurization in October 2014 (see Section 11.9.5.3, “Surface Water – Methodology11.9.3”) suggest that flow rates in Stream Segments 3, 3B, and 4 could be most affected because of their linkage to surface expressions, as described in Section 11.9.5.1, “Surface Water – Baseline Conditions.” Wetlands adjacent to or abutting these stream segments include Wetlands A, B, D, and E and could potentially be affected. In Stream Segment 1, Stream Segment 2, and Stream Segment 3A, it was documented during the depressurization that the leaks do not decrease streamflows, therefore decommissioning is not anticipated to affect Wetlands C, G, and I.

Precipitation

The amount and timing of precipitation affects shallow groundwater levels in wetlands throughout the growing season. To assess whether the precipitation observed during the shallow groundwater monitoring period from 2013 to 2014 was representative of the historical precipitation averages, annual, monthly, growing season, and non-growing season precipitation totals for monitoring period were summarized and compared to the historical average annual, average monthly, average growing season, and average non-growing season precipitation as recorded at the KPOU site from 1949 to 2014. **Figure 11.9-44** and **Table 11.9-10** show the monthly average and annual average precipitation totals for 1949 to 2014, and separate totals for calendar years 2013 and 2014. **Table 11.9-11** shows the average monthly precipitation for the growing and non-growing season for 1949 to 2014, and separate totals for calendar years 2013 and 2014.

The total precipitation recorded for 2013 (39.3 inches) and 2014 (37.9 inches) are slightly below the historical average (41.6 inches), but are reasonably close to be considered representative of a normal precipitation year. When comparing the growing season data to the historical average (21.97 inches), 2013 was close to but slightly below a wet year (defined as 125 percent of the average precipitation during the growing season, or 27.46 inches) with total growing season precipitation of 26.43 inches. The 2014 total growing season precipitation was 19.68 inches, was slightly below the historical average. The growing season precipitation totals for 2014 are considered representative of a normal year, thus the 2014 shallow groundwater monitoring data were used to prepare the wetland water budgets and to assess potential impacts to shallow groundwater elevations that may result from decommissioning.

Wetlands

An ArcGIS review of the NYSDEC and NWI wetland maps indicated the presence of NWI-mapped wetlands, but no NYSDEC regulated wetlands within the Natural Resources Study Area (see **Figure 11.9-6**). NWI wetlands adjacent to Stream Segments 1, 3, and 4, within the Natural Resources Study Area were surveyed as part of the field wetland delineation. Field investigations indicate that wetland hydrology, hydrophytic vegetation, and hydric soils are present for the NWI wetlands adjacent to Stream Segments 1, 3, and 4 (as described below). In general, the results of the wetland delineation indicate the NWI wetlands are larger than mapped, and the field determined Cowardin classes are described below.

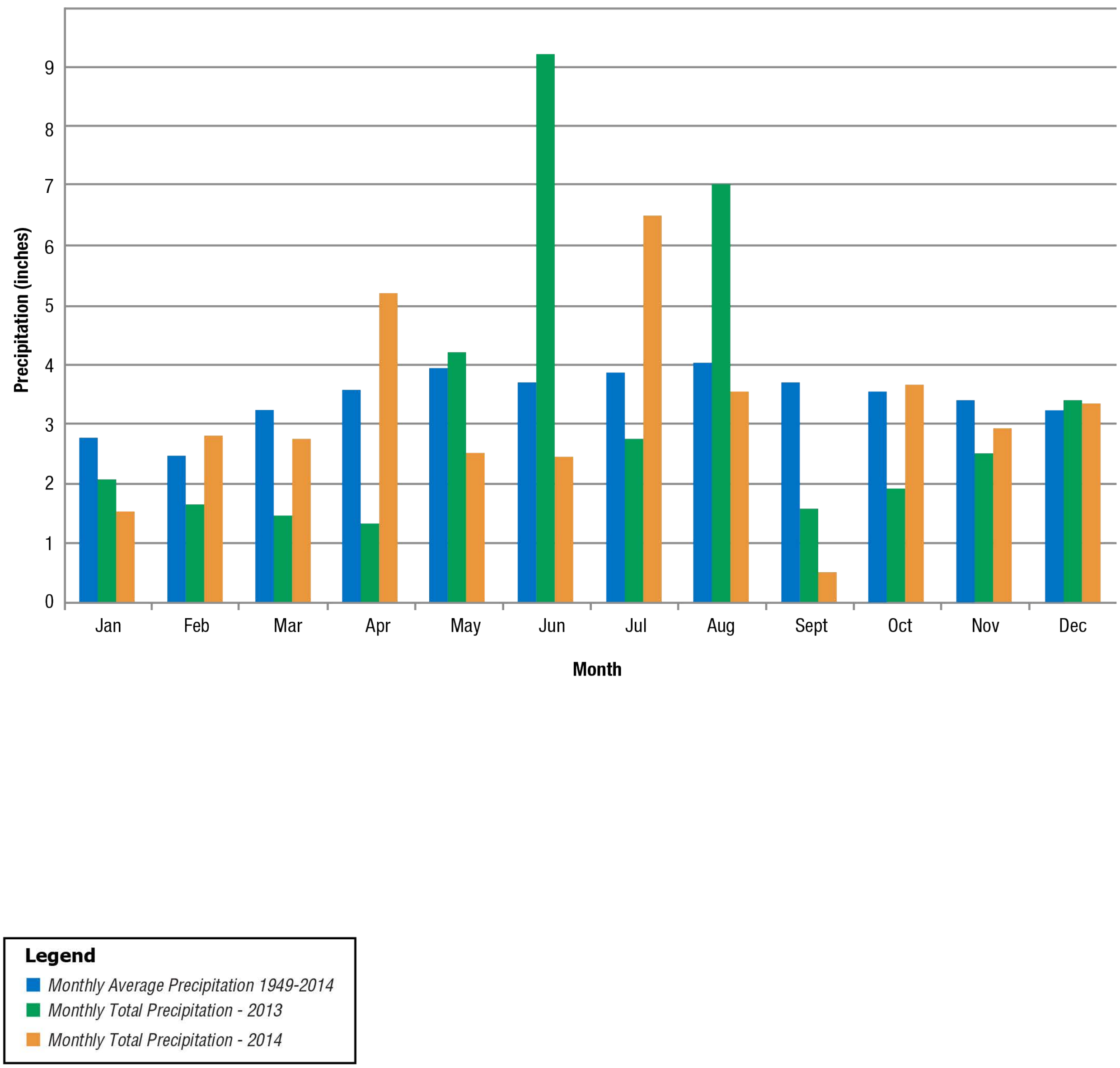


Figure 11.9-44: Historic and Baseline Precipitation Summary – Natural Resources Study Area

Table 11.9-10: Monthly Average Precipitation from 1949 to 2014 and Monthly Total Precipitation for 2013 and 2014

Month	Monthly Average Precipitation 1949 to 2014[1] (inches)	Monthly Total Precipitation 2013[2] (inches)	Monthly Total Precipitation 2014[2] (inches)
January	2.78	2.08	1.55
February	2.47	1.65	2.82
March	3.24	1.50	2.77
April	3.58	1.34	5.20
May	3.94	4.22	2.54
June	3.73	9.23	2.47
July	3.89	2.77	6.51
August	4.05	7.08	3.56
September	3.72	1.58	0.53
October	3.56	1.93	3.66
November	3.41	2.51	2.94
December	3.24	3.40	3.34
Total	**41.62**	**39.30**	**37.90**

Notes:

[1] Weather data source: Northeast Regional Climate Center stations in Poughkeepsie, Glenham, and at the Dutchess County Airport (KPOU).

[2] The 2013 through 2014 data was collected at the Roseton MS-01 Weather station. Data gaps were filled with data from Dutchess County Airport (KPOU).

Table 11.9-11: Monthly Average Precipitation from 1949 to 2014 and Monthly Total Precipitation for 2013 and 2014, by Growing Season

Month	Monthly Average Precipitation 1949 to 2014 (Inches)[1]		Monthly Total Precipitation 2013 (Inches)[2]		Monthly Total Precipitation 2014 (Inches)[2]	
	Non-Growing Season	**Growing Season[3]**	**Non-Growing Season**	**Growing Season[3]**	**Non-Growing Season**	**Growing Season[3]**
January	2.78		2.08		1.55	
February	2.52		1.65		2.82	
March	3.25		1.5		2.77	
April	2.66	0.95	1.34	<0.01	2.21	2.99
May		3.99		4.22		2.54
June		3.8		9.23		2.47
July		3.95		2.77		6.51
August		4.07		7.08		3.56
September		3.75		1.58		0.53
October	2.14	1.46	0.38	1.55	2.59	1.08
November	3.43		2.51		2.94	
December	3.29		3.4		3.34	
Totals	**20.08**	**21.97**	**12.86**	**26.43**	**18.22**	**19.68**

Notes:

[1] Weather data source: Northeast Regional Climate Center stations in Poughkeepsie, Glenham, and at the Dutchess County Airport (KPOU).

[2] The 2013 through 2014 data was collected at the Roseton MS-01 Weather station. Data gaps were filled with data from Dutchess County Airport (KPOU).

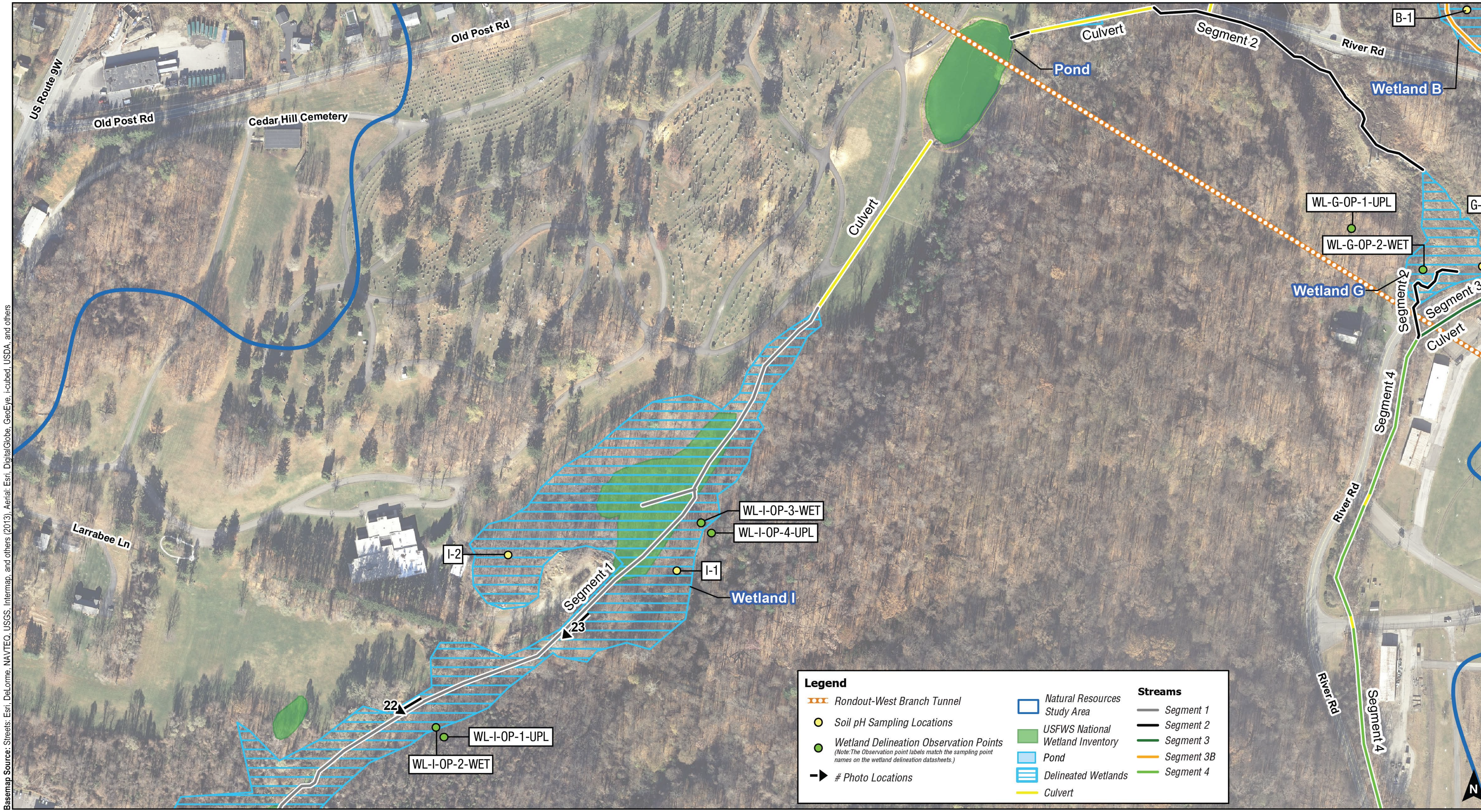
[3] Growing Season includes all dates between April 23 and October 12.

NWI wetlands and hydric soils are also mapped on the upstream reach of Segment 1, which is located southwest of the cemetery. An ArcGIS review of aerial photographs, NWI maps, and hydric soils indicates that naturally occurring wetlands are likely present in these areas (see **Figure 11.9-6**).Wetland photograph locations and the wetland observation points are shown on **Figure 11.9-45** to **Figure 11.9-48** and representative wetland photographs are presented on **Figure 11.9-49** to **Figure 11.9-52**.

A total of 10 wetlands were delineated. Their total acreage and field determined Cowardin Classifications are presented in **Table 11.9-12**, and further described in the following subsections.

Table 11.9-12: Natural Resources Study Area Wetland Summary Table

Wetland Name	Wetland Area (Acres)	Associated Stream Segment	Cowardin Classification
Wetland A	0.34	Segment 3	palustrine, emergent, persistent, seasonally flooded (PEM1E)
Wetland B	1.98	Segment 3B	palustrine, forested, broad-leaved deciduous (PFO1); common reed monoculture (PEM5)
Wetland C	0.63	Segment 3A	palustrine, forested, broad-leaved deciduous (PFO1); common reed monoculture (PEM5), palustrine, emergent, persistent (PEM1)
Wetland D	0.62	Segment 3	palustrine, emergent, persistent, seasonally flooded (PEM1C); common reed monoculture (PEM5)
Wetland E	0.42	Segment 3	palustrine, emergent, persistent, seasonally flooded/saturated (PEM1E)
Wetland F	0.08	None	common reed monoculture (PEM5)
Wetland G	1.13	Segment 2	palustrine, emergent, persistent (PEM1); palustrine, forested, broad-leaved deciduous (PFO1); common reed monoculture (PEM5)
Wetland I	10.39	Segment 1	palustrine, emergent, persistent (PEM1); palustrine scrub-shrub, broad-leaved deciduous (PSS1); palustrine, forested, broad-leaved deciduous (PFO1)
Wetland K	0.44	None	palustrine, forested, broad-leaved deciduous (PFO1)
Wetland KA	0.07	None	palustrine, emergent, persistent (PEM1)
Total	**16.10 Acres**		



Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Note: USFWS = U.S. Fish and Wildlife Service

0 250 Feet

NYC Environmental Protection

Figure 11.9-45: Delineated Wetlands, Photograph Locations, Soil pH Sampling, NWI/NYSDEC Wetlands – Natural Resources Study Area (1 of 4)

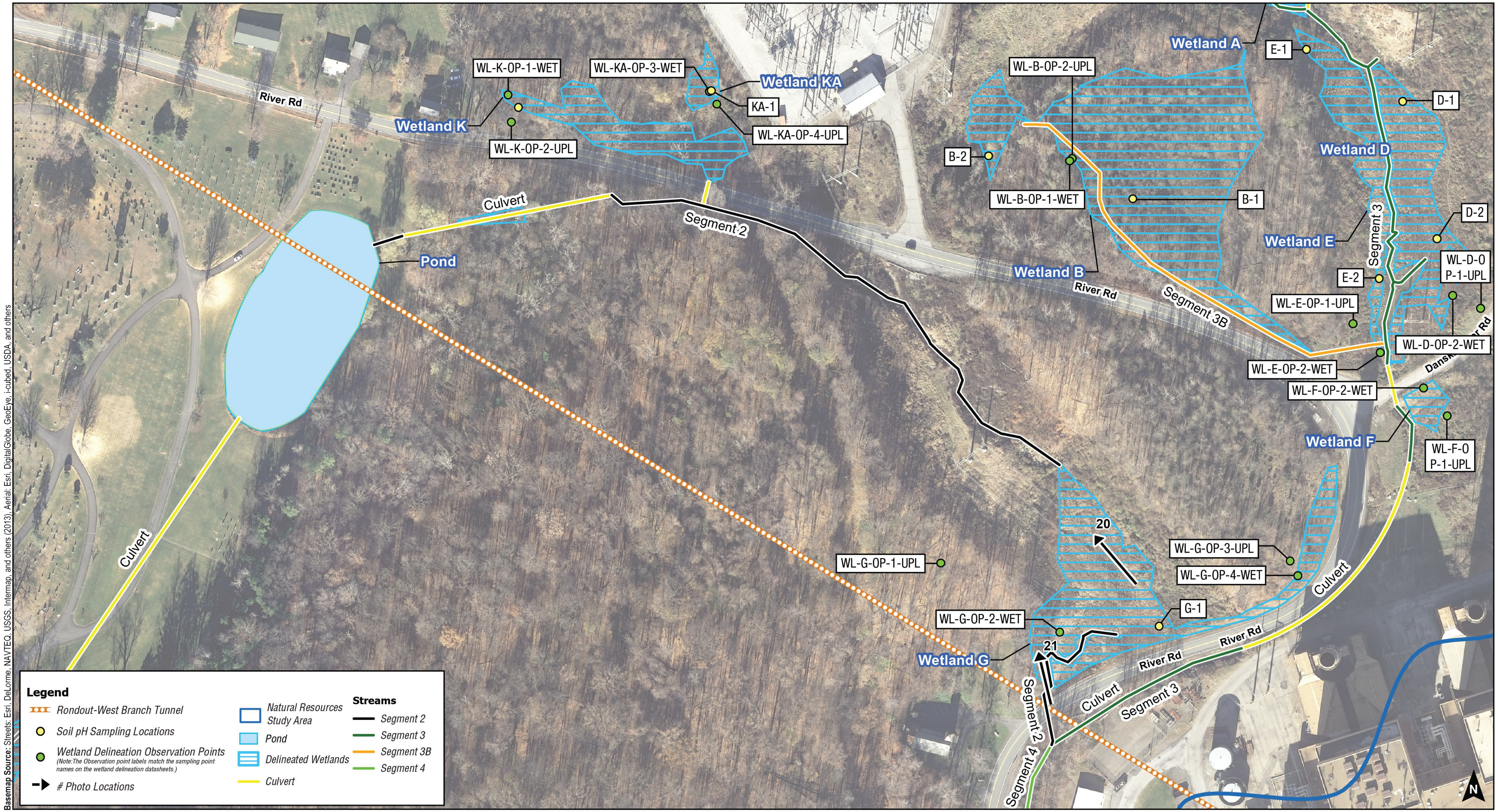
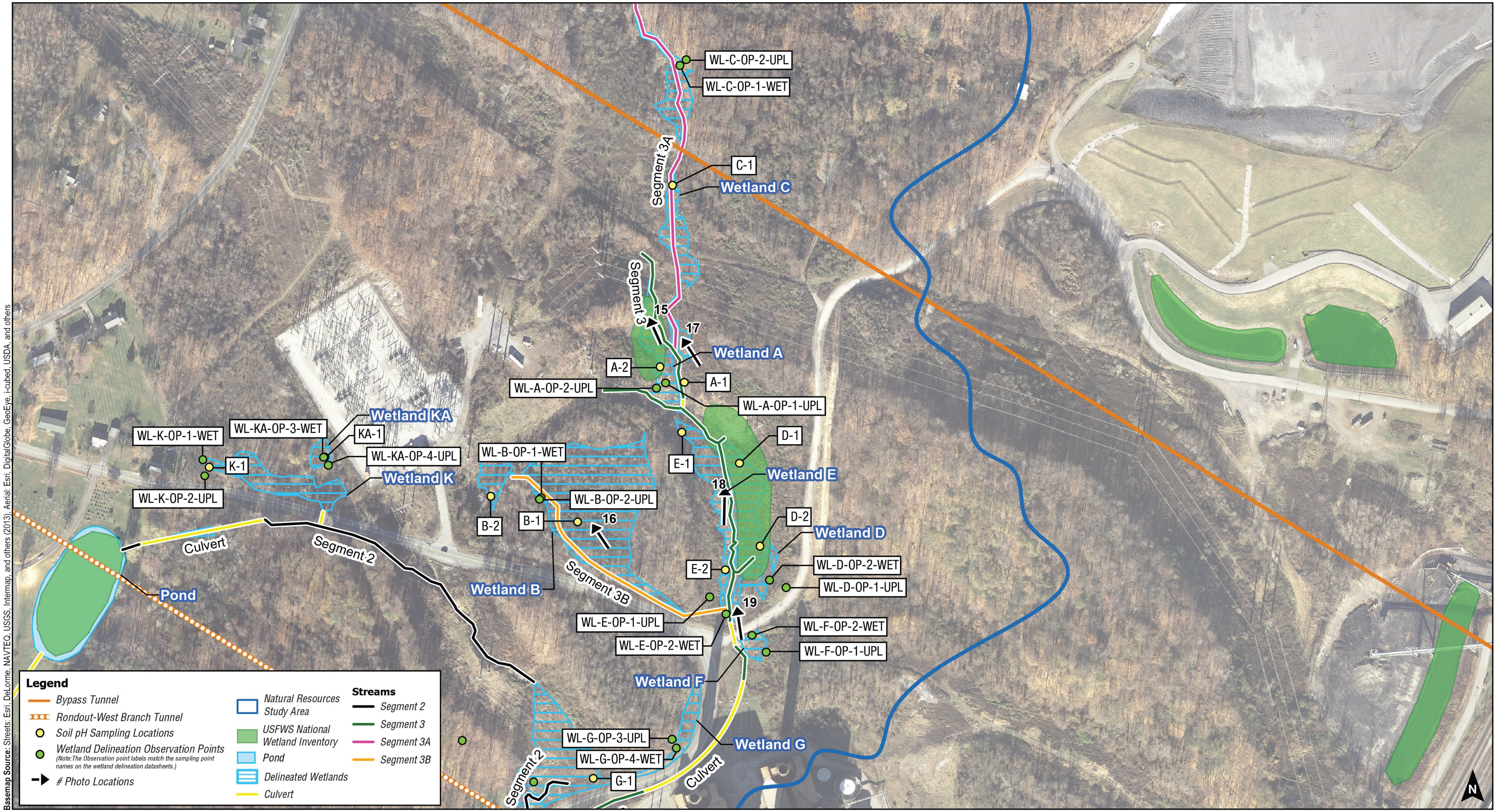


Figure 11.9-46: Delineated Wetlands, Photograph Locations, Soil pH Sampling, NWI/NYSDEC Wetlands – Natural Resources Study Area (2 of 4)



Note: USFWS = U.S. Fish and Wildlife Service

Figure 11.9-47: Delineated Wetlands, Photograph Locations, Soil pH Sampling, NWI/NYSDEC Wetlands – Natural Resources Study Area (3 of 4)

Note: USFWS = U.S. Fish and Wildlife Service

0 350 Feet

Figure 11.9-48: Delineated Wetlands, Photograph Locations, Soil pH Sampling, NWI/NYSDEC Wetlands – Natural Resources Study Area (4 of 4)

Wetland A

Wetland A is approximately 0.34 acre and located along the western side of Stream Segment 3 (see **Figure 11.9-47**). The area is characterized as a palustrine, scrub-shrub, broad-leaved deciduous, seasonally flooded, saturated (PSS1E) wetland by NWI, while the field investigation indicated this wetland is best classified as a palustrine, emergent, persistent vegetation, seasonally flooded (PEM1E) wetland based on the Cowardin Classification system (Cowardin et al. 1979).

Eighty percent of the dominant plant species are hydrophytic. Wetland A is dominated by common rush (*Juncus effusus*), clearweed (*Pilea pumila*), and wool-grass (*Scirpus cyperinus*) in the herbaceous stratum, and northern spicebush (*Lindera benzoin*) and tatarian honeysuckle (*Lonicera tatarica*) in the shrub/sapling stratum. Other abundant vegetation within Wetland A include broadleaf cattail (*Typha latifolia*), narrowleaf cattail (*Typha angustifolia*), common boneset (*Eupatorium perfoliatum*), sensitive fern (*Onoclea sensibilis*), spotted touch-me-not (*Impatiens capensis*), common reed, pilewort (*Erechtites hieraciifolius*), and purple loosestrife (*Lythrum salicaria*). With respect to shrub species, speckled alder (*Alnus incana*) is present; no trees were observed. A representative photograph of Wetland A is shown on Photograph 15 on **Figure 11.9-49.**

Soils in Wetland A are clay and meet the requirement for the hydric soil indicator F3 (Depleted Matrix), as it has a 6-inch depleted matrix layer that has 95 percent chroma 1, which is within the upper 6 inches of the soil. Primary wetland hydrology indicators present during the study include soil saturation to the surface.

Wetland B

Wetland B (see Photograph 16 on **Figure 11.9-49)** is an approximately 1.98 acres predominantly palustrine, forested, broad-leaved deciduous (PFO1) wetland, located northeast of Stream Segment 3B (see **Figure 11.9-47**). The westerly portion of the wetland was best classified as a common reed monoculture (PEM5).

Eighty percent of the dominant plant species are hydrophytic. Wetland B is dominated by field horsetail (*Equisetum arvense*) and common reed in the herbaceous stratum, northern spicebush in the shrub/sapling stratum, and European alder (*Alnus glutinosa*) in the tree stratum.

The upper 20 inches of soil within Wetland B is comprised of sandy loam, silty clay, and clay, and meets the requirement for hydric soil indicator F3 (Depleted Matrix) as it has an 8-inch depleted matrix layer that has 70 percent chroma 1, which starts within 10 inches of the soil surface. Primary hydrology indicators include standing surface water, soil saturation to the surface, high water table, water marks, and aquatic fauna (green frogs *[Lithobates clamitans]*). A secondary indicator, microtopographic relief (presence of hummocks, tussocks, and flark-and-strang topography less than 36 inches in height above the base soil level), was also observed.

Photograph 15: Stream Segment 3 and Wetland A facing northwest (upstream)

Photograph 16: View looking northwest across northwestern open common reed portion of Wetland B. Mucky soils in foreground

Figure 11.9-49: Photographs – Stream Segment 3, Wetland A, and Wetland B

Photograph 17: Stream Segment 3 and Wetland C facing north (upstream)

Figure 11.9-50: Photograph – Stream Segment 3 and Wetland C

Wetland C

Wetland C (see Photograph 17 on **Figure 11.9-50**) is an approximately 0.63 acre wetland consisting of a mix of palustrine, forested, broad-leaved deciduous (PFO1), common reed monoculture (PEM5), and palustrine, emergent, persistent (PEM1) wetland communities located northeast of Stream Segment 3 (see **Figure 11.9-47**).

Sixty-seven percent of the dominant plant species are hydrophytic. Wetland C is dominated by field horsetail and common reed in the herbaceous stratum, and Norway maple (*Acer platanoides*) in the tree stratum. There are no shrubs within a 15-foot radius of the observation point. Other abundant vegetative species include broadleaf cattail, wool-grass, mild water pepper (*Persicaria hydropiper*), flat-top goldentop (*Euthamia graminifolia*), and rice cutgrass (*Leersia oryzoides*).

Soils in Wetland C are gleyed clay from 5 to 20 inches below the soil surface and confirmed hydric due to the presence of a hydrogen sulfide odor. Hydrology is indicated by standing surface water, soil saturation to the surface, and water-stained leaves.

Wetland D

Wetland D is an approximately 0.62 acre wetland mapped and classified by NWI as a palustrine, emergent, persistent, seasonally flooded (PEM1C) wetland, though the field investigations found the majority of the wetland is a common reed monoculture (PEM5). Wetland D is located east of Stream Segment 3 (see **Figure 11.9-47**).

One hundred percent of the dominant plant species are hydrophytic. Wetland D is dominated by common reed and bearded sedge (*Carex comosa*) in the herbaceous stratum, and European alder and black raspberry (*Rubus occidentalis*) in the shrub layer. No trees are present within Wetland D.

Representative photographs of Wetland D are shown in Photographs 18 and 19 on **Figure 11.9-51**. An overhead utility right-of-way (ROW) passes over Wetland D and this area is dominated by common reed and purple loosestrife; less common herbaceous species are clearweed, wool-grass, sensitive fern, and tussock sedge (*Carex stricta*) with a few speckled alder bordering Stream Segment 3.

Soils within Wetland D are a gleyed silt loam, and the primary hydric soil indicator includes the presence of a gleyed matrix that occupies more than 60 percent of a layer starting within 12 inches of the soil surface.

Wetland hydrology indicators observed include a high water table near Stream Segment 3, soil saturation to the surface, surface water, and water marks. A surface expression was also noted as a source of hydrology at the northern end of the wetland. The depth to shallow groundwater is variable across the wetland, as a high water table exists in the wetland adjacent to Stream Segment 3, with depth to water below the ground surface increasing as the wetland slopes upward to the east towards the Danskammer Road embankment.

Photograph 18: Stream Segment 3, facing north with Wetland D (east side) at right, and Wetland E (west side) at left, north of River Road

Photograph 19: Picture taken of Stream Segment 3 and southern portion of Wetlands E and D near River Road facing north. Wetland D is to the right, Wetland E is to the left

Figure 11.9-51: Photographs – Stream Segment 3, Wetland D and Wetland E

Wetland E

Wetland E is an approximately 0.42 acre palustrine, emergent, persistent, seasonally flooded, saturated (PEM1E) wetland, located west of Stream Segment 3 (see **Figure 11.9-47**). This wetland is consistent with the NWI classification as PEM1E due to the lack of dominant woody vegetation. Representative photographs of Wetlands D and E are shown in Photographs 18 and 19 on **Figure 11.9-51**.

One hundred percent of the dominant plant species are hydrophytic. Dominant species include purple loosestrife and fox sedge (*Carex vulpinoidea*) in the herbaceous stratum; less common species consist of broadleaf cattail, clearweed, spotted touch-me-not, and tussock sedge. No trees or shrubs were observed within Wetland E.

Soils within Wetland E are a gleyed silty clay, and the primary hydric soil indicator includes the presence of a gleyed matrix that occupies more than 60 percent of a layer starting within 12 inches of the soil surface. Wetland hydrology indicators observed consist of surface water, a high water table, and soil saturation to the surface.

Wetland F

Wetland F is an approximately 0.08-acre common reed monoculture (PEM5) wetland, located along Stream Segment 3 (see **Figure 11.9-46**) south of Danskammer Road. There is no NWI wetland mapped in proximity to Wetland F.

Fifty percent of the dominant plant species are hydrophytic and the wetland passes the prevalence index test for hydrophytic vegetation with a value of 2.18. Dominant vegetation at Wetland F includes common reed in the herbaceous stratum and Virginia creeper (*Parthenocissus quinquefolia*) in the vine stratum.

The primary hydric soil indicator at Wetland F includes the presence of a gleyed matrix that occupies more than 60 percent of a layer starting within 12 inches of the soil surface. Wetland hydrology indicators include a high water table, soil saturation to the surface, and water-stained leaves.

Wetland G

Wetland G is an approximately 1.13-acre palustrine, emergent, persistent (PEM1); palustrine, forested, broad-leaved deciduous (PFO1); common reed monoculture (PEM5) wetland, located along Stream Segment 2 (see **Figure 11.9-46**). Representative photographs of Wetland G are shown on Photographs 20 and 21 on **Figure 11.9-52**.

One hundred percent of the dominant plant species are hydrophytic. Dominant hydrophytic herbaceous vegetation includes common reed, purple loosestrife, clearweed, and rice cutgrass. Dominant shrubs/saplings include European alder, and dominant trees include European alder and red maple (*Acer rubrum*). Portions of Wetland G are within a utility ROW and are periodically cleared of woody vegetation by the utility.

Photograph 20: Wetland G and Stream Segment 2 (waterfall in background) facing northwest

Photograph 21: Wetland G and Stream Segment 2 from River Road, facing northwest

Figure 11.9-52: Photographs – Stream Segment 2 and Wetland G

The primary hydric soil indicator at Wetland G consists of the presence of a gleyed matrix that occupies more than 60 percent of a layer starting within 12 inches of the soil surface. The wetland hydrology indicators include the presence of surface water and soil saturation to the surface.

Wetland I

Wetland I (see Photographs 22 and 23 on **Figure 11.9-53**) is approximately 10.39 acres and located in the floodplain of Stream Segment 1 (see **Figure 11.9-45**). There is one NWI wetland mapped in the same proximity as Wetland I, although the NWI-mapped wetland area is much smaller than Wetland I (see **Figure 11.9-45**). The NWI wetland is classified as palustrine, forested, broad-leaved deciduous, while Wetland I was classified as palustrine, emergent, persistent (PEM1); palustrine/scrub-shrub, broad-leaved deciduous (PSS1); and palustrine, forested, broad-leaved deciduous (PFO1) wetland based upon the August 2013 and May 2015 field surveys.

Eighty-eight percent of the dominant plant species are hydrophytic. Dominant hydrophytic herbaceous vegetation includes sensitive fern, clearweed, rice cutgrass, and green ash (*Fraxinus pennsylvanica*) seedlings. Northern spicebush, gray dogwood (*Cornus racemosa*), and privet (*Ligustrum* spp.) are dominant among wetland vegetation plots in the shrub/sapling stratum while red maple is dominant in the tree stratum of Wetland I.

Soils in Wetland I meet the requirement for hydric soil indicator F3 (Depleted Matrix), which starts within 10 inches of the soil surface. A hydrogen sulfide odor was also detected in the soil pit, confirming the presence of hydric soils.

The presence of surface water, a high water table, soil saturation to the surface, drift deposits, water marks, and water-stained leaves are indicative of wetland hydrology. The wetland hydrology is linked to the Stream Segment 1, with additional contribution from surface runoff and groundwater as was observed with water monitoring data collected in the wetland.

Wetlands K and KA

Wetlands K and KA are approximately 0.44 and 0.07 acre, respectively, and are located in close proximity to each other north of River Road (see **Figure 11.9-47**). These wetlands are not mapped by NWI.

Wetland K is a palustrine, forested, broad-leaved deciduous wetland (PFO1) showing typical wetland characteristics including hydric soils, wetland hydrology, and hydrophytic vegetation. Fifty percent of the dominant plant species are hydrophytic. Wetland K borders River Road and features a dense to moderate tree canopy dominated by cottonwood (*Populus deltoides*) and catalpa (*Catalpa speciosa*) with a common reed and multiflora rose (*Rosa multiflora*) understory.

Soils consisted of a shallow surface muck overlying a deep gleyed clay layer. The soils exhibit a hydrogen sulfide odor and have a loamy gleyed matrix. Observed hydrologic indicators included surface water, high water table, soil saturation to the surface, sparsely vegetated concave surface, water-stained fallen leaves, and hydrogen sulfide odor.

Photograph 22: Wetland I facing southwest

Photograph 23: Stream Segment 1 and Wetland I facing southwest

Figure 11.9-53: Photographs – Stream Segment 1 and Wetland I

A weakly defined stream channel drains east through the wetland, discharges into a culvert under River Road, and enters Stream Segment 2; the stream was flowing at the time of the May 2015 delineation.

Wetland KA is northeast of Wetland K. Wetland KA is located in a slight topographic depression infill material. It appears to be hydrologically isolated from Wetland K, and is best described as a palustrine, emergent, persistent (PEM1) wetland. Seventy-five percent of the dominant plant species are hydrophytic. Dominant wetland vegetation consists of black willow (*Salix nigra*), common winterberry (*Ilex verticillata*), common reed, and purple loosestrife.

The soils are an unconsolidated mix of fill material comprised of sand, silt and gravel. The soils have a depleted matrix, indicating hydric soils. Observed hydrologic indicators consisted of a high water table and soil saturation to the surface. Groundwater filled the wetland soil pit to within 6 inches of the soil surface.

Hudson River Tidal Inlet

The Hudson River tidal inlet and adjacent wetlands are located at the confluence of Stream Segment 4 and the Hudson River (see **Figure 11.9-48**). No wetland delineation was completed but this area was visually assessed during the April 2015 electrofishing survey. This wetland is mapped by NWI as an estuarine intertidal, emergent, irregularly flooded, oligohaline wetland. However, the wetland is larger than mapped by NWI and a majority of the wetland consists of palustrine, scrub-shrub and forested, broad-leaved deciduous, permanent-tidal (PSS/FO1V) wetlands. As this wetland is associated with the confluence of Stream Segment 4 with the Hudson River, the hydrology is driven by the tidal fluctuations of the Hudson River, freshwater drainage from Stream Segment 4, and two storm drainage features at the southern end of the wetland. The wetland lies within a topographic depression. Stream Segment 4 drains this wetland via a tidal channel with an open tidal mudflat connected to the Hudson River.

Wetlands Soil pH Testing

As described above in Section 11.9.5.4 "Wetlands – Impact Analysis Methodology," to determine whether unique calcareous wetland communities existed within the Natural Resources Study Area, the documented wetland plant species were checked for the presence of calciphiles, and soil samples were collected for analysis of pH and CEC.

Prior to soil sampling, wetland delineation results and site observations were used to assess which wetland communities featured plant species indicative of calcareous conditions, as compared to the ecological communities described by Edinger et al. (2014). The five wetlands that did contain plants identified as calciphiles were: Wetland A (3 species), Wetland G (1 species), Wetland I (12 species), Wetland K (3 species), and Wetland KA (2 species). See **Table 11.9-13** for the plant species that are documented as calciphiles by Edinger (Edinger et al. 2014) that were located within the delineated wetlands of the Natural Resources Study Area.

Table 11.9-13: Calcareous Wetland Plant Species, Natural Resources Study Area

Common Name	Scientific Name	Wetland A	Wetland G	Wetland I	Wetland K	Wetland KA
Red Maple	*Acer rubrum*		X		X	
Speckled Alder	*Alnus incana*	X			X	
Smallspike False Nettle	*Boehmeria cylindrica*			X		
Tussock Sedge	*Carex stricta*			X		
Silky Dogwood	*Cornus amomum*	X		X		
Green Ash	*Fraxinus pennsylvanica*			X	X	
Common Winterberry	*Ilex verticillata*					X
Eastern Red-cedar	*Juniperus virginiana*					X
Northern Spicebush	*Lindera benzoin*	X				
Tatarian Honeysuckle	*Lonicera tatarica*			X		
Sensitive Fern	*Onoclea sensibilis*			X		
Cinnamon Fern	*Osmunda cinnamomea*			X		
Royal Fern	*Osmunda regalis*			X		
Swamp White Oak	*Quercus bicolor*			X		
Skunk Cabbage	*Symplocarpus foetidus*			X		
Marsh Fern	*Thelypteris palustris*			X		
Southern Arrowwood	*Viburnum dentatum*			X		

Note:
X - Denotes species was located within the delineated wetland.

During the field survey on June 8 and 12, 2015, a total of 14 soil samples were collected for analysis of soil pH and CEC. Two samples were collected from each of Wetlands A, B, D, E, and I, and one sample from each of Wetlands C, G, K, and KA (see **Figure 11.9-45** to **Figure 11.9-48**). The results of the wetland soil pH and CEC analysis are shown in **Table 11.9-14**. Most of the soil samples consisted of a sandy or dense clay, with the exception of the sample from Wetland KA which consisted of homogenous fill material characterized as a mix of gravel and sandy loam.

Of the 14 soil samples analyzed, pH levels in six samples were greater than or equal to 7.4, which included Wetlands B, C, E, K, and KA, suggesting that these wetlands are potentially calcareous. Samples collected in Wetlands A, D, E, I, and G were below the 7.4 threshold.

Table 11.9-14: Results of Wetland Soil Analysis — Roseton Natural Resources Study Area

Wetland ID	Soil Sample ID	Date Sampled	pH	CEC (meq/100 g)	Magnesium (meq/100 g)	Potassium (meq/100 g)	Calcium (meq/100 g)	Sodium (meq/100 g)
Wetland A	A-1	6/8/2015	7.05	12.89	3.00	0.06	7.63	0.12
Wetland A	A-2	6/8/2015	7.10	15.57	1.64	0.08	42.07	0.08
Wetland B	B-1	6/8/2015	7.81	5.72	1.42	0.08	74.87	0.19
Wetland B	B-2	6/8/2015	8.01	7.69	1.78	0.22	41.19	0.84
Wetland C	C-1	6/8/2015	7.40	11.06	2.28	0.12	22.48	0.14
Wetland D	D-1	6/8/2015	6.69	14.32	1.93	0.08	10.98	0.46
Wetland D	D-2	6/8/2015	7.20	12.26	2.57	0.11	8.60	0.63
Wetland E	E-1	6/8/2015	6.92	15.02	2.38	0.07	26.21	0.21
Wetland E	E-2	6/8/2015	7.52	5.45	1.16	0.07	38.12	0.14
Wetland G	G-1	6/8/2015	6.50	12.91	1.76	0.11	7.14	0.22
Wetland I	I-1	6/12/2015	5.62	9.57	0.66	0.08	2.04	0.99
Wetland I	I-2	6/12/2015	6.86	10.85	1.73	0.08	5.01	0.34
Wetland K	K-1	6/8/2015	7.83	3.64	0.89	0.05	7.37	0.60
Wetland KA	KA-1	6/8/2015	7.91	5.28	1.63	0.08	34.31	0.09

Note:
Meq: Milliequivalents per 100 g

When reviewing the number of observed calciphiles along with soil pH and CEC, Wetlands K and KA were the only wetlands with observed calciphiles and a soil pH of greater than 7.4. However, the CEC was relatively low at 5.3 (meq/100g), or less. The plant species documented within Wetland K included red maple, speckled alder, and green ash, while Wetland KA included common winterberry and eastern red-cedar (*Juniperus virginiana*). The presence of these relatively common species does not indicate that Wetlands K and KA are unique calcareous wetland communities. Wetland I had the highest number of calciphiles (12) and the lowest pH level (5.62), thus there was no positive correlation between elevated soil pH and the number of observed calciphiles at this wetland.

11.9.5.13 Floodplains – Baseline Conditions

Baseline conditions of floodplains within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.5, "Floodplains – Impact Analysis Methodology." FEMA 2015 flood hazard area maps indicated that the tidal inlet area of Stream Segment 4 is classified as an area that is subject to inundation by the 1 percent- and 0.2 percent- annual chance flood hazard (i.e., 100-year and 500-year flood; see **Figure 11.9-54**). The remaining portion of the Natural Resources Study Area is not classified within the 1 percent and 0.2 percent annual chance flood hazard area.

11.9.5.14 Aquatic and Benthic Resources – Baseline Conditions

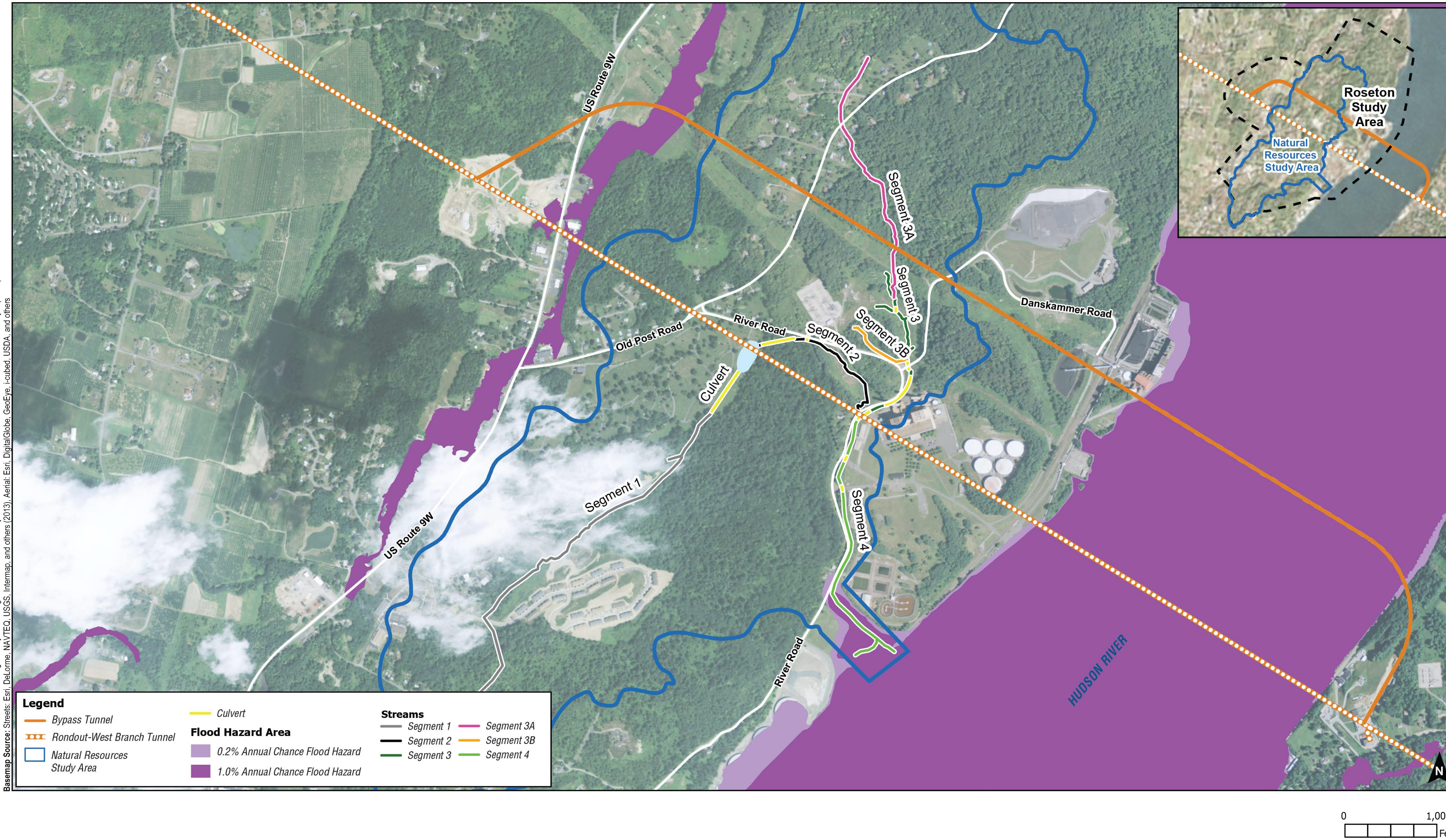
Baseline conditions of aquatic and benthic resources within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.6, "Aquatic and Benthic Resources – Impact Analysis Methodology," and are further described below.

The Roseton Brook tributary to the Hudson River within the Natural Resources Study Area is a NYSDEC Class C water within the upstream non-tidal portion and a Class A water within the tidal portion of the stream. Portions of the tributary are currently supplied with a constant flow of leaking aqueduct water that is creating an artificial temperature and flow regime which influences the aquatic resources within the Natural Resources Study Area.

Fish

A cumulative total of 1,123 individual fish representing 16 species were collected during four seasonal sampling events from 2012 through 2015. Seasonal sampling in terms of abundance and biodiversity was consistent at all stations with the exception of Stations 4C and 4D in the tidal inlet which appears to be heavily dependent on water temperature.

Electrofishing in Stream Segment 1 revealed no fish, while sampling in Stream Segment 2 revealed warmwater fish species assemblage that likely came from the upstream cemetery pond: American eel (*Anguilla rostrata*; CPUE range 1.19 to 2.02), bluegill (*Lepomis macrochirus*; CPUE range approximately 0.57 to 1.74), largemouth bass (*Micropterus salmoides*; CPUE=0.09), black crappie (*Pomoxis nigromaculatus* CPUE approximately 0.09), and yellow bullhead (*Ameirus natalis*; CPUE range approximately 0.04 to 0.14).



GIS Data Sources: Watercourses - Digitized by HDR using GPS Points Collected by HDR Field Crews. Flood Zone - The National Flood Hazard Layer (NFHL) FEMA 2015
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

NYC Environmental Protection

Figure 11.9-54: FEMA Flood Hazard Areas – Natural Resources Study Area

In contrast, the fish communities observed in Stream Segment 3 and the non-tidal portion of Stream Segment 4 were indicative of coldwater streams, mostly brown trout (*Salmo trutta*; CPUE range 0.78 to 6.21).[6]

These results are consistent with the finding that Stream Segments 3 and 4 are influenced by cold leak water from the surface expressions that feed these segments. The tidal fish community consisted of both estuarine and freshwater species. The fish community collected in the tidal portion of Stream Segment 4 was heavily dependent upon the time of year during which sampling took place and the influx of colder water from the upstream non-tidal portion of the segment. During fall and spring sampling in 2012, these locations exhibited high abundance and diversity, while summer sampling revealed a much lower abundance and diversity. For example, in fall 2012, mummichogs (*Fundulus heteroclitus*) were collected in very high numbers (CPUE=10.04) while only one individual was collected during the other two seasonal sampling events in the spring and summer.

During electrofishing surveys conducted in the Natural Resources Study Area, American eel were collected in all stream segments with the exception of Stream Segment 1 during all seasonal sampling events, totaling 153 individuals in October 2012, 86 and 74 individuals in May and August of 2013, respectively, and one individual in April 2015. The total number (313) of American eel collected was fairly evenly distributed among the stream segments: 98 from Stream Segment 2, 101 from Stream Segment 3, and 115 from Stream Segment 4.

Additional electrofishing sampling was conducted in late April 2015 with the goal of capturing any migratory species that may be utilizing the tidal inlet at the Hudson River. Only four individuals were collected, one (American eel) of which is considered migratory species (American eel, yellow perch [*Perca flavescens*], banded killifish [*Fundulus diaphanus*], and tessellated darter [*Etheostoma olmstedi*]).

A summary of the fish collected in each of the stream segments in the Natural Resources Study Area is included in **Table 11.9-15,** with CPUE presented in **Table 11.9-16** and discussed below. Seasonal sampling results from 2012 (fall) and 2013 (spring and summer) can be found in **Table 11.9-17**, **Table 11.9-18** and **Table 11.9-19**.

Stream Segment 1

Electrofishing along Stream Segment 1 yielded no fish for all sampling events. Green frogs were observed during all electrofishing surveys at these locations (see Section 11.9.5.15, "Terrestrial Resources – Baseline Conditions").

Stream Segment 2

Electrofishing along Stream Segment 2 sampling periods yielded a total of 183 individuals across 6 species. The majority of individuals collected were American eel (approximately 54 percent) and bluegill (approximately 42 percent). Less frequently collected species in this segment included brown trout, black crappie, largemouth bass, and yellow bullhead. Highest American eel collections were observed during spring collections.

6 CPUE = Catch-Per-Unit Effort is the number of fish caught during a defined period of fishing effort and is an indicator of relative abundance. In this case, CPUE is based on the number of fish collected per minute of electrofishing.

Table 11.9-15: Natural Resources Study Area Total Number of Fish Collected and Length Range (millimeter) of Each Species

Common Name	Scientific Name	Segment 1		Segment 2 Sampling Stations			Segment 2 Totals	Segment 3 Sampling Stations				Segment 3 Totals	Segment 3A	Segment 4 Sampling Stations					Segment 4 Totals	Total All Segments
		1A	1B	2A	2B	2C		3A	3B	3C	3D		3Z	4A	4B	4C	4D	Tidal Inlet		
American Eel	*Anguilla rostrata*			46 (110-350)	26 (100-340)	26 (90-310)	98 (90-350)				101 (80-340)	101 (80-340)		21 (110-520)	53 (120-370)	17 (120-430)	23 (95-420)	1 (370)	115 (95-420)	314
Banded Killifish	*Fundulus diaphanus*															18 (40-74)	16 (40-87)	1 (79)	35 (40-87)	35
Bluegill	*Lepomis macrochirus*			13 (66-132)	26 (40-146)	37 (37-132)	76 (37-146)							7 (55-119)	4 (49-103)	8 (34-75)	11 (40-59)		30 (34-119)	106
Brown Bullhead	*Ameiurus nebulosus*													1 (125)		4 (81-90)	1 (90)		6 (81-125)	6
Brook Trout	*Salvelinus fontinalis*													1 (289)					1 (289)	1
Brown Trout	*Salmo trutta*					1 (250)	1 (250)	35 (56-220)	127 (69-315)	106 (50-280)	131 (62-306)	399 (50-315)		43 (92-455)	22 (85-260)				65 (85-455)	465
Black Crappie	*Poxomis nigromaculatus*				2 (115-117)		2 (115-117)													2
Four-spined Stickleback	*Apeltes quadracus*																1 (29)		1 (29)	1
Largemouth Bass	*Micropterus salmoides*					2 (137-144)	2 (137-144)				1 (152)	1 (152)		2 (104-114)	3 (30-102)	2 (63-115)	3 (57-146)		10 (30-146)	13
Mummichog	*Fundulus heteroclitus*															78 (39-73)	24 (34-80)		102 (34-80)	102
Pumpkinseed	*Lepomis gibbosus*													9 (61-75)		14 (50-73)	11 (42-142)		34 (42-142)	34
Sea Lamprey	*Petromyzon marinus*															1 (149)			1 (149)	1
Tessellated Darter	*Etheostoma olmstedi*															7 (45-58)	10 (43-65)	1 (85)	18 (45-85)	18
White Sucker	*Catostomus commersoni*													4 (422-435)		1 (35)			5 (35-435)	5
Yellow Bullhead	*Ameiurus natalis*			1 (166)	3 (29-47)		4 (29-166)													4
Yellow Perch	*Perca flavescens*															14 (116-199)	1 (114)	1 (126)	16 (114-119)	16

Note:
Number collected displayed first; length range in parentheses.

Table 11.9-16: Natural Resources Study Area Catch per Unit Effort (Total Number of Fish Collected Per Minute of Electrofishing) of Each Species by Sampling Station

Common Name	Scientific Name	Segment 1		Segment 2			Segment 3				Segment 3A	Segment 4				
		1A	1B	2A	2B	2C	3A	3B	3C	3D	3Z	4A	4B	4C	4D	Tidal Inlet
American Eel	*Anguilla rostrata*			2.02	1.19	1.22				4.79		0.82	1.88	0.71	0.52	0.03
Banded Killifish	*Fundulus diaphanus*													0.75	0.36	0.03
Bluegill	*Lepomis machrochirus*			0.57	1.19	1.74						0.27	0.14	0.33	0.25	
Brown Bullhead	*Ameiurus nebulosus*											0.04		0.17	0.02	
Brook Trout	*Salvelinus fontinalis*											0.04				
Brown Trout	*Salmo trutta*					0.05	1.24	4.30	3.82	6.21		1.68	0.78			
Black Crappie	*Pomoxis nigromaculatus*				0.09											
Four-spine Stickleback	*Apeltes quadracus*														0.02	
Largemouth Bass	*Micropterus salmoides*					0.09				0.05		0.08	0.11	0.08	0.07	
Mummichog	*Fundulus heteroclitus*													3.26	0.55	
Pumpkinseed	*Lepomis gibbosus*											0.35		0.58	0.25	
Sea Lamprey	*Petromyzon marinus*													0.04		
Tessellated Darter	*Etheostoma olmstedi*													0.29	0.23	0.03
White Sucker	*Catostomus commersoni*											0.16		0.04		
Yellow Bullhead	*Ameiurus natalis*			0.04	0.14											
Yellow Perch	*Perca flavescens*													0.58	0.02	0.03

Table 11.9-17: Natural Resources Study Area Total Number of Fish Collected and Length Range (millimeter) of Each Species — Fall 2012 Sampling

Common Name	Scientific Name	Segment 1		Segment 2			Segment 3				Segment 4				TOTAL
		1A	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**4A**	**4B**	**4C**	**4D**	
American Eel	*Anguilla rostrata*			14	4	10				79	14	23	6	3	**153**
				(160-170)	(100-340)	(90-295)				(80-340)	(120-520)	(120-370)	(120-180)	(130-320)	
Banded Killifish	*Fundulus diaphanus*												14	5	**19**
													(40-60)	(40-57)	
Bluegill	*Lepomis macrochirus*				1	35					6	4	8	5	**59**
					(40)	(37-72)					(55-83)	(49-103)	(34-75)	(40-50)	
Brown Bullhead	*Ameiurus nebulosus*										1		1		**2**
											(125)		(82)		
Brown Trout	*Salmo trutta*						16	39	43	60	14	7			**179**
							(82-187)	(70-288)	(81-280)	(62-306)	(92-455)	(85-130)			
Four-spine Stickleback	*Apeltes quadracus*													1	**1**
														(29)	
Largemouth Bass	*Micropterus salmoides*									1	2	1			**4**
										(152)	(104-114)	(82)			
Mummichog	*Fundulus heteroclitus*												77	24	**101**
													(39-73)	(34-80)	
Pumpkinseed	*Lepomis gibbosus*										9		10	6	**25**
											(61-75)		(50-73)	(42-64)	
Sea Lamprey	*Petromyzon marinus*												1		**1**
													(149)		
Tessellated Darter	*Etheostoma olmstedi*												6	5	**11**
													(48-58)	(45-65)	
White Sucker	*Catostomus commersoni*										1				**1**
											(435)				
TOTAL		**0**	**0**	**14**	**5**	**45**	**16**	**39**	**43**	**140**	**47**	**35**	**123**	**49**	**556**

Note:
Number collected displayed first; length range in parentheses.

Table 11.9-18: Natural Resources Study Area Total Number of Fish Collected and Length Range (millimeter) of Each Species — Spring 2013 Sampling

Common Name	Scientific Name	Segment 1		Segment 2			Segment 3				Segment 3A	Segment 4				TOTAL
		1A	1B	2A	2B	2C	3A	3B	3C	3D	3Z	4A	4B	4C	4D	
American Eel	*Anguilla rostrata*			17 (110-280)	13 (120-260)	3 (130-220)				10 (140-250)		7 (110-330)	14 (170-295)	6 (135-220)	16 (95-320)	**86**
Banded Killifish	*Fundulus diaphanus*													4 (55-75)	11 (45-87)	**15**
Bluegill	*Lepomis macrochirus*			11 (66-132)	16 (72-145)	1 (132)						1 (119)			4 (42-57)	**33**
Brown Bullhead	*Ameiurus nebulosus*													3 (81-90)	1 (90)	**4**
Brown Trout	*Salmo trutta*					1 (250)	7 (101-220)	46 (85-220)	30 (90-280)	27 (89-236)		20 (110-260)	10 (145-245)			**141**
Black Crappie	*Poxomis nigromaculatus*				2 (115-117)											**2**
Largemouth Bass	*Micropterus salmoides*					2 (137-144)									1 (146)	**3**
Mummichog	*Fundulus heteroclitus*													1 (58)		**1**
Pumpkinseed	*Lepomis gibbosus*													1 (54)	4 (54-142)	**5**
Tessellated Darter	*Etheostoma olmstedi*													1 (45)	2 (43-55)	**3**
White Sucker	*Catostomus commersoni*											2 (422-426)				**2**
Yellow Bullhead	*Ameiurus natalis*			1 (166)												**1**
Yellow Perch	*Perca flavescens*													14 (116-199)	1 (114)	**15**
TOTAL		**0**	**0**	**29**	**31**	**7**	**7**	**46**	**30**	**37**	**0**	**30**	**24**	**30**	**40**	**311**

Note:
Number collected displayed first; length range in parentheses.

Table 11.9-19: Natural Resources Study Area Total Number of Fish Collected and Length Range (millimeter) of Each Species — Summer 2013 Sampling

Common Name	**Scientific Name**	**Segment 1**		**Segment 2**			**Segment 3**				**Segment 3A**	**Segment 4**				**TOTAL**
		1A	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**3Z**	**4A**	**4B**	**4C**	**4D**	
American Eel	*Anguilla rostrata*			15 (235-350)	9 (155-330)	13 (130-310)				12 (110-290)			16 (110-270)	5 (135-430)	4 (170-420)	**74**
Bluegill	*Lepomis macrochirus*			2 (105-129)	9 (72-146)	1 (122)									2 (53-59)	**14**
Brook Trout	*Salvelinus fontinalis*											1 (289)				**1**
Brown Trout	*Salmo trutta*						12 (56-191)	42 (69-315)	33 (50-271)	44 (47-283)		9 (169-259)	5 (76-234)			**145**
Largemouth Bass	*Micropterus salmoides*												2 (30-102)	2 (63-115)	2 (57-71)	**6**
Pumpkinseed	*Lepomis gibbosus*													3 (63-70)	1 (63)	**4**
Tessellated Darter	*Etheostoma olmstedi*														3 (29-35)	**3**
White Sucker	*Catostomus commersoni*											1 (426)		1 (35)		**2**
Yellow Bullhead	*Ameiurus natalis*				3 (29-47)											**3**
TOTAL		**0**	**0**	**17**	**21**	**14**	**12**	**42**	**33**	**56**	**0**	**11**	**23**	**11**	**12**	**252**

Note:
Number collected displayed first; length range in parentheses.

Stream Segment 3

Stream Segment 3 yielded the most individuals of all segments sampled with a total of 501 individuals across 3 species. The majority of individuals collected were brown trout (approximately 80 percent) and American eel (approximately 20 percent). One largemouth bass was also collected. Length-frequency analysis indicated two distinct cohorts of brown trout with the smaller making up the majority of trout collected. These results suggest that Stream Segment 3 functions primarily as a brown trout spawning and nursery area.

Stream Segment 4

Stream Segment 4 yielded the second most individuals of all segments sampled with a total of 439 individuals across 14 species. The majority of individuals collected were American eel (approximately 26 percent) and mummichog (approximately 23 percent). However, this segment has two very distinct habitats, the tidally influence inlet portion (Stations 4C and 4D), and the upstream portion (Stations 4A and 4B). These two portions have two distinctive fish communities. Brown trout make up the majority of individuals within this upstream portion of Segment 4. American eel, bluegill, largemouth bass, pumpkinseed (*Lepomis gibbosus*), and white sucker (*Catostomus commersoni*) were also collected in the upper portion of Stream Segment 4. Length-frequency analysis shows that, like Segment 3, the upstream reaches of Stream Segment 4 function as a brown trout nursery.

Benthic Macroinvertebrates

Two distinct macroinvertebrate assemblages (as described below) were apparent within the Natural Resources Study Area across all seasons sampled. The benthic community metrics for seasonal sampling from 2012 (fall) and 2013 (spring and summer) can be found in **Table 11.9-20**, with overall metric ranges shown for all sampling stations in **Table 11.9-21**.

Assemblage 1 — Stream Segments 1 and 2

The benthic communities of Stream Segments 1 and 2 were dominated by flatworms (order Tricladida), bivalve mollusks (order Veneroida), and isopods (family Asellidae). These benthic communities had lower family and Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness along with lower PMA scores and higher HBI scores than those found in Stream Segment 3 and the upstream, non-tidal portion of Stream Segment 4. The tidal portion of Stream Segment 4 has a similar benthic community to what was found in Stream Segments 1 and 2 and from previous sampling in 2011. This is most likely due to the reduced current velocity, water temperature influence from the Hudson River, and the presence of fine-grained substrate.

Assemblage 2 — Stream Segments 3 and 4

In Stream Segment 3 and the non-tidal portion of Stream Segment 4, the invertebrate communities had more diversity of both EPT taxa and all taxa combined, along with higher PMA scores and lower HBI scores. Currently, the largest portions of these benthic communities are dominated by midges and amphipods (families Chironomidae and Gammaridae) and mayflies (order Ephemeroptera).

Table 11.9-20: Natural Resources Study Area Seasonal Benthic Invertebrate Community Metrics

	Fall 2012														
Metric	**1A**	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**3Z**	**4A**	**4B**	**4C**	**4D**	**Overall**
Family Richness[1]	14	12	12	15	6	18	15	15	14	NA	12	10	9	10	41
EPT Richness[1]	1	2	3	2	0	6	6	5	8	NA	5	5	0	1	16
Percent Model Affinity	25.0	16.7	31.1	31.3	17.5	55.5	44.6	42.1	40.6	NA	40.6	32.8	30.0	31.1	44.8
Hilsenhoff Biotic Index	6.07	6.85	4.97	6.11	6.23	5.51	5.21	5.69	5.61	NA	5.52	5.78	6.36	6.50	5.88
	Spring 2013														
Metric	**1A**	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**3Z**	**4A**	**4B**	**4C**	**4D**	**Overall**
Family Richness[1]	12	7	12	10	6	10	12	11	9	11	11	12	10	9	38
EPT Richness[1]	1	0	2	0	0	4	5	5	6	3	5	8	1	2	16
Percent Model Affinity	36.5	31.0	37.6	41.9	32.0	75.9	75.6	75.5	59.4	31.0	77.8	76.2	33.7	39.9	63.7
Hilsenhoff Biotic Index	6.41	6.19	5.74	5.61	6.32	3.93	4.28	4.45	4.31	7.43	4.46	3.59	6.41	6.70	5.40
	Summer 2013														
Metric	**1A**	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**3Z**	**4A**	**4B**	**4C**	**4D**	**Overall**
Family Richness[1]	8	11	11	11	7	11	13	15	15	9	13	10	7	9	37
EPT Richness[1]	1	1	1	1	0	5	5	5	5	4	4	3	0	0	10
Percent Model Affinity	18.5	30.8	18.7	36.0	35.9	64.0	64.1	81.7	66.8	37.3	48.5	36.9	31.8	35.0	53.0
Hilsenhoff Biotic Index	6.51	7.07	6.95	6.47	6.97	4.91	5.60	5.68	4.83	6.86	5.81	5.85	6.80	7.59	6.30

Notes:
[1] Species and EPT richness are measured in number of taxa at particular location.
NA = Not Available

Table 11.9-21: Natural Resources Study Area Benthic Invertebrate Community Metric Ranges

Metric	**Full Monitoring Period**													
	1A	**1B**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**	**3D**	**3Z**	**4A**	**4B**	**4C**	**4D**	**Overall**
Family Richness	8-14	7-12	11-12	10-15	6-7	10-18	12-15	11-15	9-15	9-11	11-13	10-12	7-10	9-10	37-41
EPT Richness	1-1	0-2	1-3	0-2	0-0	4-6	5-6	5-5	5-8	3-4	4-5	3-8	0-1	0-2	10-16
Percent Model Affinity	18.5-36.5	16.7-31.0	18.7-37.6	31.3-42.0	17.5-35.9	55.5-75.9	44.6-75.6	42.1-81.7	40.6-66.8	31.0-37.3	40.6-77.8	32.8-76.2	30.0-33.7	31.1-39.9	44.8-63.7
Hilsenhoff Biotic Index	6.07-6.51	6.19-7.07	4.97-6.95	5.61-6.47	6.23-6.97	3.93-5.51	4.28-5.6	4.45-5.69	4.31-5.61	6.86-7.43	4.46-5.81	3.59-5.85	6.36-6.8	6.5-7.59	5.40-6.30

2015 Odonate Sampling

Odonate nymphs were collected at five of the eight sampling sites: in Wetland B ponded surface expression, at the border of Wetlands D and E, the streamcourse in Wetland I and the microhabitats described in Section 11.9.5.12, “Wetlands – Baseline Conditions,” in Wetlands G and I. **Table 11.9-22** summarizes the location, species and number of Odonates that were collected at each location. The greatest number of Odonate species and individuals were collected in the remnants of the beaver pond in Wetland I. Large numbers of leeches and midge larvae were also observed at this location; this site also featured a very low (0.09 parts per million) dissolved oxygen level. No adult Odonates or exuviae (shed nymphal skins) were observed at any of the sites by the sampling crew on either of the May 2015 sampling dates. Several adult ebony jewelwings (*Calopteryx maculata*) and two adult common whitetails (*Plathemis lydia*) were observed in Wetlands G and D respectively during site surveys in June 2015.

Three genera of dragonfly (*Aeshna, Anax,* and *Plathemis*) and three genera of damselfly (*Argia, Ischnura,* and *Calopteryx*) nymphs were also observed. All of the Odonates identified to species level had been previously reported in both Orange and Ulster counties in the *New York Dragonfly and Damselfly Survey 2005 – 2009* (NYSDEC 2010). No representatives of the three genera (*Gomphus, Ophiogomphus,* and *Tachopteryx*) of Odonates listed as Threatened or Special Concern Species by NYSDEC were observed.

Water Quality Observed During Fish/Benthic Sampling

During the fall 2012 sampling event, measurements of pH and DO at all sampling locations fell within established standards for NYSDEC Class C Waters. Water temperature across the sites excluding the Hudson River tidal inlet ranged from 15.1°C to 18.6°C (59°F to 65°F). Specific conductivity is an indirect measure of salinity or some other dissolved inorganic materials or electrolytes and is routinely monitored for an indicator of stream health. Specific conductivity ranged from 10 µSiemens/cm (µS/cm) to 206 µS/cm, with an outlier value (426 µS/cm) observed at Station 2A (see **Table 11.9-23**). During the spring 2013 sampling event, measurements of pH and DO at sampling locations also fell within established standards for NYSDEC Class C Waters. Water temperatures across all sites ranged from 7.3°C to 16.3°C (45°F to 61°F). Specific conductivity ranged from 74.3 µS/cm to 672.0 µS/cm (see **Table 11.9-23**). During the summer 2013 sampling event, measurements of pH and DO at all sampling locations again fell within established standards for NYSDEC Class C Waters. Water temperatures across all segments ranged from 12.4°C to 21.1°C (54°F to 70°F). Temperature within the Hudson River was substantially higher than those measured in nearby macroinvertebrate/electrofishing Stations 4C and 4D during all three seasonal sampling events. This may have influenced the fish assemblage in the tidal portion of Segment 4, resulting in a marked decrease in the number of species observed in summer in comparison to spring. Specific conductivity during summer 2012 ranged from 82 µS/cm to 713 µS/cm (see **Table 11.9-23**).

Table 11.9-22: Results of Spring 2015 Odonate Survey

Location	Common Name	Scientific Name	Individuals	Comments
Site 4 Ponded Surface Expression Wetland B	Dragonfly - Hawker genus	*Aeshna* spp.	1	Immature specimen
Site 3 Wetland D/E	Damselfly - Variable Dancer	*Argia fumipennis*	6	
Site 5 Wetland G	Damselfly - Eastern Forktail	*Ischnura* spp.	2	Immature-species level determination possible with mature specimen; prob I. verticalis
Site 6 Wetland I	Damselfly - Ebony Jewelwing	*Calopteryx maculata*	4	Two immatures aggregated
Site 6A Wetland I Microhabitat	Damselfly - Eastern Forktail	*Ischnura* spp.	20	Immature specimens-species level determination possible with mature specimens; prob I. verticalis
Site 6A Wetland I Microhabitat	Dragonfly - Green Darner	*Anax junius*	1	
Site 6A Wetland I Microhabitat	Dragonfly - Common Whitetail	*Plathemis lydia*	3	
Site 6A Wetland I Microhabitat	Dragonfly - Hawker genus	*Aeshna* spp.	1	Immature specimen

Table 11.9-23: Water Quality Parameters Measured at Electrofishing/Macroinvertebrate Locations Baseline Conditions

Water Quality Parameter	Dissolved Oxygen (mg/L)			pH			Temperature (°C)			Specific Conductivity (µS/cm)		
Station	Fall 2012	Spring 2013	Summer 2013	Fall 2012	Spring 2013	Summer 2013	Fall 2012	Spring 2013	Summer 2013	Fall 2012	Spring 2013	Summer 2013
1A	6.68	8.61	7.73	7.2	7.5	7.6	18.6	14.0	15.9	12	587	694
1B	7.73	8.67	8.40	7.5	7.6	7.8	15.2	14.1	16.3	10	554	681
2A	9.75	8.87	8.09	7.8	7.9	7.9	16.5	16.3	21.1	426	502	614
2B	9.57	9.04	8.08	7.6	7.9	8.0	16.0	16.1	20.6	14	565	614
2C	8.51	8.18	8.20	7.7	7.7	8.2	15.9	14.9	20.0	15	556	600
3A	7.38	13.72	9.06	7.4	7.6	6.7	15.6	7.3	13.0	72	74	82
3B	8.42	13.32	9.60	8.0	7.6	7.4	15.6	7.6	12.8	109	94	120
3C	8.36	13.44	9.65	7.4	7.6	7.0	15.2	8.2	13.0	116	94	126
3D	8.70	13.31	10.26	7.4	7.7	7.0	15.3	8.3	12.7	144	96	129
3Z	-	9.86	10.26	-	7.5	7.4	-	11.8	12.4	-	672	713
4A	9.57	12.86	10.08	7.9	7.7	8.0	15.1	8.9	13.6	181	125	183
4B	8.98	12.76	9.91	7.6	7.7	7.3	15.6	9.0	13.5	206	130	181
4C	8.70	12.38	9.95	7.6	7.2	7.3	15.8	8.7	15.2	198	140	209
4D	8.70	12.43	9.58	7.6	7.2	7.2	15.8	8.7	15.2	198	140	208
Hudson R.	7.21	10.50	6.36	7.4	7.6	7.8	20.4	13.4	25.7	287	196	241

Notes:
mg/L : Milligrams per liter
°C: Celsius
µS: µSiemens

Water quality was collected during late April 2015 fish collection in the tidal inlet as well as the Hudson River just outside of the inlet. The water quality parameters collected included specific conductivity, dissolved oxygen, pH, temperature and salinity (see **Table 11.9-24**). There was a noted difference between the Hudson River temperature and tidal inlet that is likely influencing the seasonal fish assemblage.

Table 11.9-24: Water Quality Recorded during Tidal Inlet Fish Sampling April 27, 2015

Water Quality Parameter	Tidal Inlet	Hudson River
Temperature (°C)	7.6	10.5
Salinity (ppt)	0.08	0.09
Specific Conductivity (µS/cm)	174	192
Dissolved Oxygen (mg/L)	12.5	13.7
pH	7.6	7.5

Notes:
mg/L : Milligrams per liter
ppt: Parts per thousand
°C: Celsius
µS/cm: Microsiemens per centimeter

11.9.5.15 Terrestrial Resources – Baseline Conditions

Baseline conditions of terrestrial resources within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.7, "Terrestrial Resources – Impact Analysis Methodology," and are further described below.

This section provides a summary of the ecological communities and wildlife documented or anticipated to have the potential to occur in the Natural Resources Study Area from 2012 to 2015. Observations of terrestrial resources were recorded during several site visits, Phase I, II, and III bog turtle surveys, wood turtle/spotted turtle surveys, and wetland delineations. Incidental observations of wildlife and vegetation in the Natural Resources Study Area were recorded during the electrofishing and wetland and watercourse delineations and other site visits; these observations were concentrated along the stream corridors and wetlands within the Natural Resources Study Area, as well as the adjacent upland habitats which consisted of fragmented second growth hardwood forest with a shrub-dominated understory. The stream corridors flowed through sections of the utility ROW that is periodically subject to vegetation maintenance such as mowing or tree trimming. As a result, ROW areas were predominately vegetated with shrubs, thick grasses, and seedling/sapling trees in both wetland and upland areas along the alignments.

The field observations were also supplemented with the most recent readily available information from the following sources: DEP correspondence and survey data presented in the previous EIS, NYNHP, USFWS data and OSL for Orange County, NYSDEC Region 3 correspondence, NYSDEC 2000—2005 Breeding Bird Atlas Data, NYSDEC Herp Atlas Data, and field surveys and observations conducted by DEP.

Ecological Communities

Eleven ecological communities and habitats are found throughout the Natural Resources Study Area. These are shallow emergent marsh, freshwater tidal swamp, shrub swamp, red maple-hardwood swamp, marsh headwater stream, ditch/artificial intermittent stream, successional old field, successional southern hardwoods, mowed roadside/pathway, mowed lawn with trees, and paved road/pathway. There are also residentially and industrially developed areas within the Natural Resources Study Area. Descriptions of these ecological communities can be found in Edinger (Edinger et al. 2014).

Most of the natural ecological communities and habitats in the Natural Resources Study Area have been modified and/or cleared due to decades of human habitation. Disturbances from farming, forest clearing, stream channel modifications and relocation, residential construction, brick making, industry, power generation, shipping, and construction of roads and utility ROW in the area are some examples of past and recent human activity in the study area.

Wildlife

Baseline conditions of wildlife resources within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.7, “Terrestrial Resources – Impact Analysis Methodology,” and are further described below.

Amphibians and Reptiles

Based on the desktop review, the Natural Resources Study Area is within the Wappingers Falls, New York quadrangle. This USGS quadrangle Atlas Block covers an area larger than the study area, including east of the Hudson River within Dutchess County. Numerous additional habitat types exist within the total Wappingers Falls USGS quadrangle that do not exist in the Natural Resources Study Area. Thus, many species identified by the Herp Atlas within the Wappingers Falls USGS quadrangle may not occur or were not directly observed in or adjacent to the Natural Resources Study Area. As an example, two species (wood turtle and spotted turtle) reported in the Herp Atlas were not found in the study area despite intensive spring 2015 field surveys or during any of the other field studies.

Overall, 31 species of reptiles and amphibians were documented in the Wappingers Falls Atlas Block. Of these, 18 species were observed in the Natural Resources Study Area during field surveys. Two species: northern red salamander (*Pseudotriton ruber*) and northern spring salamander (*Gyrinophilus porphyriticus*) were not listed in the Wappingers Falls Atlas Block but were observed in the study area during field surveys. Four of the amphibians or reptiles identified through the Herp Atlas are State Special Concern Species, eastern box turtle (*Terrapene carolina*), Jefferson Salamander (*Ambystoma jeffersonianum*), spotted turtle, and wood turtle (see Section 11.9.5.16, “Federal/State Threatened and Endangered Species and State Species of Special Concern – Baseline Conditions.”). A list of species that includes results from fall 2012, spring and summer 2013, and spring 2015 site visits and field surveys, whether the species was documented previously, and other amphibian and reptiles documented in the USGS Wappingers Falls quadrangle during the Herp Atlas, is provided in **Table 11.9-25**.

Table 11.9-25: Amphibian and Reptile Species with the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Previously Documented in 2011 as Observed in the Natural Resources Study Area	Observed Natural Resources Study Area - October 2012	Observed Natural Resources Study Area – Spring/ Summer 2013	Observed Natural Resources Study Area - Spring 2015	Source
Allegheny Mountain Dusky Salamander	*Desmognathus ochrophaeus*					Herp Atlas
American Toad	*Anaxyrus americanus*		Yes	Yes	Yes	Herp Atlas/Field Observation
Black Rat Snake	*Elaphe alleghaniensis*					Herp Atlas
American Bullfrog	*Lithobates catesbeianus*	Yes	Yes	Yes		Herp Atlas/Field Observation
Common Gartersnake	*Thamnophis sirtalis*	Yes		Yes	Yes	Herp Atlas/Field Observation
Eastern Musk Turtle	*Sternotherus odoratus*					Herp Atlas
Copperhead	*Agkistrodon contortrix*					Herp Atlas
Dekay's Snake	*Storeria dekayi*					Herp Atlas
Dusky Salamander	*Desmognathus fuscus*		Yes	Yes	Yes	Herp Atlas/Field Observation
Eastern Box Turtle[1]	*Terrapene carolina*			Yes	Yes	Herp Atlas/Field Observation
Red-spotted Newt	*Notophthalmus viridescens*	Yes				Herp Atlas/Field Observation
Common Five-lined Skink	*Plestiodon fasciatus*					Herp Atlas
Gray Treefrog	*Hyla versicolor*		Yes	Yes	Yes	Herp Atlas/Field Observation
Green Frog	*Lithobates clamitans*	Yes	Yes	Yes	Yes	Herp Atlas/Field Observation
Jefferson Salamander[1]	*Ambystoma jeffersonianum*					Herp Atlas
Milksnake	*Lampropeltis triangulum*					Herp Atlas
Northern Leopard Frog	*Lithobates pipiens*					Herp Atlas

Table 11.9-25: Amphibian and Reptile Species with the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Previously Documented in 2011 as Observed in the Natural Resources Study Area	Observed Natural Resources Study Area - October 2012	Observed Natural Resources Study Area – Spring/ Summer 2013	Observed Natural Resources Study Area - Spring 2015	Source
Northern Slimy Salamander	*Plethodon glutinosus*					Herp Atlas
Northern Two-lined Salamander	*Eurycea bislineata*	Yes		Yes	Yes	Herp Atlas/Field Observation
Common Watersnake	*Nerodia sipedon*			Yes		Herp Atlas/Field Observation
Eastern Painted Turtle	*Chrysemys p. picta*		Yes		Yes	Herp Atlas/Field Observation
Pickerel Frog	*Lithobates palustris*			Yes		Herp Atlas/Field Observation
North American Racer	*Coluber constrictor*					Herp Atlas
Northern Red Salamander	*Pseudotriton ruber*			Yes	Yes	Field Observation
Eastern Redback Salamander	*Plethodon cinereus*	Yes	Yes			Herp Atlas/Field Observation
Pond Slider	*Trachemys scripta*				Yes	Herp Atlas/Field Observation
Snapping Turtle	*Chelydra serpentina*		Yes	Yes	Yes	Herp Atlas/Field Observation
Spotted Salamander	*Ambystoma maculatum*					Herp Atlas
Spotted Turtle[1]	*Clemmys guttata*					Herp Atlas
Northern Spring Peeper	*Pseudacris crucifer*		Yes		Yes	Herp Atlas/Field Observation
Northern Spring Salamander	*Gyrinophilus porphyriticus*			Yes	Yes	Field Observation
Wood Frog	*Lithobates sylvaticus*					Herp Atlas
Wood Turtle[1]	*Glyptemys insculpta*					Herp Atlas

Note:
[1] State Species of Special Concern

Avian Species

The Hudson River and Hudson River Valley is a migration corridor with abundant stop-over, foraging and nesting habitats for migrant and resident birds, including bays, shoreline (riparian habitat), wetlands, upland forests, open fields, and other ecological communities. Prior to any field surveys, the 2000—2005 Breeding Bird Atlas data for Orange County was used to develop a list of birds that may potentially be observed in the Natural Resources Study Area. The Breeding Bird Atlas is a survey that documents the distribution of breeding birds across the State. The State was divided into 10 regions containing Atlas blocks; each measured 3-miles by 3-miles (5,332 blocks Statewide). Volunteers and State biologists then surveyed each block and recorded evidence of breeding birds. Breeding Bird Atlas Block 5760D included areas in the west section of the Natural Resources Study Area and Block 5860C included areas in the east section of the Natural Resources Study Area, including the Hudson River and parts of Dutchess County east of the Hudson River. Each Atlas Block encompasses some larger and more diverse tracts of habitat than are present within the Natural Resources Study Area. As such, some species that appear in the Atlas for these blocks are unlikely to breed in the Natural Resources Study Area.

In Block 5860C that includes the eastern section of the Natural Resources Study Area, the 2000—2005 Breeding Bird Atlas lists a total of 64 bird species as occurring in the block. The breeding status of these birds can be either confirmed (39 species), probable (17 species), or possible (8 species). Out of the 64 species, three State listed Threatened or Species of Special Concern occurred in the block: the Bald Eagle (*Haliaeetus leucocephalus*), the Sharp-shinned Hawk (*Accipiter striatus*), and the Cooper's Hawk (*Accipiter cooperii*). The Bald Eagle and Sharp-shinned Hawk were confirmed as breeding in Block 5860C, while the Cooper's Hawk was identified as a possible nesting species.

In Block 5760D that includes the western portion of the study area, the 2000-2005 Breeding Bird Atlas lists a total of 60 bird species as occurring in the block. The breeding status of these birds can be either confirmed (30 species), probable (12 species), or possible (18 species). Out of the 60 species, one State Endangered Species occurred in the block: the Peregrine Falcon (*Falco peregrinus*). The Peregrine Falcon was a confirmed breeding species in Block 5760D.

When site visits and field studies were conducted, birds were identified visually and/or audibly within wetland, forested, and open field communities present in the Natural Resources Study Area. In total, 75 species of birds were observed within the study area. A list of species that includes results from fall 2012, spring and summer 2013, winter 2014, and spring 2015 site visits and field surveys are found in **Table 11.9-26**. Also shown in **Table 11.9-26** are whether or not these species were previously documented in the study area, and if these species occur in the 2000—2005 Breeding Bird Atlas.

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Alder Flycatcher	*Empidonax alnorum*								Breeding Bird Atlas, 2000 to 2005
American Black Duck	*Anas rubripes*			Yes					Field Observation
American Crow	*Corvus brachyrhynchos*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
American Goldfinch	*Spinus tristis*			Yes	Yes	Yes	Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
American Redstart	*Setophaga ruticilla*			Yes		Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
American Robin	*Turdus migratorius*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
American Woodcock	*Scolopax minor*			Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
Bald Eagle	*Haliaeetus leucocephalus*	Bald and Golden Eagle Protection Act	Threatened	Yes			Yes		Field Observation/ Breeding Bird Atlas, 2000 to 2005
Baltimore Oriole	*Icterus galbula*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Barn Swallow	*Hirundo rustica*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Bay-breasted Warbler	*Dendroica castanea*			Yes					Field Observation
Belted Kingfisher	*Megaceryle alcyon*			Yes	Yes				Field Observation
Black-capped Chickadee	*Poecile atricapillus*			Yes	Yes		Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Black-crowned Night Heron	*Nycticorax nycticorax*								Breeding Bird Atlas, 2000 to 2005

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Blue Jay	*Cyanocitta cristata*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Blue-gray Gnatcatcher	*Polioptila caerulea*								Breeding Bird Atlas, 2000 to 2005
Blue-winged Warbler	*Vermivora cyanoptera*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Brown Thrasher	*Toxostoma rufum*			Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
Brown-headed Cowbird	*Molothrus ater*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Canada Goose	*Branta canadensis*			Yes	Yes		Yes		Field Observation/ Breeding Bird Atlas, 2000 to 2005
Carolina Wren	*Thryothorus ludovicianus*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Cedar Waxwing	*Bombycilla cedrorum*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Chestnut-sided Warbler	*Setophaga pensylvanica*			Yes					Field Observation
Chimney Swift	*Chaetura pelagica*			Yes	Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005
Chipping Sparrow	*Spizella passerina*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Common Grackle	*Quiscalus quiscula*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Common Merganser	*Mergus merganser*			Yes			Yes		Field Observation
Common Raven	*Corvus corax*				Yes	Yes		Yes	Field Observation

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Common Yellowthroat	*Geothlypis trichas*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Cooper's Hawk	*Accipiter cooperii*		Special Concern		Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005
Dark-eyed Junco	*Junco hyemalis*			Yes	Yes				Field Observation
Double-crested Cormorant	*Phalacrocorax auritus*			Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
Downy Woodpecker	*Picoides pubescens*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Eastern Bluebird	*Sialia sialis*			Yes	Yes		Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Eastern Kingbird	*Tyrannus tyrannus*			Yes				Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Eastern Phoebe	*Sayornis phoebe*			Yes	Yes			Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Eastern Towhee	*Pipilo erythrophthalmus*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Eastern Wood Pewee	*Contopus virens*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
European Starling	*Sturnus vulgaris*			Yes	Yes	Yes	Yes		Field Observation/ Breeding Bird Atlas, 2000 to 2005
Field Sparrow	*Spizella pusilla*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Fish Crow	*Corvus ossifragus*			Yes	Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Gray Catbird	*Dumetella carolinensis*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Great Black-backed Gull	*Larus marinus*			Yes					Field Observation
Great Blue Heron	*Ardea herodias*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Great Crested Flycatcher	*Myiarchus crinitus*			Yes		Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Great Horned Owl	*Bubo virginianus*								Breeding Bird Atlas, 2000 to 2005
Green Heron	*Butorides virescens*								Breeding Bird Atlas, 2000 to 2005
Hairy Woodpecker	*Picoides villosus*			Yes				Yes	Field Observation
Hermit Thrush	*Catharus guttatus*			Yes		Yes			Field Observation
Herring Gull	*Larus argentatus*			Yes					Field Observation
Hooded Merganser	*Lophodytes cucullatus*			Yes					Field Observation
House Finch	*Carpodacus mexicanus*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
House Sparrow	*Passer domesticus*			Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
House Wren	*Troglodytes aedon*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Indigo Bunting	*Passerina cyanea*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Killdeer	*Charadrius vociferus*			Yes	Yes			Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Least Flycatcher	*Empidonax minimus*							Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Louisiana Waterthrush	*Parkesia motacilla*								Breeding Bird Atlas, 2000 to 2005
Mallard	*Anas platyrhynchos*			Yes	Yes		Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Mourning Dove	*Zenaida macroura*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Mute Swan	*Cygnus olor*								Breeding Bird Atlas, 2000 to 2005
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*					Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Northern Cardinal	*Cardinalis cardinalis*			Yes	Yes	Yes	Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Northern Flicker	*Colaptes auratus*			Yes	Yes	Yes	Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Northern Mockingbird	*Mimus polyglottos*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Orchard Oriole	*Icterus spurius*			Yes					Field Observation
Ovenbird	*Seiurus aurocapilla*					Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Palm Warbler	*Dendroica palmarum*				Yes				Field Observation
Peregrine Falcon	*Falco peregrinus*		Endangered	Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
Pileated Woodpecker	*Dryocopus pileatus*			Yes				Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Prairie Warbler	*Dendroica discolor*			Yes		Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Red-bellied Woodpecker	*Melanerpes carolinus*			Yes	Yes	Yes	Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Red-eyed Vireo	*Vireo olivaceus*			Yes	Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005
Red-shouldered Hawk	*Buteo lineatus*		Special Concern		Yes				Field Observation
Red-tailed Hawk	*Buteo jamaicensis*			Yes	Yes	Yes	Yes	Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Red-winged Blackbird	*Agelaius phoeniceus*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Ring-billed Gull	*Larus delawarensis*			Yes					Field Observation
Rock Pigeon	*Columbia livia*			Yes	Yes	Yes			Field Observation
Rose-breasted Grosbeak	*Pheucticus ludovicianus*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Ruby-crowned Kinglet	*Regulus calendula*				Yes				Field Observation
Ruby-throated Hummingbird	*Archilochus colubris*			Yes	Yes			Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Scarlet Tanager	*Piranga olivacea*			Yes		Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Sharp-shinned Hawk	*Accipiter striatus*		Special Concern		Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005
Song Sparrow	*Melospiza melodia*			Yes	Yes	Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Spotted Sandpiper	*Actitis macularius*			Yes				Yes	Field Observation

Table 11.9-26: Avian Species With the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Federal Protection Status	State Protection Status	Previously Documented in the Natural Resources Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Winter 2014	Observed in the Natural Resources Study Area - Spring 2015	Source
Swainson's Thrush	*Catharus ustulatus*			Yes					Field Observation
Swamp Sparrow	*Melospizia georgiana*				Yes				Field Observation
Tree Swallow	*Tachycineta bicolor*			Yes				Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Tufted Titmouse	*Baeolophus bicolor*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Turkey Vulture	*Cathartes aura*			Yes	Yes				Field Observation/ Breeding Bird Atlas, 2000 to 2005
Veery	*Catharus fuscescens*			Yes				Yes	Field Observation /Breeding Bird Atlas, 2000 to 2005
Warbling Vireo	*Vireo gilvus*			Yes		Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
White-breasted Nuthatch	*Sitta carolinensis*			Yes	Yes		Yes		Field Observation/ Breeding Bird Atlas, 2000 to 2005
White-throated Sparrow	*Zonotrichia albicollis*			Yes	Yes				Field Observation
Wild Turkey	*Meleagris gallopavo*			Yes	Yes	Yes			Field Observation/ Breeding Bird Atlas, 2000 to 2005
Wood Duck	*Aix sponsa*								Breeding Bird Atlas, 2000 to 2005
Wood Thrush	*Hylocichla mustelina*			Yes					Field Observation/ Breeding Bird Atlas, 2000 to 2005
Yellow Warbler	*Setophaga petechia*			Yes		Yes		Yes	Field Observation/ Breeding Bird Atlas, 2000 to 2005
Yellow-rumped Warbler	*Setophaga coronata*			Yes	Yes				Field Observation
Yellow-throated Vireo	*Vireo flavifrons*								Breeding Bird Atlas, 2000 to 2005

Three State Special Concern Species, Red-shouldered Hawk (*Buteo lineatus*), Cooper's Hawk, and Sharp-shinned Hawk, were observed within the Natural Resources Study Area during the October 2012 site visits. One State Threatened and federally protected (BGPA) species, the Bald Eagle, was observed foraging along the Hudson River and within the Natural Resources Study Area (Stream Segments 3 and 4) during the winter 2014 site visit.

The majority of bird species observed during the 2012 to 2015 site visits included permanent avian residents according to the Breeding Bird Atlas. These included Canada Goose (*Branta canadensis*), Wild Turkey (*Meleagris gallopavo*), Red-tailed Hawk (*Buteo jamaicensis*), Belted Kingfisher (*Megaceryle alcyon*), Red-bellied Woodpecker (*Melanerpes carolinus*), Downy Woodpecker (*Picoides pubescens*), Blue Jay (*Cyanocitta cristata*), American Crow (*Corvus brachyrhynchos*), Black-capped Chickadee (*Poecile atricapillus*), Tufted Titmouse (*Baeolophus bicolor*), White-breasted Nuthatch (*Sitta carolinensis*), Carolina Wren (*Thryothorus ludovicianus*), Northern Mockingbird (*Mimus polyglottos*), Song Sparrow (*Melospiza melodia*), and Northern Cardinal (*Cardinalis cardinalis*).

Other species observed during field studies were considered migratory, and occur primarily during the spring and fall migration periods. Migratory species also include some species of which small contingents may remain in the Natural Resources Study Area through the late spring and summer for courtship and nesting (summer avian residents), while other species may have contingents of individuals that may remain in the area for most of the winter season (winter avian residents). The breeding/nesting species include species such as Chimney Swift (*Chaetura pelagica*), Eastern Wood Pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), American Robin (*Turdus migratorius*), Eastern Towhee (*Pipilo erythrophthalmus*),and Red-winged Blackbird (*Agelaius phoeniceus*), which use the area during the spring and early summer nesting period and migrate south during the fall/early winter. The winter residents include species such as White-throated Sparrow (*Zonotrichia albicollis*) and Dark-eyed Junco (*Junco hyemalis*) that use the area during the late fall and winter and migrate north during the spring to nest in more northern areas.

Mammals

During the 2012 to 2015 site visits and field surveys, seven mammals were observed by direct observation in the Natural Resources Study Area including white-tailed deer (*Odocoileus virginianus*), eastern chipmunk (*Tamias striatus*), eastern gray squirrel (*Sciurus carolinensis*), red fox (*Vulpes vulpes*), woodchuck (*Marmota monax*), common muskrat (*Ondatra zibethicus*), and meadow jumping mouse (*Zapus hudsonius*). Four mammals were observed by evidence such as droppings, tracks, burrows, nests, and browse. These were the coyote (*Canis latrans*) (droppings), northern raccoon (*Procyon lotor*) (tracks), eastern cottontail (*Sylvilagus floridanus*) (droppings), and American beaver (*Castor canadensis*) (tree cuttings and dams). The same mammal species with the addition of the meadow vole (*Microtus pennsylvanicus*) were documented previously. The mammalian species that were observed utilizing habitats of the study area are listed in **Table 11.9-27**. None of the mammals observed in the Natural Resources Study Area are State or federally listed species.

Table 11.9-27: Mammal Species with the Potential to Exist within the Natural Resources Study Area

Common Name	Scientific Name	Previously Documented in the Study Area	Observed in the Natural Resources Study Area - October 2012	Observed in the Natural Resources Study Area - Spring 2013	Observed in the Natural Resources Study Area - Spring 2015	Source
American Beaver	*Castor canadensis*		Yes	Yes	Yes	Field Observation
Coyote	*Canis latrans*				Yes	Field Observation
Eastern Chipmunk	*Tamias striatus*	Yes	Yes	Yes	Yes	Field Observation
Eastern Cottontail	*Sylvilagus floridanus*	Yes	Yes			Field Observation
Eastern Gray Squirrel	*Sciurus carolinensis*	Yes	Yes	Yes	Yes	Field Observation
Meadow Jumping Mouse	*Zapus hudsonius*		Yes			Field Observation
Meadow Vole[1]	*Microtus pennsylvanicus*	Yes				Field Observation
Common Muskrat	*Ondatra zibethicus*		Yes	Yes	Yes	Field Observation
Raccoon	*Procyon lotor*	Yes	Yes	Yes	Yes	Field Observation
Red Fox	*Vulpes vulpes*		Yes			Field Observation
White-tailed Deer	*Odocoileus virginianus*	Yes	Yes	Yes	Yes	Field Observation
Woodchuck	*Marmota monax*		Yes	Yes	Yes	Field Observation

Note:
[1] Unidentified mole or vole species.

11.9.5.16 Federal/State Threatened and Endangered Species and State Species of Special Concern – Baseline Conditions

Baseline conditions of federal/State Threatened, Endangered, and Candidate Species, and State Species of Special Concern within the Natural Resources Study Area were developed based on the methodology described in Section 11.9.5.8 "Federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and Unlisted Rare and Vulnerable Species – Impact Analysis Methodology," and further described below. The list of federal/State Threatened, Endangered, and Candidate Species, and State Species of Special Concern identified in Orange County, the Hudson River, and within or near the Natural Resources Study Area are summarized in **Table 11.9-28**. Results of field surveys conducted in the study area to identify the potential for occurrence of federal/State Threatened and Endangered Species and State Species of Special Concern, or their potential habitats is described below.

<u>Federally Listed Species</u>

Indiana Bat (Myotis sodalis)

The Indiana bat (*Myotis sodalis*) is a federal and State Endangered Species. NYNHP correspondence dated October 15, 2015 indicates confirmed maternity colonies on the east side of the Hudson River in Dutchess County, New York (see Appendix 1).

The Indiana bat is an insectivorous bat that has four distinct life history phases: hibernation, spring staging and autumn swarming, spring and autumn migration, and summer roosting (USFWS 2007). From approximately September to April, Indiana bats hibernate in caves or abandoned mines. In April through May, bats emerge from their hibernacula and migrate to their summer roosting locations. Although some males and non-reproductive females may stay within the vicinity of the hibernacula, the majority of females migrate, in some cases up to several hundred miles (Winhold and Kurta 2006), to their summer habitat. In the northeast, migration distances tend to be shorter (Britzke et al. 2006).

At the summer habitat, males disperse and remain solitary until mating season at the end of the summer. Pregnant females form maternity colonies where gestation, birth, nursing/lactation, and rearing young occur. Maternity roosts and general roosting sites are usually under loose, exfoliating bark or in the crevices of trees. Indiana bat roosting sites have been documented in numerous species of deciduous trees. Tree availability, diameter, altitude, bark characteristics, condition/damage, and solar exposure appear to be more important factors than tree species for roost site selection (USFWS 2014).

Certain species of mature, live trees exhibit suitable bark characteristics. Examples of these species are shagbark hickory (*Carya ovata*), sugar maple (*Acer saccharum*), black locust (*Robinia pseudoacacia*), and white oak (*Quercus alba*). However, most tree species must be damaged and/or dying before bark separation occurs and suitable crevices develop. In addition to suitable crevices, the amount of solar exposure needed to warm exfoliating bark and crevices is important. Indiana bats often roost near forest gaps or edges where trees receive direct sunlight for much of the day.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Indiana Bat	*Myotis sodalis*	Endangered	Endangered	Yes	Yes	NYNHP, USFWS OSL	NYNHP – Information Services - Response Letter October 15, 2015, indicates confirmed within 2.5 miles of the study area. Potential roost/maternity trees occur in the study area, and potential foraging occurs in wetland areas, along stream corridors, along utility ROWs, and in forested areas, edges, and clearings.
Northern Long-eared Bat	*Myotis septentrionalis*	Threatened	Threatened	Yes	Yes	USFWS OSL	USFWS - Official Species List - Potential roost/maternity trees and structures occur in the Natural Resources Study Area and potential foraging occurs in wetland areas, along stream corridors, along utility ROWs, and in forested areas, edges, and clearings.
Atlantic Sturgeon	*Acipenser oxyrinchus oxyrinchus*	Endangered	Endangered	No	No	NOAA NMFS	National Marine Fisheries Service Response Letter dated January 24, 2011, indicates that Atlantic Sturgeon could occur in the Hudson River adjacent to the study area. The Atlantic sturgeon is unlikely to enter the tributary stream in the study area and therefore no potential habitat exists.
Shortnose Sturgeon	*Acipenser brevirostrum*	Endangered	Endangered	No	No	NYNHP, NOAA NMFS	NYNHP - Information Services - Response Letter dated October 15, 2015, indicates this species has been documented at or near the study area, generally within 0.5 mile. The shortnose sturgeon is unlikely to enter the tributary stream in the study area and therefore no potential habitat exists in the study area.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Dwarf Wedgemussel	*Alasmidonta heterodon*	Endangered	Endangered	No	No	USFWS OSL	Typical habitat includes cool, clear, freshwater brooks to rivers (100 m wide) with slow to moderate velocities and silt, sand, and gravel substrates distributed in small areas between and downstream of larger cobbles and boulders (Strayer and Jirka 1997; Michaelson and Neves 1995). The only known population in New York occurs in the lower Neversink River, a small (40 m wide) coolwater river where individuals are found bedded in fine sediments that accumulate between cobbles (Strayer and Jirka 1997). Known host species include tessellated and johnny darters and mottled sculpin (Michaelson and Neves 1995). Tessellated darters (the only known host species within range) were collected in the lower tidal portion of Stream Segment 4. Habitat above the tidal influence in perennial Stream Segments 2 and 3 are primarily mucky and lack the stable substrate of compacted silt and sand to retain individuals. Stream Segment 1 and the upper portion of Stream Segment 2 may not be perennial and the waters are warmer and more turbid than preferred by this species. Therefore, potential habitat is not present in the Natural Resources Study Area.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Small Whorled Pogonia	*Isotria medeoloides*	Threatened	Endangered	No	No	USFWS OSL	Habitat includes mid-successional hardwood or mixed forest with acidic, sandy loams with an impervious pan layer generally occurring along microdrainages with canopy gaps and woody debris. In Orange County, this species is associated with Arnot complex soils, which are not present in the Natural Resources Study Area, and other acidic sandy loams with an impervious pan layer that are not found in the Natural Resources Study Area. Potential habitat is not expected to occur in the Natural Resources Study Area because the soils associated with this species are not found in or near the Natural Resources Study Area.
Bald Eagle	*Haliaeetus leucocephalus*	Bald and Golden Eagle Protection Act	Threatened	Yes	Yes	NYNHP, Breeding Bird Atlas 2000 to 2005, Field Observation	NYNHP-Information Services Response Letter dated October 15, 2015, indicates confirmed within 1.0 mile of the Natural Resources Study Area. Bald Eagles were observed foraging along the Hudson River and near Stream Segment 3 and Stream Segment 4 during winter 2014.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Peregrine Falcon	*Falco peregrinus*	Not Listed	Endangered	Yes	Yes	Breeding Bird Atlas 2000 to 2005, Field Observation	The Peregrine Falcon was documented breeding in Block 5760D in in the 2000-2005 Breeding Bird Atlas. Additionally, this species was observed along the Hudson River during field studies completed for the previous EIS. No suitable nesting sites were observed in the Natural Resources Study Area. There are potential foraging areas for Peregrine Falcons, including large trees and snags along the Hudson River and also man-made structures within or near the Natural Resources Study Area.
Cooper's Hawk	*Accipiter cooperii*	Not Listed	Special Concern	Yes	Yes	Breeding Bird Atlas 2000 to 2005, Field Observation	The Natural Resources Study Area provides some potential nesting habitat including patches of deciduous forests. It provides stop-over habitat (resting and foraging) for migrating Cooper's Hawks, and may be used for extended periods during the spring and fall migrations and during the winter. A Cooper's Hawk was observed in Wetland A during the October 2012 site visit.
Red-shouldered Hawk	*Buteo lineatus*	Not Listed	Special Concern	Yes	Yes	Field Observation	The forested wetlands and adjacent second growth deciduous forest along and near Wetland I contain potential Red-shouldered Hawk nesting and foraging habitat, and this species could nest in or near the Natural Resources Study Area. Red-shouldered Hawk was not documented in the 2000-2005 Breeding Bird Atlas. However, one was observed in Wetland I during the October 2012 site visit.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Sharp-shinned Hawk	*Accipiter striatus*	Not Listed	Special Concern	Yes	Yes	Breeding Bird Atlas 2000 to 2005, Field Observation	The Natural Resources Study Area provides some potential nesting habitat including large, dense stands of deciduous forests. It provides stop-over habitat (resting and foraging) for migrating Sharp-shinned Hawks and may be used for extended periods during the spring and fall migrations. The Sharp-shinned Hawk was documented in the 2000 to 2005 Breeding Bird Atlas. A Sharp-shinned Hawk was observed in Wetland A during the October 2012 site visit
Bog Turtle	*Clemmys [= Glyptemys] muhlenbergii*	Threatened	Endangered	Yes	Unlikely	USFWS OSL, Field Surveys	While Phase I surveys identified potential bog turtle habitat, no bog turtles were observed during the Phase II surveys conducted within wetlands A, B, C, D, E, G, and I in accordance with USFWS guidelines and protocols. No bog turtles were captured during the Phase III surveys conducted in 2015 within Wetland I in accordance with USFWS guidelines and protocols. Therefore, this species is unlikely to occur in the wetlands in the Natural Resources Study Area.
Eastern Box Turtle	*Terrapene carolina*	Not Listed	Special Concern	Yes	Yes	Herp Atlas, Field Observation	Box turtles were observed during the Phase I, II, and III bog turtle surveys. At least five different eastern box turtles were observed (some were observed multiple times) during the 2013 Phase II bog turtle surveys. A box turtle was also observed during wetland delineations completed in 2015, and during the Phase III bog turtle survey in Wetland I.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Spotted Turtle	*Clemmys guttata*	Not Listed	Special Concern	Yes	Yes	Herp Atlas	Potential habitat for the spotted turtle is present in the vicinity of Wetlands A, D, E, G, and I. No spotted turtles were observed during the Phase I, II, and III bog turtle surveys or during the stream surveys for fish and benthic and aquatic invertebrates and wetland delineation surveys. No spotted turtles were observed during spotted turtle surveys completed in spring 2015.
Wood Turtle	*Glyptemys insculpta*	Not Listed	Special Concern	Yes	Yes	Herp Atlas	The Natural Resources Study Area contains potential wood turtle habitat, including the streams, vegetated riparian corridors, emergent and forested wetlands, open ROWs, and successional woodlands in the vicinity of Wetlands A, D, E, G, and I. No wood turtles were observed during the Phase I, II, and III bog turtle surveys or during the stream surveys for fish and benthic and aquatic invertebrates and wetland delineation surveys. No wood turtles were observed during wood turtle surveys completed in spring 2015.

Table 11.9-28: Threatened, Endangered, and Special Concern Species with the Potential to Occur within the Natural Resources Study Area[1]

Common Name	Scientific Name	Federal Status	State Status	Potential Habitat Present in the Natural Resources Study Area	Species Potentially Present in the Natural Resources Study Area	Sources Used to Determine Potential Species Presence	Notes
Jefferson Salamander	*Ambystoma jeffersonianum*	Not Listed	Special Concern	Yes	Yes	Herp Atlas	There is limited potential breeding habitat for Jefferson salamander in the vicinity of Stream Segment 1 and Wetland I, including one small ephemeral pool/depression near Wetland I, the cemetery pond that holds some water, and two other small beaver-created depressions that were observed and also hold some water. The seasonal duration of water in these small depressions is unknown, but likely not suitable for Jefferson salamander breeding. The two beaver-created pools are seasonal and fish-free (no fish were collected in the two stream segments nearest to these pools). The pools may provide potential breeding habitat that could be used by Jefferson salamanders and other amphibians. These are considered marginal breeding habitats due to their location along Segment 1 and because the duration of seasonal water outside the small stream channel is unknown.

Notes:
[1] Federal/State Candidate Species and unlisted rare and vulnerable species screen out and do not warrant an analysis. An impact analysis was conducted for applicable federal/State Threatened and Endangered Species, and State Species of Special Concern.

Summer foraging habitat includes riparian, wetland, bottomland/floodplain, and fragmented upland forests with openings, as well as agricultural areas (Gardner et al. 1991; Miller et al. 2002; Carter 2003).

Suitable foraging habitat exists within the Natural Resource Study Area along the forest edges, wetland fringes, and stream segments. A summer habitat survey was not warranted. However, it is likely that in areas of more mature forest, suitable roosting trees could be found.

Northern Long-eared Bat (Myotis septentrionalis)

The northern long-eared bat (*Myotis septentrionalis*) is a federal and State Threatened Species. Similar to the Indiana bat, this species hibernates in mines and caves (called hibernacula) from as early as August (but more typically October) to March or April when they emerge to forage and begin their dispersal to summer habitat (USFWS 2014b). Foraging habitat includes mature forested areas under the canopy, with occasional foraging taking place over clearings and water, and along roads from sunset and lasting 5 to 8 hours after sunset (Kunz 1973).

Breeding occurs in late summer to early fall and commences when males begin to swarm hibernacula and initiate copulation activity (Kurta 1980). Females store sperm over winter, exhibiting a delayed fertilization strategy, eventually giving birth in late May or early June to a single pup in a maternity colony. Maternity colony selection, in terms of canopy and tree height, is dependent on reproductive stage relative to pre- and post-lactation periods (Kunz 1973). Lactating northern long-eared bats have been shown to roost higher in tall trees situated in areas of relatively less canopy cover and tree density.

The northern long-eared bat is comparable to the Indiana bat in terms of summer roost selection, but appears to be more opportunistic, often using live trees and sometimes man-made structures for roosting habitat (USFWS 2014b). In areas where both species occur, there may be a small amount of roost-selection overlap or competition for roost sites (Foster and Kurta 1999; Timpone et al. 2010).

There are potential roosting and maternity trees that occur and potential foraging habitat is found in wetland areas, along utility ROWs, and in forested areas and clearings in the Natural Resources Study Area.

Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus)

The New York Bight distinct population segment of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is currently listed as Endangered by NMFS and includes sturgeon found in the Hudson River that migrate upriver to spawn. Atlantic sturgeon is a long-lived, estuarine dependent, anadromous fish. Anadromous species are species that migrate into freshwater to spawn then return to estuarine or salt water. Spawning adults migrate upriver beginning in April and May in the mid-Atlantic. Spawning occurs in the saline sections of deep rivers with flowing water in (May to early July) (Smith 1985a). Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within 4 to 6 weeks. Juveniles move downstream and inhabit brackish waters until (October or November) (Smith 1985a). This species typically forages on benthic invertebrates such as crustaceans, worms, and mollusks.

Historically, overharvesting has reduced population numbers, while current threats to the population include by catch, habitat loss and degradation, habitat impediments such as dams, and ship strikes (NOAA 2013).

No potential habitat for Atlantic sturgeon exists within the stream segments of the Natural Resources Study Area, as these watercourses are too shallow to support spawning or foraging activities. There are also some large changes stream segment elevation that would be a barrier to sturgeon movement. Atlantic sturgeon may use habitat in the Hudson River adjacent to the Natural Resources Study Area where Stream Segment 4 discharges into the Hudson River. Because there is no suitable habitat in the within the Natural Resources Study Area itself for Atlantic sturgeon, it was excluded from further analysis. In e-mail correspondence dated September 16, 2015, NMFS indicated that they have no objections to DEP's determination that decommissioning would have no effect on EFH or Endangered Species Act-listed species under NMFS jurisdiction.

Shortnose Sturgeon (Acipenser brevirostrum)

The shortnose sturgeon (*Acipenser brevirostrum*) is a federal and State Threatened Species. It is considered as such throughout its range by NMFS. The shortnose sturgeon is an amphidromous species that spawn in coastal rivers along the east coast of North America from the St. John River in Canada south to the St. Johns River in Florida. As opposed to anadromous species, amphidromous species are born in estuaries or freshwater, drift as larvae into the ocean and before migrating back into freshwater where they grow into adults. The shortnose sturgeon prefers the nearshore marine, estuarine, and riverine habitat of large river systems. This species also typically forages on benthic invertebrates such as crustaceans, worms, and mollusks. Threats to this species are the same as the Atlantic sturgeon (NOAA 2013).

Like the Atlantic sturgeon, there is the potential for shortnose sturgeon to inhabit the adjacent Hudson River where Stream Segment 4 discharges into the Hudson River. There is no suitable habitat for shortnose sturgeon within the Natural Resources Study Area itself because the watercourses are too shallow to support spawning or foraging activities. There are also some large changes in stream segment elevation that would be a barrier to sturgeon movement. Because there is no suitable habitat in the study area for shortnose sturgeon, it was excluded from further analysis. In e-mail correspondence dated September 16, 2015, NMFS indicated that they have no objections to DEP's determination that decommissioning would have no effect on EFH or Endangered Species Act-listed species under NMFS jurisdiction.

Dwarf Wedgemussel (Alasmidonta heterodon)

The dwarf wedgemussel (*Alasmidonta heterodon*) is a federal and State Endangered Species whose habitat typically consists of cool, clear, freshwater brooks and rivers with slow to moderate velocities (USFWS 1993), and silt, sand, and gravel substrates distributed in small areas between downstream areas of larger cobbles and boulders (Strayer and Jirka 1997; Michaelson and Neves 1995). The dwarf wedgemussel reproductive cycle requires host fish, which the mussels parasitize to metamorphose into juveniles. Known host species include tessellated darter, johnny darter (*Etheostoma nigrum*), and mottled sculpin (*Cottus bairdi*)

(Michaelson and Neves 1995). Reasons for the decline of this species include water pollution, habitat loss, and invasive clam species.

The only known populations of dwarf wedgemussel that occur in the State are in the Neversink River and the Delaware River. Even though tessellated darters were collected in Stream Segment 4 of the Natural Resources Study Area, the streams either lack suitable substrate characteristics, are potentially not perennial, or the waters are warmer and more turbid than the waters dwarf wedgemussel prefers. Because there is no potential dwarf wedgemussel habitat in the Natural Resources Study Area, it was excluded from further analysis.

Small Whorled Pogonia (Isotria medeoloides)

The small whorled pogonia (*Isotria medeoloides*) is a federal Threatened and State Endangered plant species. Small whorled pogonia habitat consists of upland sites in mixed-deciduous or mixed-deciduous/coniferous forests that are generally in the second or third growth of successional stages. Sites often include sparse to moderate ground cover, a relatively open understory canopy, and proximity to features that create long-persisting breaks in the forest canopy. Soils associated with small whorled pogonia are usually highly acidic and nutrient poor with moderately high soil moisture values and sometimes with an impervious pan layer (USFWS 1992; NatureServe 2014). Small whorled pogonia cannot persist when the canopy grows in completely and full shade conditions occur. It has been documented to appear in areas following disturbances in the tree canopy such as a gypsy moth outbreak in New Hampshire (Brackley 1991) and a major ice storm in North Carolina (USFWS 1992).

Small whorled pogonia was thought to be extirpated in New York but has recently been rediscovered in Orange County. Identifying this species can be confounding for several reasons. It looks very similar to the large whorled pogonia (*Isotria verticillata*) and the Indian cucumber root (*Medeola virginiana*); all three of these species are often found in the same locations. The small whorled pogonia can go dormant or not flower for as much as 8 years, and when a plant does produce seed, germination requires mycorrhizal fungi to aid in the uptake of soil nutrients, in lieu of a stored food supply (Adamovic 2014).

The acidic sandy loams and impervious pan layer that small whorled pogonia prefers in Orange County are not present in the Natural Resources Study Area. Because there are no suitable soils for small whorled pogonia in the Natural Resources Study Area, it was excluded from further analysis.

Bald Eagle (Haliaeetus leucocephalus)

The Bald Eagle was delisted from the Federal Endangered Species Act in 2007, but Bald Eagles remain federally protected under the BGPA. The Bald Eagle is also a State Threatened Species. Bald Eagles engage in courtship and nest-building in December and fledge young by mid to late summer at about 12 weeks after hatching. Nests are typically several feet wide and located in tall, live trees near water (Nye 2008). Bald Eagles along the Hudson River forage primarily in areas of shallow water such as bays, intertidal marshes and mudflats, along shorelines, and over open water, especially during winter (Thompson and McGarigal 2002). In the winter 2014, three mature and two juvenile Bald Eagles were observed foraging along the tidal reach of Stream Segment 4, and in the Hudson River close to the Natural Resources Study Area.

Bald Eagle populations in New York have grown dramatically over the past few decades. Many Bald Eagles overwinter and forage along the lower Hudson River, where they can be commonly found in large trees (also used for day roosts) along the Hudson River and on ice flows near open water. Overwintering Bald Eagles often congregate in communal night roost trees near the Hudson River. Communal night roosts are in older, dominant trees with open flight paths and clear views of the surroundings.

No nests or suitable nesting sites were observed during site visits completed from 2013 to 2015 in the Natural Resources Study Area; however there are several trees along the Hudson shoreline that provide potential foraging sites and perches for Bald Eagles.

Bog Turtle (Clemmys [= Glyptemys] muhlenbergii)

The bog turtle is a federal Threatened and State Endangered Species, listed by USFWS as occurring in Orange County (known extant populations in Orange County, New York). A NYNHP file search request did not indicate known extant or historic populations of bog turtles on or within 1 mile of the study area (NYNHP Response Letter October 15, 2015).

Based on consultation with USFWS, Phase I, II, and III bog turtle surveys were conducted in the wetlands in the study area (Wetlands I-A and I-B) as described in Section 11.9.5.7, "Terrestrial Resources – Impact Analysis Methodology." Additional details regarding Phase I and II bog turtle survey methodology and results are provided in the Rondout-West Branch Tunnel Roseton Natural Resources Study Area Bog Turtle Habitat Phase I Survey Report (referred to herein as the "Phase I Bog Turtle Survey Report"), which DEP submitted to USFWS on April 3, 2013 and RWBT Roseton Natural Resources Study Area Phase II Visual Assessment for Bog Turtle Report (referred to herein as the "Phase II Bog Turtle Survey Report"), which DEP submitted to USFWS on April 22, 2014. Detailed methodology and results for the Phase III Trapping Surveys are provided in the Rondout-West Branch Tunnel Roseton Habitat Area I and Catskill Aqueduct Repair and Rehabilitation Study Area 8 Phase III Trapping Survey Results for Bog Turtle (referred to herein as the "Phase III Bog Turtle Survey Report"), which DEP submitted to USFWS and NYSDEC on August 25, 2015.

Bog turtle habitat consists of open areas with cool, shallow, slow-moving water, deep, soft, mucky soils, and tussock-forming herbaceous vegetation, such as wetlands (USFWS 2001). Wetlands that provide this suitable bog turtle habitat are usually emergent wetlands characterized by a mosaic of microhabitats that include dry pockets, saturated areas, and areas that are periodically flooded. Bog turtles depend on a diversity of microhabitats for foraging, nesting, basking, hibernation, shelter, and other needs. Throughout the bog turtles' northern range, these wetlands are often seep or spring-fed emergent wetlands located at the headwaters of streams or small tributaries (USFWS 2001). Forested, closed-canopy wetlands are primarily considered unsuitable habitat for bog turtle; however bog turtles may use these areas when moving between suitable habitats within wetlands/wetland complexes. No bog turtles were observed, recorded, or trapped in the Natural Resources Study Area based on Phase I, II, and III surveys conducted in

October 2013, May 2014, and May 2015, respectively; as described above potential bog turtle habitat was found in two wetlands associated with streams (Wetlands I-A and I-B).

State Listed Species

Peregrine Falcon (Falco peregrinus)

The Peregrine Falcon (*Falco peregrinus*) is a State Endangered Species. Populations of Peregrine Falcons in the State have grown dramatically since the 1970s when the population numbers had been decimated by use of the pesticide DDT. Currently, Peregrine Falcon numbers are stable in New York and the species is anticipated to be delisted (Loucks 2008).

Peregrine Falcons traditionally nest on cliff ledges; however, in the Hudson Valley they also commonly nest on man-made structures such as bridges and buildings, and often use nest boxes provided by NYSDEC that are intended to reduce egg loss and increase nest success. Peregrine Falcons generally prefer open landscapes, including over open water, particularly for foraging during the nesting and non-nesting periods. No suitable nesting sites were observed in the Natural Resources Study Area.

The Peregrine Falcon was documented breeding in Block 5760D (which includes the western portion of the study area) in the 2000-2005 New York State Breeding Bird Atlas. Additionally, this species was observed along the Hudson River during previous field surveys.

There is suitable foraging habitat for Peregrine Falcons along the Hudson River within the Natural Resources Study Area. Peregrine Falcons are known to nest on both the Mid-Hudson and Newburgh–Beacon bridges and their respective foraging ranges could include the Natural Resources Study Area.

Cooper's Hawk (Accipiter cooperii)

The Cooper's Hawk is closely related to the Sharp-shinned Hawk and is one of North America's most widespread and common raptors. Cooper's Hawk is a State Species of Special Concern. However, populations in the eastern United States have increased in recent years (Hames and Lowe 2008). In the New York State, the density and range of both breeding and overwintering Cooper's Hawks have increased markedly in recent decades.

Cooper's Hawks generally nest in deciduous and mixed forests, but they are considered relatively tolerant of human disturbance and fragmentation, and are occasionally found nesting in small woodlots and even urban parks. During migration and winter, Cooper's Hawks utilize a variety of forested and open habitats, ranging from large forests to forest openings and fragmented lands. Hunting usually takes place from an inconspicuous perch or from longer, searching flights (Bielefeldt et al. 1992).

Cooper's Hawk was documented in the 2000-2005 Breeding Bird Atlas. A Cooper's Hawk was observed in Wetland A during the October 2012 site visit.

There is potential nesting and stop-over habitat within the Natural Resources Study Area consisting of patches of deciduous forest. Migrating Cooper's Hawks may use stop-over habitat (resting and foraging) for extended periods during the spring and fall migrations and during the winter.

Red-shouldered Hawk (Buteo lineatus)

The Red-shouldered Hawk is a State Species of Special Concern that favors large tracts of mature deciduous and mixed forest in riparian areas or flooded swamps/wetlands (Dykstra et al. 2000). Breeding Bird Atlas data show a steady increase in Red-shouldered Hawk populations, particularly in the Hudson River Valley as farmland has been abandoned and is reverting back to forest habitat (Crocoll 2008; Dykstra et al. 2000). Red-shouldered Hawks occasionally nest in suburban areas where forest cover is less contiguous. Migration and wintering habitats are similar to breeding habitat, although non-breeding birds occur more frequently in fragmented landscapes and open areas than when nesting (Dykstra et al. 2000). When foraging, Red-shouldered Hawks hunt beneath the forest canopy and in open terrain that is moist or close to water. It hunts from perches or from low flights (Palmer 1988).

The forested wetlands and adjacent second growth deciduous forest near Wetland I within the Natural Resources Study Area contain potential Red-shouldered Hawk nesting and foraging habitat. The Red-shouldered Hawk was not documented in the 2000—2005 Breeding Bird Atlas; however, one was observed in Wetland I during the October 2012 site visit.

Sharp-shinned Hawk (Accipiter striatus)

The Sharp-shinned Hawk is a small, migratory hawk that is common and widely distributed across North America. It is a State Species of Special Concern. The Sharp-shinned Hawk was documented in the 2000-2005 New York State Breeding Bird Atlas, including within the Natural Resources Study Area. Sharp-shinned Hawks are most common in the lower Hudson Valley during the spring and fall migration periods (DeOrsey and Butler 2006), and inhabit forested or open woodland habitats that can be deciduous, coniferous, or mixed (AOU 1983). It hunts from inconspicuous perches or by flights along paths or around bushes and trees (Evans 1982).

There is potential nesting habitat within the Natural Resources Study Area including large, dense stands of deciduous forests. The forests can also provide stop-over habitat for migrating Sharp-shinned Hawks and may be used for extended periods during the spring and fall migrations. A Sharp-shinned Hawk was observed in Wetland A during the October 2012 site visit.

Eastern Box Turtle (Terrapene carolina)

The eastern box turtle (*Terrapene carolina*) is a State Species of Special Concern. It is a terrestrial species that uses a variety of habitats from forests with sandy, well-drained soils, dry open uplands such as meadows, pastures, open fields, and utility ROWs, to moist lowlands and wetlands (Gibbs et al. 2007). They are poor swimmers and generally avoid streams and open waters. Eastern box turtles typically have small home ranges. Eastern box turtles were observed during the first EIS natural resource surveys, located west of the Natural Resources Study Area.

Eastern box turtles were observed within the study area during the Phase I, II, and III bog turtle surveys from 2012 to 2015. At least five different eastern box turtles were captured (some were captured multiple times) during the 2013 Phase II bog turtle surveys. The individuals were located within Wetlands A, B, C, D, and E. A box turtle was also observed in Wetland A during wetland delineations completed in 2015, and during the 2015 Phase III bog turtle survey at Wetland I.

Spotted Turtle (Clemmys guttata)

The spotted turtle is a State Species of Special Concern that inhabits marshy meadows, bogs, swamps, ponds, ditches, and other small bodies of still water. Individuals are usually active from March to October, with the breeding season extending from March to May. At the end of the breeding season, females leave breeding pools in search of nesting areas that typically comprise open, sunny areas such as meadows, fields, or road edges (Gibbs et al. 2007).

No spotted turtles were observed during the Phase I, II, and III bog turtle surveys or during the stream surveys for fish and benthic and aquatic invertebrates and wetland delineation surveys. Spotted turtle presence/absence surveys were conducted during spring 2015 to determine if this species is using aquatic and wetland habitats in the Natural Resources Study Area. These surveys were conducted on April 28, May 12 and 26, and June 3, 2015, along Stream Segments 1, 2, 3, and 4 and in adjacent wetlands within the Natural Resources Study Area. These surveys were completed when spotted turtles would likely be active and/or basking in appropriate habitats. No spotted turtles were found during these surveys.

Although the existing Natural Resources Study Area habitats could potentially be used by spotted turtles, these habitats are marginal. Higher flows and limited riparian habitat adjacent to Stream Segment 4 make this unsuitable for spotted turtles. Close proximity to River Road to the west and industrial property to the east further decreases the habitat value. Stream Segments 1 and 2 and adjacent wetlands may provide potential habitat for spotted turtles. However the lack of vernal pools may limit its suitability. High flows and lack of vernal pools also greatly limits the habitat suitability of Stream Segment 3 for spotted turtle.

The 2015 spotted turtle survey results indicate that it is unlikely that this species is present in the Natural Resources Study Area. This conclusion is further supported by the Phase I, II, and Phase III bog turtle surveys, the wetland and watercourse delineation, and other site surveys conducted in 2013 and 2015, respectively.

Wood Turtle (Glyptemys insculpta)

The wood turtle is a State Species of Special Concern. Wood turtles have large home ranges and typically inhabit riverside or streamside environments bordered by woodlands or meadows and utilize open sites with low canopy cover (Gibbs et al. 2007). Individuals bask along stream banks and hibernate in creeks.

No wood turtles were observed during the Phase I, II, and III bog turtle surveys or during the stream surveys for fish and benthic and aquatic invertebrates and wetland delineation surveys. Wood turtle presence/absence surveys were conducted during spring 2015 to determine if this species is using aquatic and wetland habitats in the Natural Resources Study Area. These surveys were conducted on April 28, May 12 and 26, and June 3, 2015, along Stream Segments 1, 2, 3, and 4 and in adjacent wetlands within the study area. These surveys were completed when wood turtles would likely be active and/or basking in appropriate habitats. No wood turtles were found during these surveys.

Stream Segments 1 and 2 are considered marginal habitat for wood turtles, primarily due to the shallow (less than 1 foot deep and 6 to 10 foot wide) depth and low-flow conditions, and due to restricted in stream cover for wood turtles. The adjacent habitat in Wetlands I and G does provide suitable riparian habitat for wood turtles. The habitat adjacent to Wetland I has limited basking sites and the streamcourse is too small to provide hibernating sites. Wetland G contains a large stand of common reed and borders River Road. Stream Segment 3 and associated wetlands could also provide marginal wood turtle habitat. Although the existing study area habitats could be used by wood turtles, these habitats are considered marginal habitats. Stream Segment 3 is also bordered by stands of common reed (portions) and does not have the undercut banks needed for hibernating sites. Higher flows and limited riparian habitat adjacent to Stream Segment 4, with close proximity to River Road to the west and industrial property to the east make this marginal habitat for wood turtles.

The 2015 wood turtle survey results indicate that it is unlikely that this species is present in the Natural Resources Study Area. This conclusion is further supported by the Phase I, II, and Phase III bog turtle surveys conducted in 2013 and 2015 and the wetlands delineation, electrofishing, and Odonate surveys where no wood turtles were observed.

Jefferson Salamander (Ambystoma jeffersonianum)

The Jefferson salamander is a State Species of Special Concern. This species primarily inhabits large tracts of upland deciduous and mixed-deciduous/coniferous forests with abundant stumps and logs. In these habitats they are generally subterranean, burying in small mammal burrows, under leaf litter, and decaying logs (Gibbs et al. 2007). Breeding occurs in early spring in ephemeral pools and semi-permanent wetlands with emergent vegetation. Jefferson salamander was documented previously west of the Natural Resources Study Area in the Herp Atlas. No Jefferson salamanders were observed during field surveys within the study area.

Habitat that could potentially support Jefferson salamanders is limited in the Natural Resources Study Area. There is one small depression/ephemeral pool proximate to Stream Segment 1 and Wetland I. Also, there is a small pond on the cemetery site, and two other small beaver-created depressions that hold water. The seasonal duration of inundation of these features is unknown. However, the beaver-created pools are most likely fish-free and have the potential to support Jefferson salamander breeding.

11.9.5.17 Geology and Soils – Baseline Conditions

As described previously, a portion of the water leaking from the RWBT currently flows from the tunnel through the bedrock into the unconsolidated aquifer laterally and towards the ground surface. The upward flow raises the potentiometric water level (added pressure) in the bedrock and raises the piezometric water level in the unconsolidated aquifer above the water level that would have occurred naturally before construction of the RWBT. It could also be contributing to changes in geology and soils in the Roseton Study Area that have occurred since the RWBT began leaking. These changes include flushing of soil-filled voids in the bedrock, enlargement of subsurface flow channels in the bedrock, and softening of the fine-grained lacustrine soils due to upwards water flow (see Section 11.9.2, “Description of Rondout-West Branch Tunnel Decommissioning,” and Section 11.9.3, “Roseton Study Area: Location and Description,” for further information).

The influence of this upward flow on geology and soils is used in this analysis as the baseline conditions of the geology and soils within the Roseton Study Area. As described in Section 11.9.3, “Roseton Study Area: Location and Description,” the Roseton Study Area was initially found to be appropriate for all assessment categories. Therefore, the baseline conditions of geology and soils within the Roseton Study Area were developed based on the methodology described in Section 11.9.5.9, “Geology and Soils – Impact Analysis Methodology.” They are described in Section 11.9.5.17 “Geology and Soils – Baseline Conditions,” to provide context to the description of groundwater in the study area, and are also further described below.

Surficial Geology

The more recent geologic history of the region is dominated by Pleistocene continental glaciation, which reached its maximum southern extent approximately 20,000 years before present in this area. The various episodes of glaciation account for much of the surficial geology within the Roseton Study Area. **Figure 11.9-17** presents the surficial geology based on the Surficial Geology Map of New York (New York State Museum 1989). The Roseton Study Area is very close to an area that was historically the southernmost extent of a large glacial lake formed in the Hudson River Valley, known as Lake Albany. Lake Albany extended from approximately Glens Falls, Warren County, New York, to Newburgh, and existed from approximately 15,000 to 12,600 years before present.

The thick sequence of Lake Albany glacial lake clays, silts, and sands found in this area ranges from approximately 75 to 85 feet in thickness. These glacial lake deposits tend to exist within the low-lying elevations (0 to 60 feet above mean sea level) of the Roseton Study Area on the valley bottom in close proximity to the Hudson River. At higher elevations along the uplands, the clays, silts, and sands grade into glacial till. In most areas, this contact between the lake deposits and till is not visible, but the Surficial Geology Map of New York (New York State Museum 1989) depicted on **Figure 11.9-17** is a reasonable approximation of where the surficial geology transitions from lake deposits to till.

The valley that was cut into the Wappinger Group trends north to south through the lower elevations of the study area (see **Figure 11.9-16**). The valley, which holds a majority of the known surface expressions, is filled by unconsolidated material and is drained by Roseton Brook, south of River and Danskammer Roads. DEP investigations indicate that the unconsolidated materials are dominated by thin layers of silt, silty clay, clayey silt, clay, and sand. The sand content increases closer to the bedrock surface. In the southern part of the valley, the unconsolidated deposits are dominated by clay, which was the source material for the Roseton brick works that previously existed within the Roseton Study Area.

A general description of the geologic layers within the Estimated Unconsolidated Aquifer Groundwater Influence Area is provided below (see also **Figure 11.9-17**).

- **Fill:** Fill material in the Roseton Study Area was deposited by human activities. Fill generally consists of varying amounts of fine to coarse sand and gravel, silty to clayey sand, low to high plasticity silt and clay, and occasional boulders and cobbles. The fill also contains variable amounts of construction debris, including brick, slag, and rock fragments. In some areas, the fill may contain organic material. The fill was likely placed by a range of methods, including dumping and hydraulic filling.

- **Organic soils**: An organic layer was encountered in the Estimated Unconsolidated Aquifer Groundwater Influence Area, approximately 750 to 2,000 feet from RWBT. The organic materials varied in thickness from approximately 4 to 7 feet and are composed of peat, wood, and decaying organic matter. It is likely that the organic layer that underlies the fill is remnants of a streambed or marshy area that was filled by development of the land. In addition organic soils were encountered in a historic boring in the vicinity of Roseton Brook (GWP-9).

- **Estuarine Deposit:** The estuarine deposits are composed of a thick upper layer/lens of very soft to very stiff, low plasticity clay with silt and sand interbeds. With depth, the deposit is more coarse grained, characterized predominantly by loose to very dense silt and silty sand layers with clay interbeds.

- **Glacial Till:** The glacial till consists of silty sand with gravel to sandy gravel with silt. It is found below the estuarine deposit where present and over the bedrock in the upland areas.

- **Bedrock:** The bedrock elevation changes abruptly across the area, with depths ranging along the RWBT alignment from above the ground surface (visible outcrops in the vicinity of the power plants) to greater than 180 feet at the Hudson River.

Bedrock Geology

The Roseton Study Area is located in the Hudson-Mohawk Lowlands between the Hudson Valley Fold-Thrust Belt to the west and the Hudson Highlands to the east. The bedrock units found in this province are composed of upper Cambrian to middle Ordovician aged strata (500 to 450 million years before present) (Marshak 1989).

The bedrock formations found in the Roseton Study Area (from west to east along the alignment of the RWBT and bypass tunnel) include, from youngest to oldest, the Normanskill Formation, the Wappinger Group, and the Mount Merino Formation (see **Figure 11.9-55**). The contact between the Normanskill Formation and the Wappinger Group roughly follows U.S. Route 9W just to the east of the Roseton Study Area. The contact between the Wappinger Group and Mount Merino Formation is beneath the Hudson River. Outcrops of the Wappinger Group are found in several locations within the Roseton Study Area, most notably along River Road, Old Post Road, and on the eastern side of the power plant properties.

The Normanskill Formation in the vicinity of the Roseton Study Area consists of shale, a fine-grained sedimentary rock formed by compaction and consolidation of clay, silt, and mud. The shale has been extensively folded and faulted resulting in the formation of a series of minor fractures oriented according to the main fault zone that passes through the Roseton Study Area (see **Figure 11.9-55**). Within the prominent fault zone, the shale is often crushed, and the fault is filled with mud.

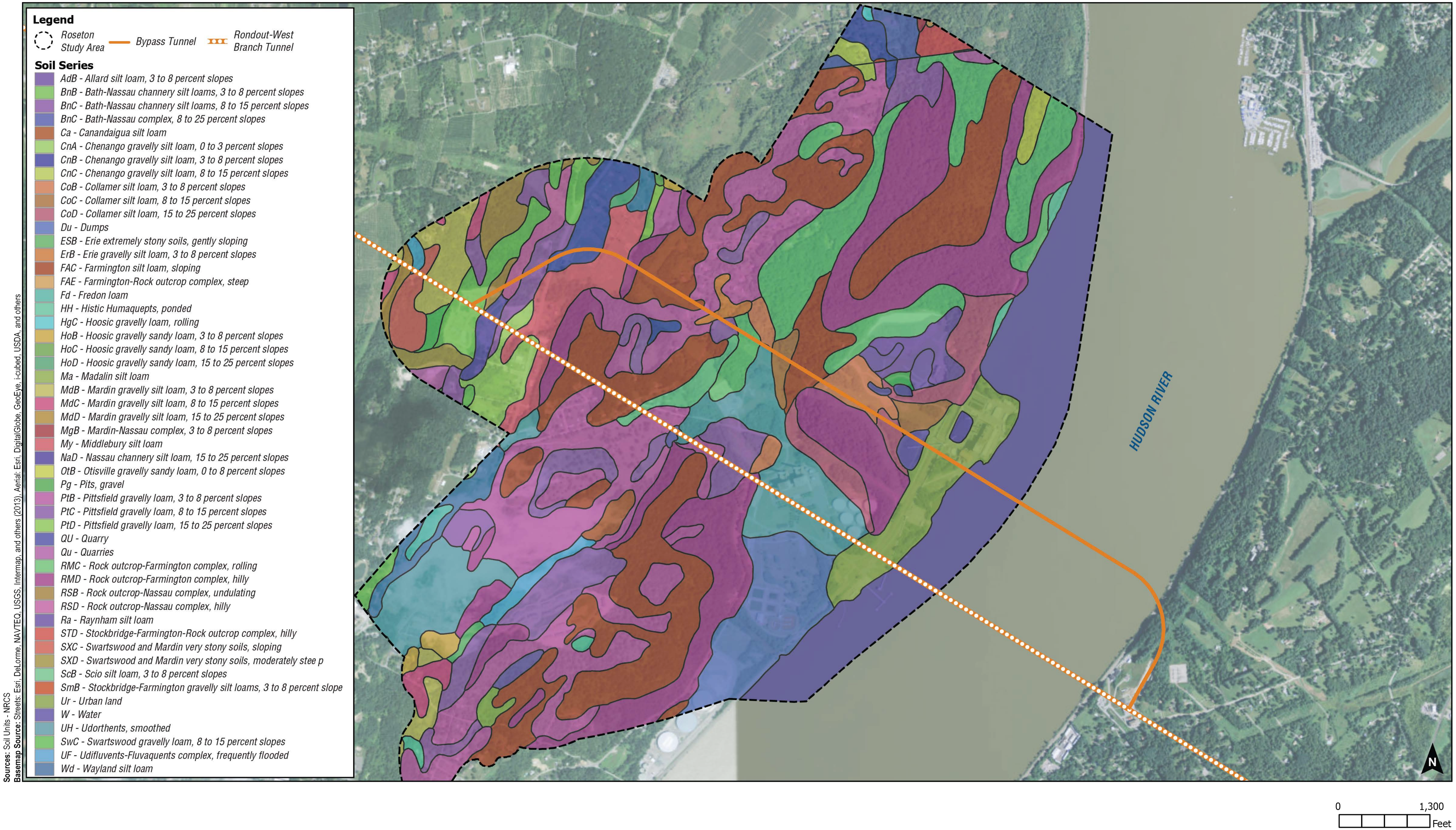


Figure 11.9-55: Soil Map – Roseton Study Area

The primary rock types of the Wappinger Group in the Roseton Study Area are dolostone, dolomitic limestone, and limestone. Typically, the rocks of the Wappinger Group are competent, except in areas that are heavily faulted or folded. In these areas, the rock quality can be poor due to a combination of tectonic forces and the dissolution of the calcium carbonate matrix by groundwater. In areas where the rock quality is low, the rock is often highly fractured, very soft, and disintegrated. Although cavities can be found in the Wappinger Group, these cavities have not developed into well-connected caves or a highly developed solution channel network for groundwater within the Roseton Study Area.

Original RWBT investigations and construction drawings revealed that bedrock formations are heavily deformed in the region, with one major fault zone intersecting the RWBT (Roseton Fault) and several other fault zones intersecting the tunnel just east of the Roseton Fault. This heavily deformed bedrock was recognized prior to tunnel construction and a steel lining was installed in this section of the tunnel. It is in this area where the bedrock is highly fractured and faulted, and is allowing groundwater to move through these more transmissive paths, which can eventually reach the ground surface. In some sections of the Roseton Study Area, the pressure within the RWBT is also sufficient to allow the leaking water to discharge at the ground surface, previously defined as surface expressions (see Section 11.9.2, “Description of Rondout-West Branch Tunnel Decommissioning,” and Section 11.9.5, “Natural Resources”). Although surface expressions from the leaks may have existed for many years, the presence of the surface expressions was first visibly noticed in 1988, and subsequent dye testing confirmed the RWBT as their source in the 1990s (see **Figure 11.9-6**).

Surficial Soils

The majority of the surficial soils in the Roseton Study Area are loams, a mixture of sand, silt, and clay. The parent materials of many of the noted soils are sands, silts, and clays deposited in or around the shores of the former glacial Lake Albany at the end of the last Ice Age.

Beginning in the nineteenth century and ending in the early part of the twentieth century, the area along the Hudson River was used for brick manufacturing. These were large-scale operations that altered the soils in the area such that the soils are now classified as udorthents (Uh), dump (Du), and urban land (Ur). The udorthents are cut and fill areas (former quarries), while the Du and Ur soil classifications are largely composed of broken and crushed brick fragments that were used as fill.

According to the USDA NRCS, the Roseton Study Area contains multiple varieties of soil series (soils derived from similar parent material and in similar conditions; see **Figure 11.9-55**). The 29 dominant soil series found with the Roseton Study Area are identified and described in **Table 11.9-29**.

Table 11.9-29: USDA Soil Series for the Roseton Study Area

Soil Series Name	Soil Series Description
Allard silt loam, 3 to 8 percent slopes (adB)	Deep, well-drained, gently sloping soil formed in silty deposits over sandy or gravelly glacial outwash deposits. It is on undulating terraces and convex benches along valley floors and on plains.
Bath-Nassau channery silt loams, 3 to 8 percent (BnB), 8 to 15 percent (BnC), 8 to 25 percent (BnC)	Soil complex consisting of deep, well-drained soils and shallow, somewhat excessively drained soils that formed in glacial till deposits derived from shale and slate.
Canandaigua silt loam (Ca)	Deep, nearly level, poorly drained soil formed in glacial lake deposits, dominated by clay, silt, and very fine sand.
Chenango gravelly silt loam, 0 to 3 percent (CnA), 3 to 8 percent slopes (CnB), 8 to 15 percent (CnC)	Deep, well-drained to somewhat excessively drained, gently sloping soil formed in glacial outwash deposits that have high gravel content.
Collamer silt loam, 3 to 8 percent slopes (CoB), 8 to 15 percent slopes (CoC), and 15 to 25 percent slopes (CoD)	Deep, moderately well-drained, gently sloping soil formed in glacial lake deposits that have high silt contents of silt and very fine sand.
Dumps (Du)	Miscellaneous areas consisting mostly of excavations that have been filled (or are being filled) with refuse and trash. In this area, refuse is largely broken and crushed bricks used as fill many years ago.
Erie extremely stony soils, gently sloping (ESB)	Deep, somewhat poorly drained due to a shallow fragipan, gently sloping soils. They formed in glacial till deposits derived from shale, slate, and sandstone.
Erie gravelly silt loam, 0 to 3 percent slopes (ErA), and 3 to 8 percent slopes (ErB)	Deep, somewhat poorly drained due to a shallow fragipan. Nearly level, it formed in glacial till deposits derived from shale, slate, and sandstone. It occurs as broad, flat hilltops and foot slopes of the uplands.
Farmington silt loam, sloping (FAC)	Shallow, well-drained, sloping and gently sloping soil. Formed in glacial till deposits derived from limestone, shale, slate, and siltstone.
Fredon loam (Fd)	Deep, somewhat poorly drained, nearly level soil formed in glacial outwash deposits that have a high content of sand and gravel. It is on low terraces and outwash plains along valley floors in lowlands.
Histic Humaquepts, ponded (HH)	Deep, very poorly drained, level mineral soils capped with a thin layer of organic soil material.
Hoosic gravelly sandy loam, 3 to 8 percent slopes (HoB), 15 to 25 percent slopes (HoD)	Deep, somewhat excessively drained, gently sloping soil formed in glacial outwash deposits that have a high content of sand and gravel.
Madalin silt loam (Ma)	Deep, poorly drained and very poorly drained, nearly level soil formed in glacial lake deposits of silt and clay.
Mardin gravelly silt loam, 3 to 8 percent slopes (MdB), and 8 to 15 percent slopes (MdC)	Deep, moderately well-drained, gently sloping soil formed in glacial till deposits derived from sandstone, shale, and slate, with a dense fragipan in the subsoil.
Middlebury silt loam (My)	Deep, moderately well-drained to somewhat poorly drained, nearly level soil formed in recent silty alluvial deposits. It is on flood plains adjacent to streams that flood periodically.
Nassau channery silt loam, 15 to 25 percent slopes (NaD)	Shallow, somewhat excessively drained, moderately steep soil formed in glacial till deposits derived from slate and shale. It is on hillsides and valley sides in uplands.

Table 11.9-29: USDA Soil Series for the Roseton Study Area

Soil Series Name	Soil Series Description
Otisville gravelly sandy loam, 0 to 8 percent slopes (OtB)	Deep, excessively drained, nearly level to gently sloping soil formed in glacial outwash deposits that are dominantly sand and gravel.
Pits, gravel (Pg)	Excavations mainly in gravelly and sandy glacial outwash deposits. The pits were created by removing gravel and sand for construction. They are 3 to 50 feet deep. The sides are generally steep and the floor is relatively level.
Pittsfield gravelly loam, 3 to 8 percent (PtB), and 8 to 15 percent (PtC), 15 to 25 percent slopes (PtD)	Deep, well-drained, gently sloping soil formed in glacial till deposits derived from limestone and schist.
Rock Outcrop-Farmington complex, rolling (RMC) and Farmington complex, hilly (RMD)	Complex of exposed bedrock and shallow, somewhat excessively drained to well-drained Farmington soils found on hills, knolls, and ridges in uplands. The Farmington soil formed in a thin mantle of glacial till deposits over limestone or limy shale bedrock. Slopes range from 3 to 25 percent.
Rock outcrop-Nassau complex, undulating (RSB), hilly (RSD)	Complex consisting of exposed bedrock and shallow, somewhat excessively drained Nassau soil. It is on upland hills, ridge sides, and valley sides that have irregular sloping topography. The Nassau soil formed in a thin mantle of glacial till deposits over shale or slate bedrock.
Raynham silt loam (Ra)	Deep, moderately well-drained, gently sloping soil formed in glacial lake-laid deposits that are dominantly silt and very fine sand.
Swartswood and Mardin very stony soils, sloping (SXC), moderately steep (SXD)	Well-drained and moderately well-drained Swartswood soil and moderately well-drained Mardin soil. Some areas are Swartswood soil, others are Mardin soil, and a few include both soils. These deep soils have fragipan. They formed in glacial till deposits on hillsides and ridges in uplands.
Scio silt loam, 3 to 8 percent slopes (ScB)	Deep, moderately well-drained, gently sloping soil formed in glacial lake-laid deposits that are dominantly silt and very fine sand.
Swartswood gravelly loam, 8 to 15 percent (SWC)	Deep, well-drained and moderately well-drained, sloping soil formed in glacial till deposits derived from gray and brown conglomerate and sandstone. It has a fragipan in the lower part of the subsoil. It is on convex hill crests, hillsides, and ridges in uplands. Areas are mostly oval and 10 to 20 acres.
Udifluvents-Fluvaquents complex, frequently flooded (UF)	Commonly termed alluvial land. It consists of deep, well-drained to very poorly drained, nearly level to gently sloping soils that formed in recent alluvial deposits.
Udorthents, smoothed (UH)	Soils formed in man-made cut and fill areas, which are generally near industrial sites, urban developments, or other construction sites. They consist of excavated earthy material that has been stockpiled for eventual use as fill or topdressing; soil and rock material that has been trucked from other areas and leveled; or soil left in areas that have been excavated or cut.
Urban land (UR)	Areas where at least 80 percent of the surface is covered with asphalt, concrete, other impervious materials, or buildings. These areas are mostly parking lots, shopping centers, industrial parks, and business centers in villages and cities.

Table 11.9-29: USDA Soil Series for the Roseton Study Area

Soil Series Name	Soil Series Description
Wayland silt loam (Wd)	Deep, poorly drained and very poorly drained, nearly level soil formed in silty alluvial deposits. It is on low floodplains adjacent to streams that overflow. The slope is no more than 3 percent. Areas are oval or long and narrow and are mostly 5 to 15 acres.
Source: U.S. Department of Agriculture. 2013. Natural Resources Conservation Service Soil Survey Custom Soil Report.	

Field Investigations

The initial field observations, remote sensing data sets (LiDAR survey, orthoimagery, and thermal imagery) and geophysical survey (ground penetrating radar) results confirm that the conditions of the geology and soils in the Roseton Study Area are consistent with results from desktop review of available information for the Roseton Study Area, as well as site observations. Specifically, the following were confirmed:

- No localized or more regional elevation changes associated with the RWBT have occurred since 2012 (2012 LiDAR data compared to the 2014 data);
- RWBT linked surface expressions are the same as previously identified based on the thermal imaging showing the water flowing from them is warmer than the normal, seasonal site drainage features; and
- No new or developing changes to geology are present in near surface soils along the geophysical survey lines since 2009 (2009 ground penetrating radar data compared to the 2014 data).

11.9.5.18 Groundwater – Future Without Decommissioning

In the future without decommissioning, the RWBT would continue to leak water into the bedrock aquifer. This water would continue to be transmitted through the bedrock aquifer into the unconsolidated aquifer ultimately discharge to surface water and Hudson River.

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no planned projects that would affect groundwater resources are anticipated within the Roseton Study Area within the timeframe of the impact analysis. The features that together characterize groundwater resources, including aquifer classifications, regional groundwater flow directions and aquifers, users, recharge and discharge areas within the Roseton Study Area would be the same as baseline conditions in the future without decommissioning. Groundwater levels and quality in the Roseton Study Area would also be expected to remain as described above under baseline conditions.

In the future without decommissioning, few, if any, future changes would be expected. The groundwater system has been sustained by a steady input of leak water that has contributed to the water levels and water quality in the study area since the RWBT began leaking, and the flows and quality of the leak water are relatively consistent.

Therefore, in the future without decommissioning, it is assumed that groundwater levels within the Roseton Study Area would be the same as baseline conditions.

11.9.5.19 Surface Water – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no projects or developments that would affect surface water resources are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. Because DEP's monitoring efforts have indicated a stream system sustained by a steady input of aqueduct water with little natural variation since at least the beginning of the monitoring in 2008, there would be few, if any, future changes expected. Consistent leak flow from the RWBT has shaped the leak-affected portions of the Natural Resource Study Area into a highly atypical but stable watercourse and wetland system.

Without decommissioning, baseflows and water levels would continue to be elevated from leak water contributions. Water temperatures would continue to be influenced by leak water that is cooler and more stable than naturally occurring groundwater for much of the year. This would prevent affected watercourses from experiencing the full range of natural fluctuations and responses to temperature (such as freezing and thawing) that unaffected segments experience. Without decommissioning, conductivity would likely remain abnormally low, and dissolved oxygen would likely remain artificially elevated in comparison to natural streams without leak water influence.

Therefore, in the future without decommissioning, it is assumed that surface water resources in the Natural Resources Study Area would generally remain the same as those of baseline conditions.

11.9.5.20 Wetlands – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no projects or developments that would affect wetlands or shallow groundwater resources are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. The features that together characterize the shallow groundwater resources (i.e., existing shallow groundwater levels and shallow groundwater discharge to surface water, wetlands, and surface expressions) within the Natural Resources Study Area would be the same as baseline conditions. Because the wetland system has been sustained by a steady input of RWBT leak water for several decades, there would be few, if any, future successional changes expected to wetlands. It is likely that all successional changes to this system took place shortly after the RWBT began to leak and have stabilized, as exhibited by baseline conditions. Consistent flow and temperatures from the leak water have shaped affected portions of the Natural Resource Study Area into an atypical but stable wetland system. Without decommissioning, baseflows would continue to be higher and shallow groundwater levels would continue to be elevated as influenced by the leaks.

Therefore, in the future without decommissioning, it is assumed that the wetlands and shallow groundwater resources within the Natural Resources Study Area would generally remain the same as that of baseline conditions.

11.9.5.21 Floodplains – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no projects or developments are anticipated to occur within the Natural Resources Study Area within the timeframe of the impact analysis. Therefore, in the future without decommissioning, it is assumed that the future conditions of floodplain resources within the Natural Resources Study Area would generally remain the same as that of baseline conditions indicated in the FEMA 2010 floodplain maps.

11.9.5.22 Aquatic and Benthic Resources – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new project or developments are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. The leak water would continue to contribute to the baseflow of the streams and they would also experience very little natural seasonal and precipitation based variations. Without decommissioning, any future successional changes expected in the fish and benthic invertebrate communities from decommissioning would be incremental and any effects muted by prior land use and ongoing land uses in the Natural Resources Study Area watershed. Therefore, in the future without decommissioning, it is assumed that aquatic and benthic resources for all stream segments within the Natural Resources Study Area would generally remain the same as that of baseline conditions.

11.9.5.23 Terrestrial Resources – Future Without Decommissioning

Ecological Communities

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new project or developments that would affect ecological communities are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. Natural processes, such as changes in habitat due to natural vegetative succession, are anticipated to continue. Therefore, in the future without decommissioning, it is assumed that ecological communities within the Natural Resources Study Area would generally remain the same as that of baseline conditions with changes only occurring due to natural succession.

Wildlife

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new project or developments that would affect wildlife are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. Natural processes, such as changes in habitat due to natural vegetative succession, are anticipated to continue. Therefore, in the future without decommissioning, it is assumed that wildlife within the Natural Resources Study Area would generally remain the same as that of baseline conditions with changes only occurring due to natural succession of habitat.

11.9.5.24 Federal/State Threatened and Endangered Species, and State Species of Special Concern – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new project or developments that would affect federal/State Threatened, Endangered, and State Species of Special Concern are anticipated within the Natural Resources Study Area within the timeframe of the impact analysis. Natural processes, such as changes in habitat due to natural vegetative succession, are anticipated to continue. Therefore, in the future without decommissioning, it is assumed that the federal/State Threatened, Endangered, and State Species of Special Concern within the Natural Resources Study Area would generally remain the same as that of baseline conditions with changes only occurring due to natural succession of habitat.

11.9.5.25 Geology and Soils – Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new project or developments are anticipated within the Roseton Study Area within the timeframe of the impact analysis. In the future without decommissioning, the leak water would continue to flow through the highly fractured bedrock. Therefore, it is assumed that geology and soil resources within the Roseton Study would not be significantly different than baseline conditions in the future without decommissioning.

11.9.5.26 Groundwater – Probable Impacts With Decommissioning

Decommissioning would result in the cessation of leaks that contribute approximately 15 mgd of water to the unconsolidated and bedrock aquifers and affect the local groundwater resources within the Roseton Study Area.

Potential impacts are expected to occur at the start of the temporary shutdown when the RWBT would be unwatered. Potentiometric water level in the bedrock aquifer and the water table in the unconsolidated aquifer would begin to decline when the RWBT is unwatered. The groundwater flow model was used to estimate the area that could potentially be affected during the temporary shutdown and over the long term after decommissioning in the unconsolidated and bedrock aquifers.

Probable Impacts During the Temporary Shutdown

When the RWBT would be unwatered and maintained in an unwatered state over the temporary shutdown, the HGL within the RWBT would be approximately 600 feet below mean sea level (see **Figure 11.9-9**). During this period, a measurable decline in groundwater levels could occur within hours or days of the start of the temporary shutdown.

The groundwater flow model was used to simulate the RWBT temporary shutdown. Results showed groundwater levels in the unconsolidated aquifer could decline during the temporary shutdown in areas south of the RWBT Bypass between the east side of the cemetery and the Hudson River. The area that would experience the largest change in water levels would be the area along the RWBT between River Road and the Hudson River. The Estimated Unconsolidated Aquifer Groundwater Influence Area during the temporary shutdown is shown on **Figure 11.9-56**.

No actively used water supply wells are located within the area of largest estimated groundwater level decline in the unconsolidated aquifer. One water supply well is located within the area of largest estimated groundwater level decline; however, this well is not actively used. The potential for impacts to water supply wells are further described in Section 11.9.13, "Water and Sewer Infrastructure."

The groundwater flow model results also show that groundwater levels in the bedrock aquifer would decline during unwatering in areas south of the RWBT Bypass between the east side of the cemetery and the Hudson River. The area that would experience the largest change in groundwater levels would also be the area along the RWBT between River Road and the Hudson River. The Estimated Bedrock Aquifer Groundwater Influence Area during the temporary shutdown is shown on **Figure 11.9-57**.

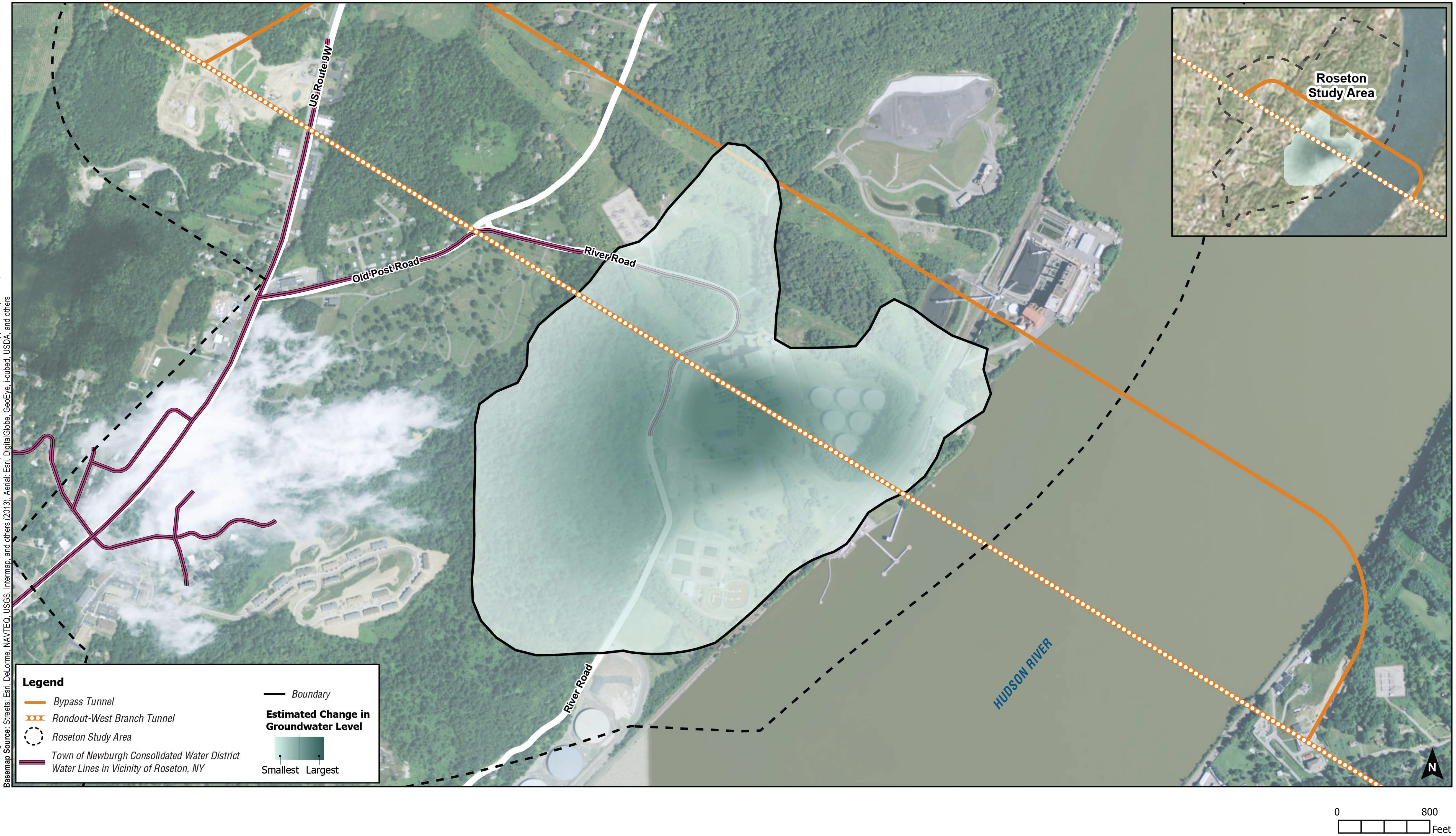
Probable Impacts Over the Long Term After Decommissioning

Once the RWBT returns to service following connection of the bypass tunnel, the water level in the unconsolidated and bedrock aquifers is expected to return to the water level before RWBT construction and stabilize at a level that balances groundwater recharge, physical properties of the aquifer, and aquifer discharge.

The groundwater flow model was used to simulated changes in groundwater levels that could occur over the long term after decommissioning when a new equilibrium would be reached and water levels return to conditions that likely existed before RWBT construction. Under this condition, the groundwater system would no longer be influenced by the leaks, and the natural patterns of groundwater flow would resume based on the new groundwater levels in the unconsolidated and bedrock aquifers.

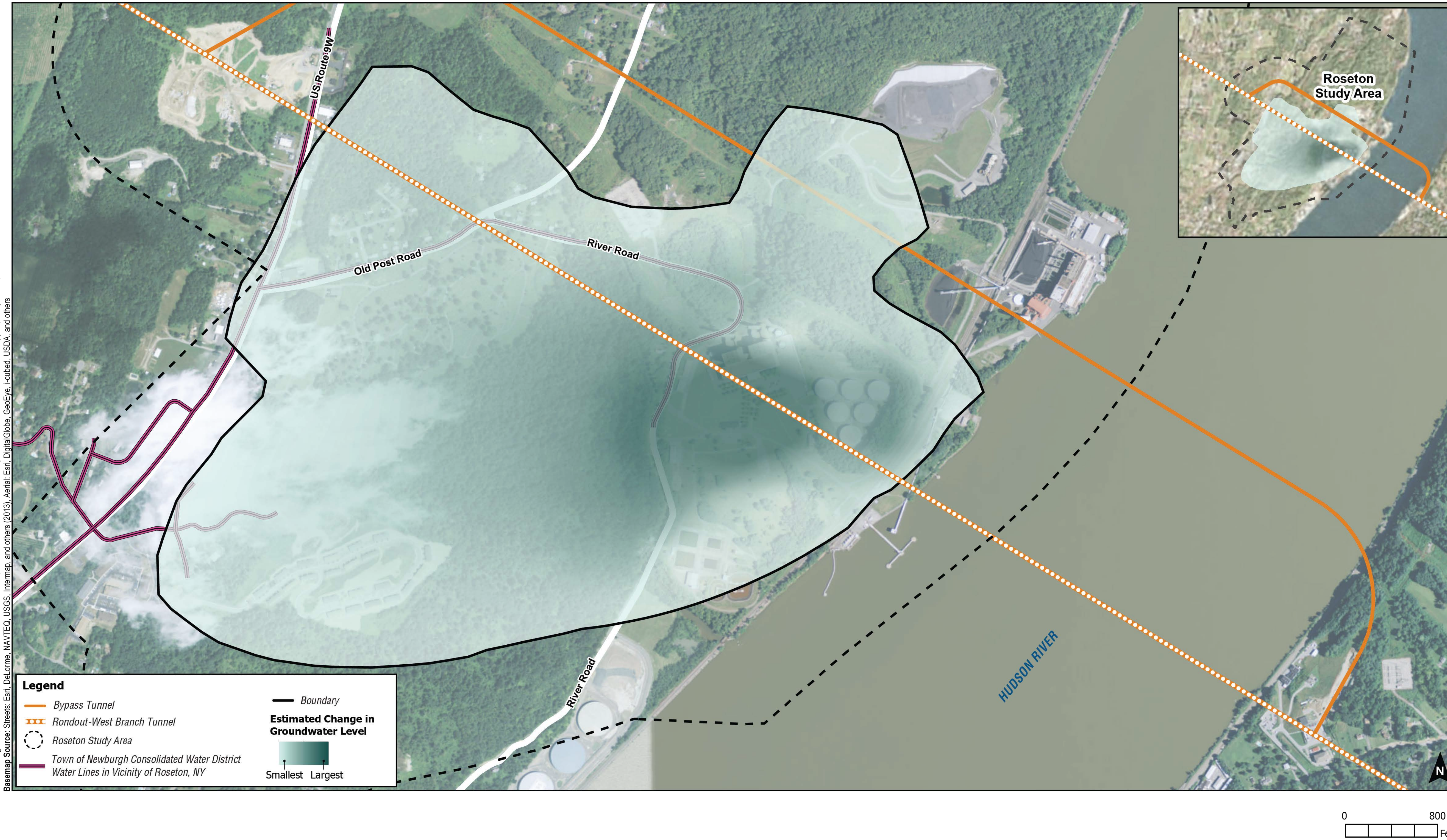
Results of the groundwater flow model analysis show groundwater levels in the unconsolidated aquifer could decline in areas south of the RWBT Bypass between the east side of the cemetery and the Hudson River. The area that would experience the largest change in water levels would be the area along the RWBT between River Road and the Hudson River. The Estimated Unconsolidated Aquifer Groundwater Influence Area over the long term after decommissioning is shown on **Figure 11.9-58**.

The groundwater model results also show that groundwater levels in the bedrock aquifer would decline over the long term after decommissioning in areas south of the RWBT Bypass between the east side of the cemetery and the Hudson River. The area that would experience the largest change in groundwater levels would be the area along the RWBT between River Road and the Hudson River. The Estimated Bedrock Aquifer Groundwater Influence Area over the long term after decommissioning is shown on **Figure 11.9-59.**



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

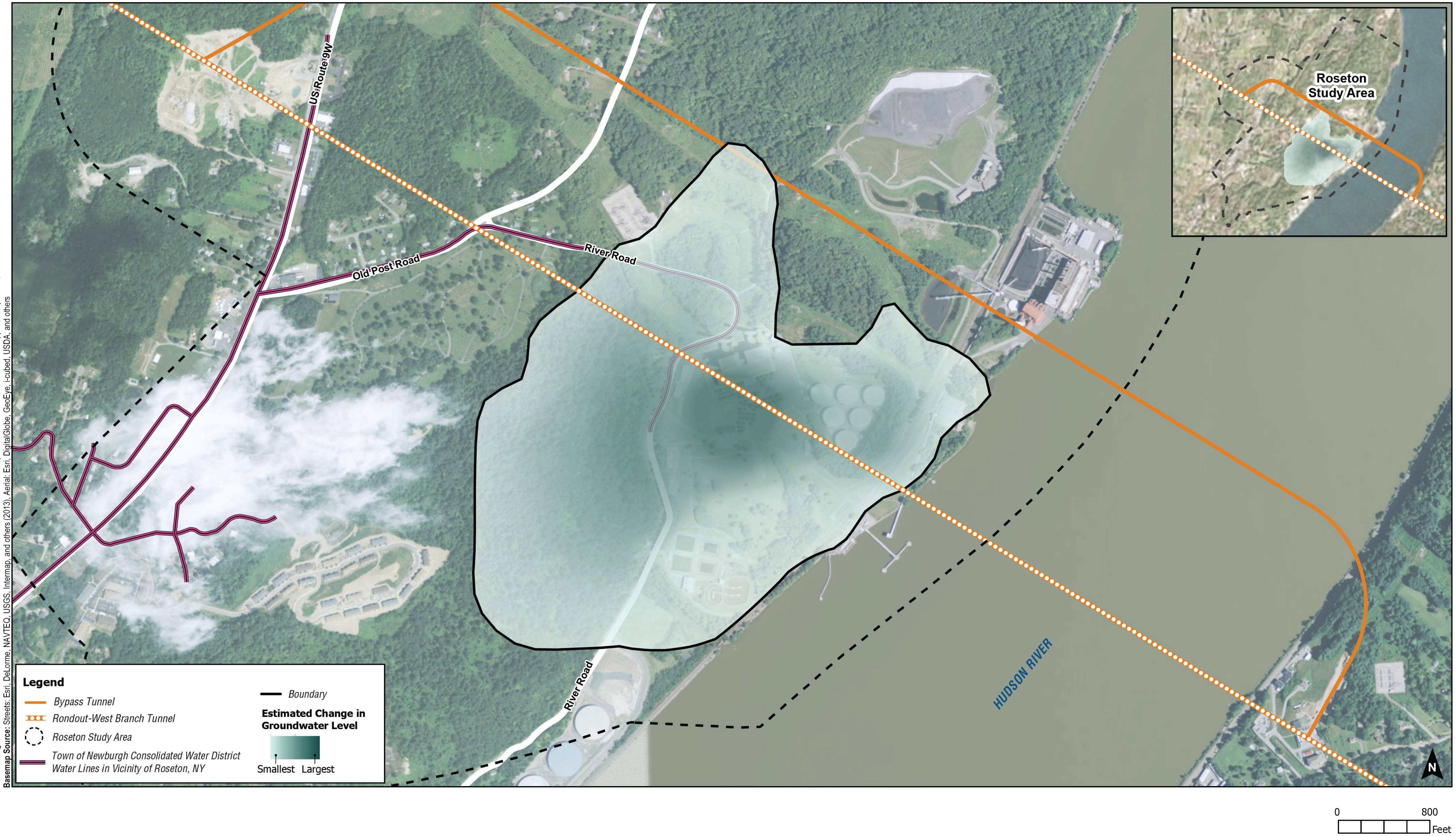
Figure 11.9-56: Potential Change in Groundwater Level in the Unconsolidated Aquifer During the Temporary Shutdown



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

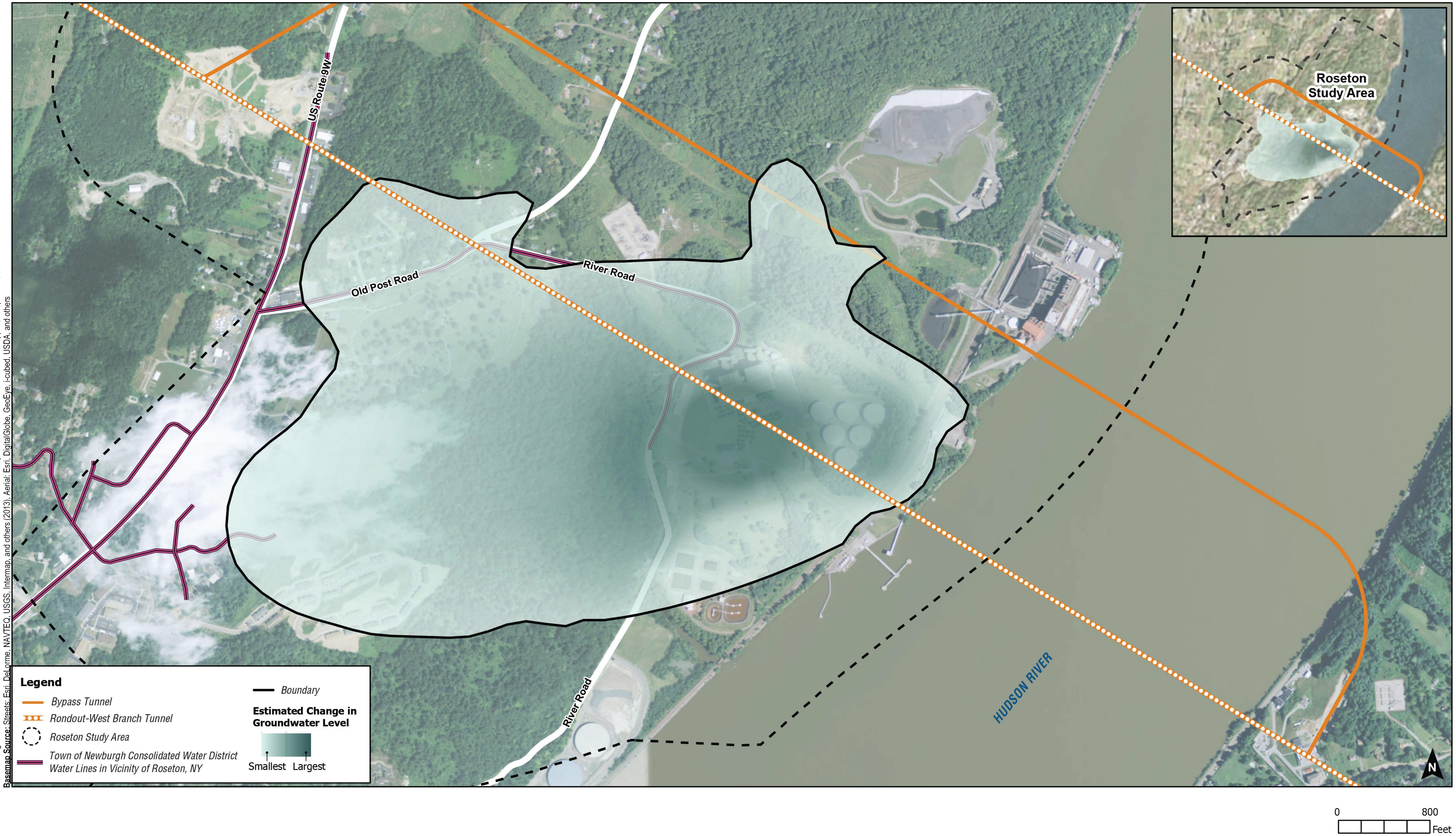
Environmental Protection

Figure 11.9-57: Potential Change in Groundwater Level in the Bedrock Aquifer During the Temporary Shutdown



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Figure 11.9-58: Potential Change in Groundwater Level in the Unconsolidated Aquifer Long Term Over the Long Term After Decommissioning



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Figure 11.9-59: Potential Change in Groundwater Level in the Bedrock Aquifer Long Term Over the Long Term After Decommissioning

The Estimated Unconsolidated Aquifer Groundwater Influence Area is smaller and is within the larger Estimated Bedrock Aquifer Groundwater Influence Area shown on **Figure 11.9-58** and **Figure 11.9-59**. Therefore, the Estimated Bedrock Aquifer Groundwater Influence Area was used to identify parcels with known, potential or future potential private drinking water supply wells in the unconsolidated and bedrock aquifers. The potential for impacts to these water supply wells are further described in Section 11.9.13, "Water and Sewer Infrastructure."

Groundwater resources in the Roseton Study Area would continue to receive recharge after decommissioning. As discussed in Section 11.9.5.10, "Groundwater – Baseline Conditions," approximately 600 gpd of groundwater recharge can be expected to occur on each one-acre residential property during an average precipitation year.

The potentiometric water level decline in the unconsolidated and bedrock aquifers over the majority of the study area is expected to be relatively minimal, and, although measureable, is not expected to affect the local groundwater resources. The water table in many areas of the Roseton Study Area would likely not change. Some isolated areas of the unconsolidated aquifer that correspond to the areas shown on **Figure 11.9-58** could experience a decrease in the water table. However, the water table would return to the elevation before the construction of the RWBT.

Summary

Based on the above, the anticipated decrease in water level during the temporary shutdown and over the long term after decommissioning is not expected to result in significant adverse impacts to groundwater resources in the study area. Therefore, while there may be some changes to groundwater levels, decommissioning would not result in significant adverse impacts to groundwater resources within the Roseton Study Area.

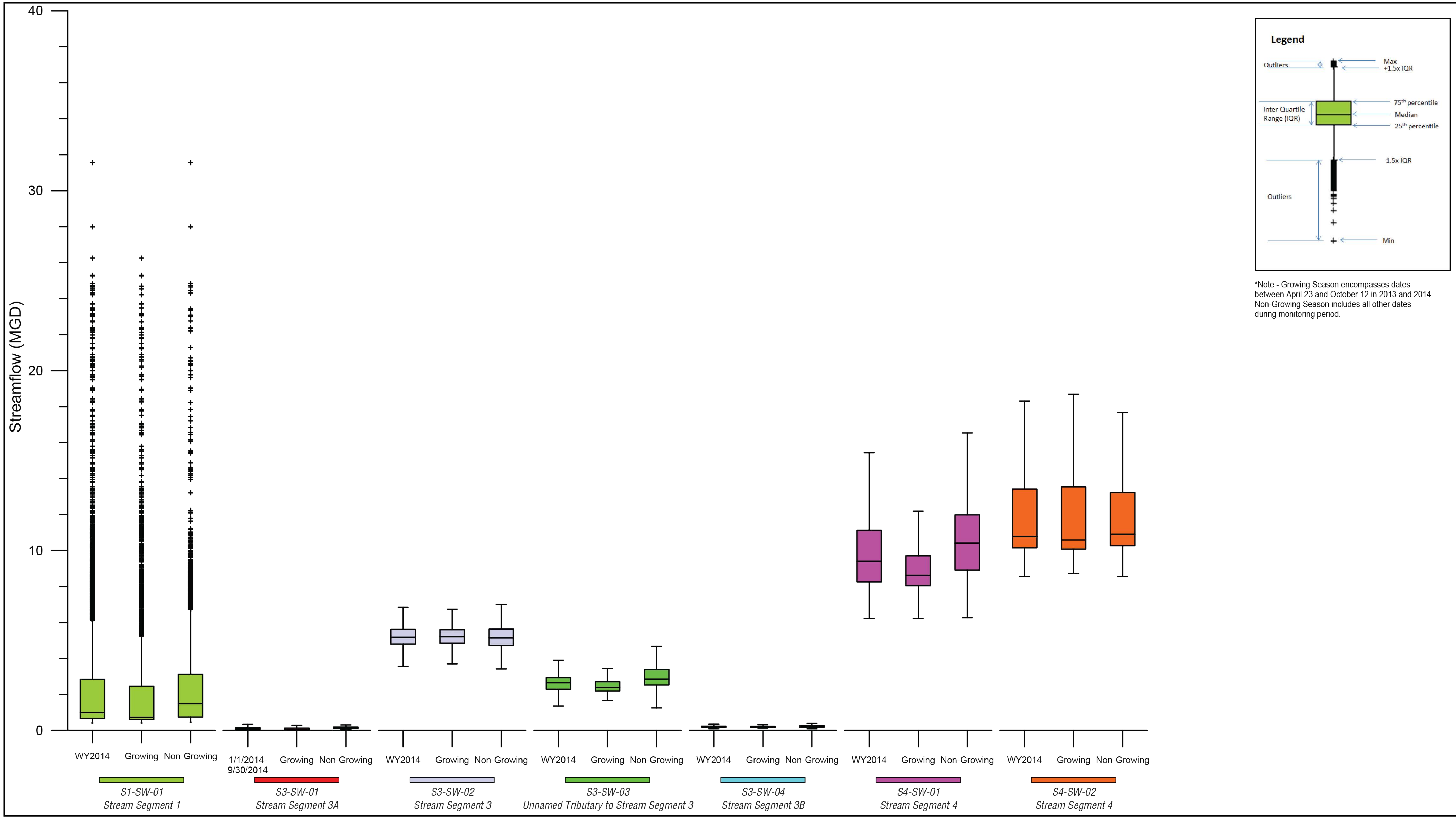
A discussion of the potential impacts to geology and soils is included in Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning." A discussion of the potential impacts to water supply and septic systems is included in Section 11.9.13, "Water and Sewer Infrastructure." Finally, a discussion of the potential impacts on water quality is included in Section 11.9.19, "Public Health."

11.9.5.27 Surface Water – Probable Impacts With Decommissioning

Decommissioning would result in cessation of the leaks in the Roseton area that contribute to surface water resources in the Natural Resources Study Area. Based on the methodology described in Section 11.9.5.3, "Surface Water – Methodology," an analysis of potential impacts from decommissioning is summarized below.

Surface Water Trends from Long-Term Monitoring: Streamflow and Stream Stage

Monitoring data from the network described in Section 11.9.5.3, "Surface Water – Methodology," were examined to assess trends in streamflow, stream stage, and water quality in the Natural Resources Study Area. **Figure 11.9-60** presents box plots of streamflow observations during the monitoring period (which corresponds to Water Year 2014), along with those for just the growing season (April 23 to October 12) and non-growing season of that time frame. Box plots are a way of depicting the distribution and variability of a dataset.



Note: Hourly average data from October 1, 2013 to September 30, 2014, for all stations except for S3-GW-01 which is January 1, 2014 to September 30, 2014
WY = Water Year

Figure 11.9-60: Streamflow Distributions for Water Year 2014, Growing Season and Non-Growing Season

In statistics, a common measure of variability is the so-called interquartile range, which is defined as the spread of the middle 50 percent of data in a dataset (and is therefore sometimes referred to as the “middle fifty”). In a box plot, each box represents this middle fifty, with the lower bound equal to the 25th percentile of the dataset, the upper bound equal to the 75th percentile of the dataset, and the horizontal line in between equal to the median of the dataset. Points above and below the box represent the remaining data in the dataset, but it is generally the middle fifty that is most useful for analytical purposes.

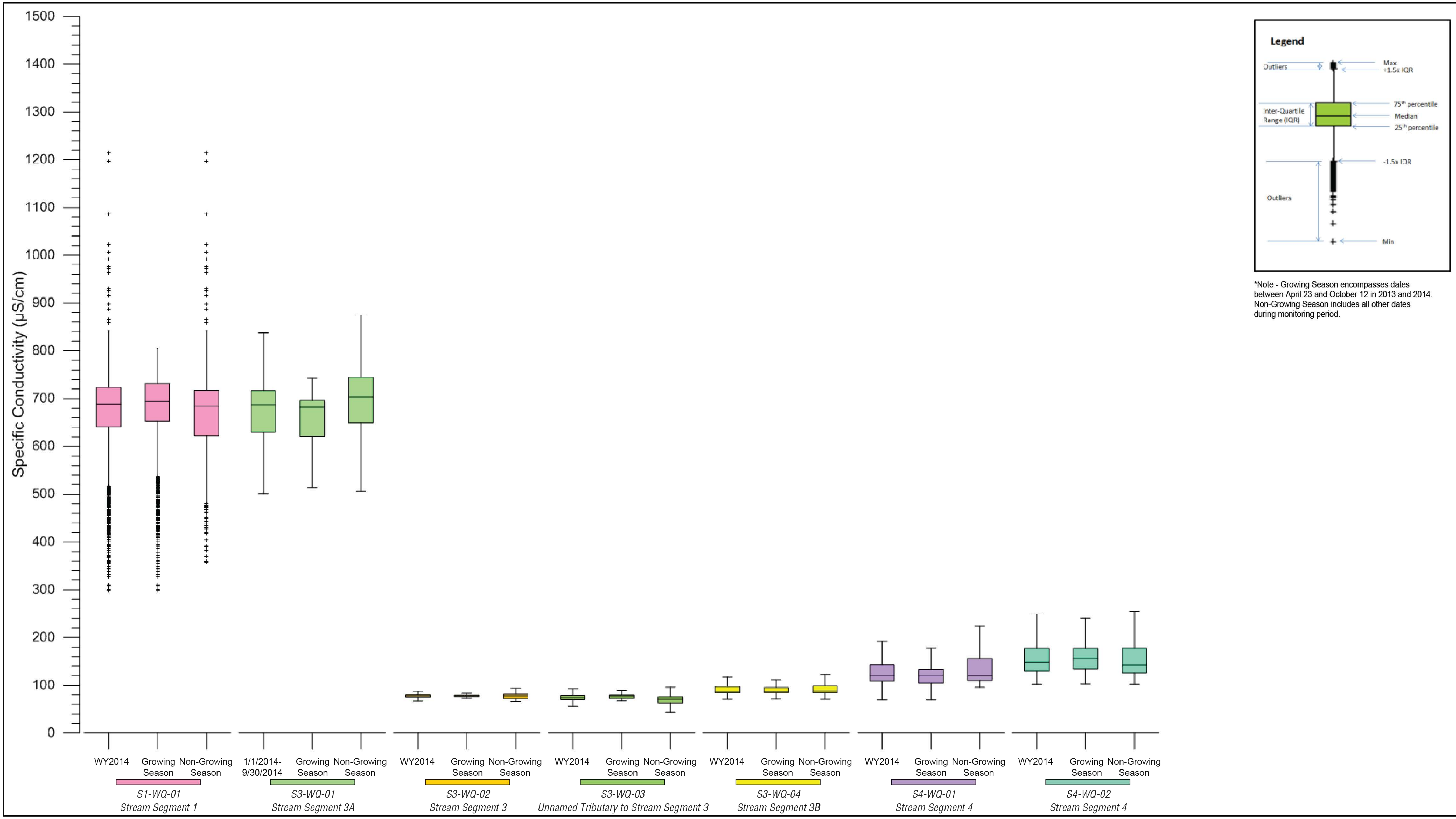
The relationships between stream segments are important for a general understanding of the stream system. As shown on **Figure 11.9-60,** the median streamflow for the entire surface water system was approximately 11 mgd in Water Year 2014 (October 1, 2013 to September 30, 2014). This was measured at S4-SW-02, the most downstream station on Stream Segment 4. Just upstream on Stream Segment 4 at S4-SW-01, the median streamflow was slightly lower at approximately 9 mgd. Of the two tributaries to Stream Segment 4, approximately 8 mgd came from Stream Segment 3, with a median streamflow of approximately 5 mgd at its upstream end (S3-SW-02) and approximately 3 mgd along an unnamed tributary (S3-SW-03). Stream Segment 2, the other tributary to Stream Segment 4, contributed the remaining 1 mgd, as measured for Stream Segment 1 upstream (S1-SW-01). Contributions from Stream Segments 3A (S3-SW-01) and 3B (S3-SW-04), both tributaries to Stream Segment 3, were negligible in comparison. In general, streamflows were slightly higher during the non-growing season than the growing season.

In the context of leak detection, the variability of streamflow is more meaningful than its magnitude. In this regard, Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01) exhibit a high degree of variability. Their middle fifties are relatively large in the context of their corresponding median streamflow values (for example, Stream Segment 1 has a median streamflow of approximately 1 mgd but a middle fifty of approximately 2 mgd). For the other five stations, middle fifties are only a fraction of their median streamflows, suggesting the influence of leak water, whose relatively stable flow rates serve to limit the range of flows experienced at any one location.

Figure 11.9-61 presents the distributions of stream stages (i.e., water levels) observed during the monitoring period. Median stream stages range from a minimum of 5 inches along the unnamed tributary to Stream Segment 3 (S3-SW-04) to a maximum of 27 inches along Stream Segment 4 (S4-SW-01). Those during the non-growing season were generally higher than those during the growing season. As for streamflow, there is a large contrast in variability between Stream Segments 1 and 3A, whose middle fifties are relatively large, and the remaining stream segments, whose middle fifties are relatively small.

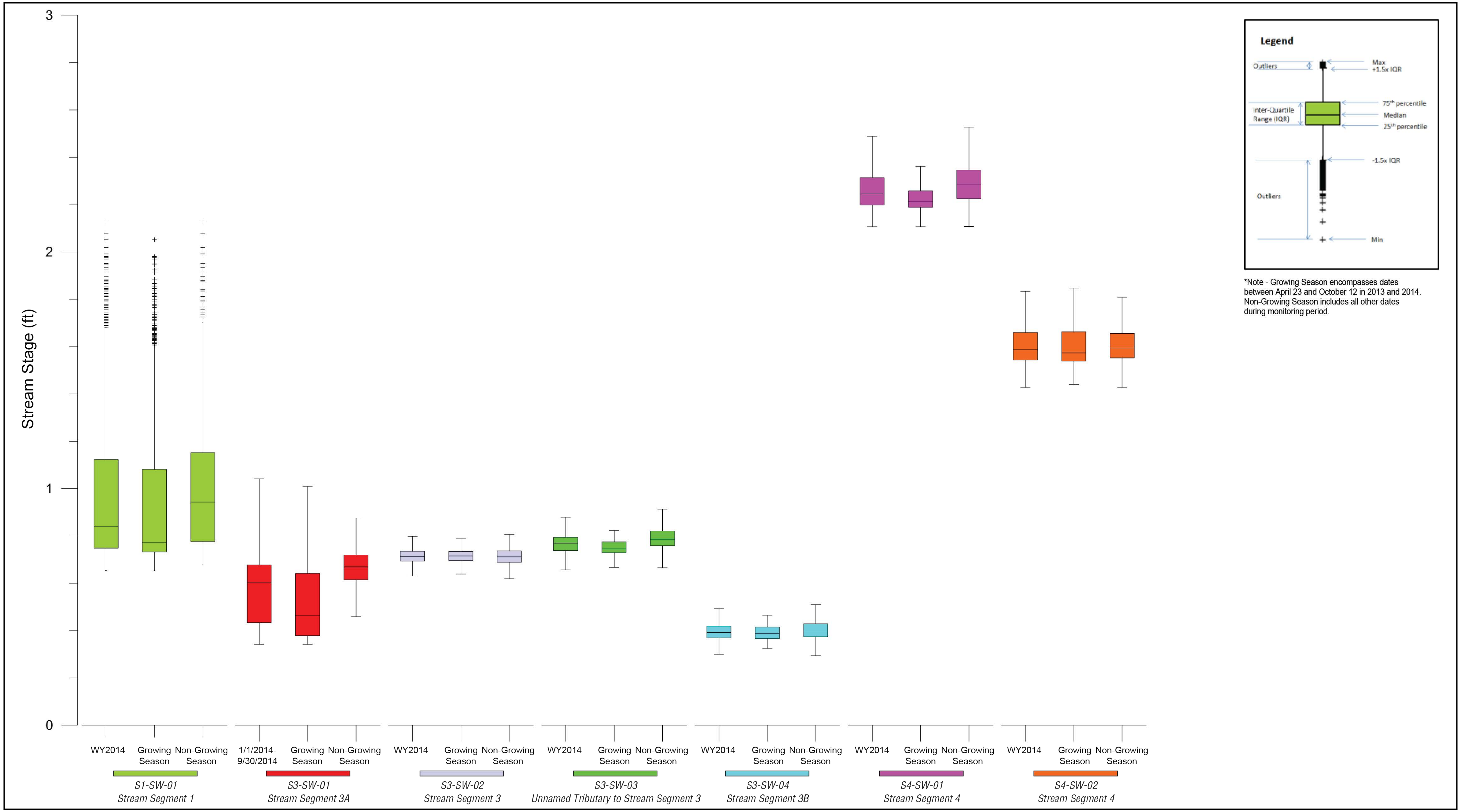
Surface Water Trends from Long-Term Monitoring: Water Quality

Figure 11.9-62 presents distributions for specific conductivity, which is used to measure the concentration of dissolved solids in water. It is clear that conductivities for the last five stations – located along Stream Segment 3, its unnamed tributary, Stream Segment 3B, and Stream Segment 4 – are both lower and less variable than they are for the first two stations on Stream Segments 1 and 3A.



Note: Hourly average data from October 1, 2013 to September 30, 2014, for all stations except for S3-WQ-01 which is January 1, 2014 to September 30, 2014
WY = Water Year

Figure 11.9-61: Stream Stage Distributions for Water Year 2014, Growing Season, and Non-Growing Season



Note: Hourly average data from October 1, 2013 to September 30, 2014, for all stations except for S3-GW-01 which is January 1, 2014 to September 30, 2014
WY = Water Year

Figure 11.9-62: Specific Conductivity Distributions for Water Year 2014, Growing Season, and Non-Growing Season

This again suggests the influence of leak water, whose mineral content is lower and more stable than that of water in the natural environment. The relatively elevated and more variable conductivities along Stream Segment 4 (S4-WQ-01 and S4-WQ-02) are potentially influenced by the tidal inlet, which is hydraulically connected to Segment 4 at its confluence with the Hudson River.

Water temperature distributions are presented on **Figure 11.9-63**. For Stream Segments 1 (S1-WQ-01) and 3A (S3-WQ-01), the range of temperatures during the growing season are distinct from those during the non-growing season, indicative of natural conditions. However, these ranges overlap for Stream Segment 3 (S3-WQ-02), its unnamed tributary (S3-WQ-03), and Stream Segment 3B (S3-WQ-04), suggesting the influence of leak water, whose cooler and more stable temperatures serve to moderate seasonal effects. For Stream Segment 4 (S4-WQ-01 and S4-WQ-02), the seasonal temperature difference is somewhere between these two conditions, suggesting that leak water influence is somewhat diminished at this point in the system.

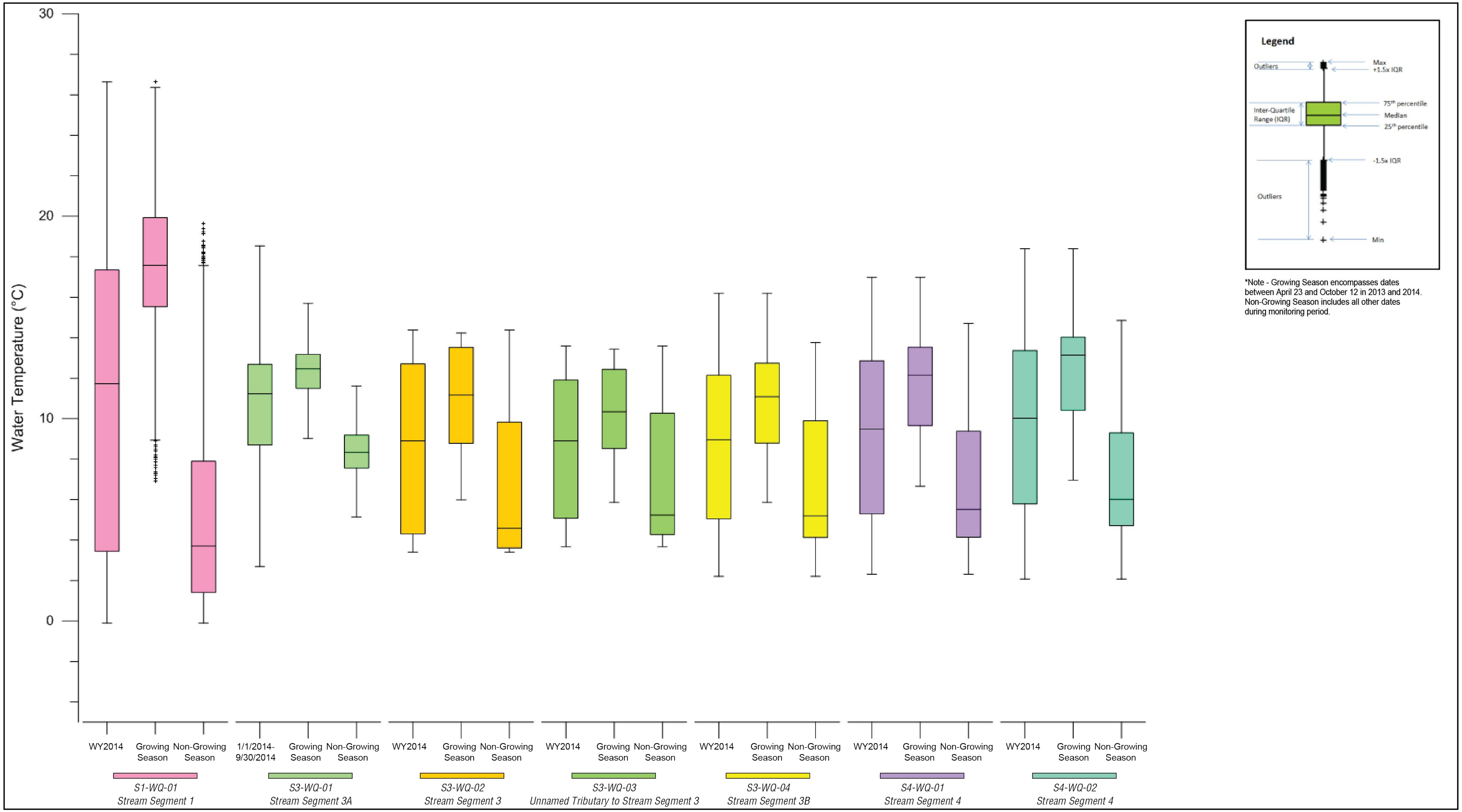
Figure 11.9-64 presents time series plots of these temperature observations. Diurnal variability is clearly evident for Stream Segment 1 (S1-SW-01) and, to a lesser extent, Stream Segment 3A (S3-SW-01). For the remaining segments, diurnal variability is less pronounced, with almost no variability for Stream Segment 3 (S3-SW-02) or its unnamed tributary (S3-SW-03). Such consistency indicates the influence of leak water, whose relatively constant temperature serves to stabilize streamflow temperatures.

Surface Water Trends from Depressurization Monitoring

As described further in Section 11.9.5.3, "Surface Water – Methodology," monitoring data from periodic depressurizations were reviewed to estimate potential impacts from decommissioning. Data collected at surface expressions within the Natural Resources Study Area before, during, and after these depressurizations provide evidence of their relationship (or lack thereof) to RWBT flow rates and, consequently, leak water influence. Streamflow measurements collected at a weir just downstream of the confluence of Stream Segments 3 and 3B were used as a proxy for leak water flow rates due to their location downstream of most surface expressions within the study area. These streamflow measurements are plotted against RWBT water pressure data for all depressurization events from 2008 to 2014 on **Figure 11.9-65**. Data indicate a somewhat exponential relationship between RWBT water pressure and presumed leak flow rates. Observations of trends from the depressurization monitoring are further detailed below.

February/March 2008 Depressurization of the RWBT

The first depressurization, blow-off, and refill occurred over the period of February 18 to March 5, 2008. A limited number of surface water locations were monitored for the effect of the change in RWBT water pressure on flow rates and water levels. Staff gauge readings at a ponded surface expression and the above-mentioned weir indicated water level responses that correlated with the change in RWBT water pressure during the RWBT blow-off, stabilization, and refilling cycle. These water features were also observed as being muddy during the depressurization, possibly related to mobilization of sediment due to the induced variation in leak water flow.



Note: Hourly average data from October 1, 2013 to September 30, 2014, for all stations except for S3-WQ-01 which is January 1, 2014 to September 30, 2014
WY = Water Year

Figure 11.9-63: Water Temperature Distributions for Water Year 2014, Growing Season, and Non-Growing Season

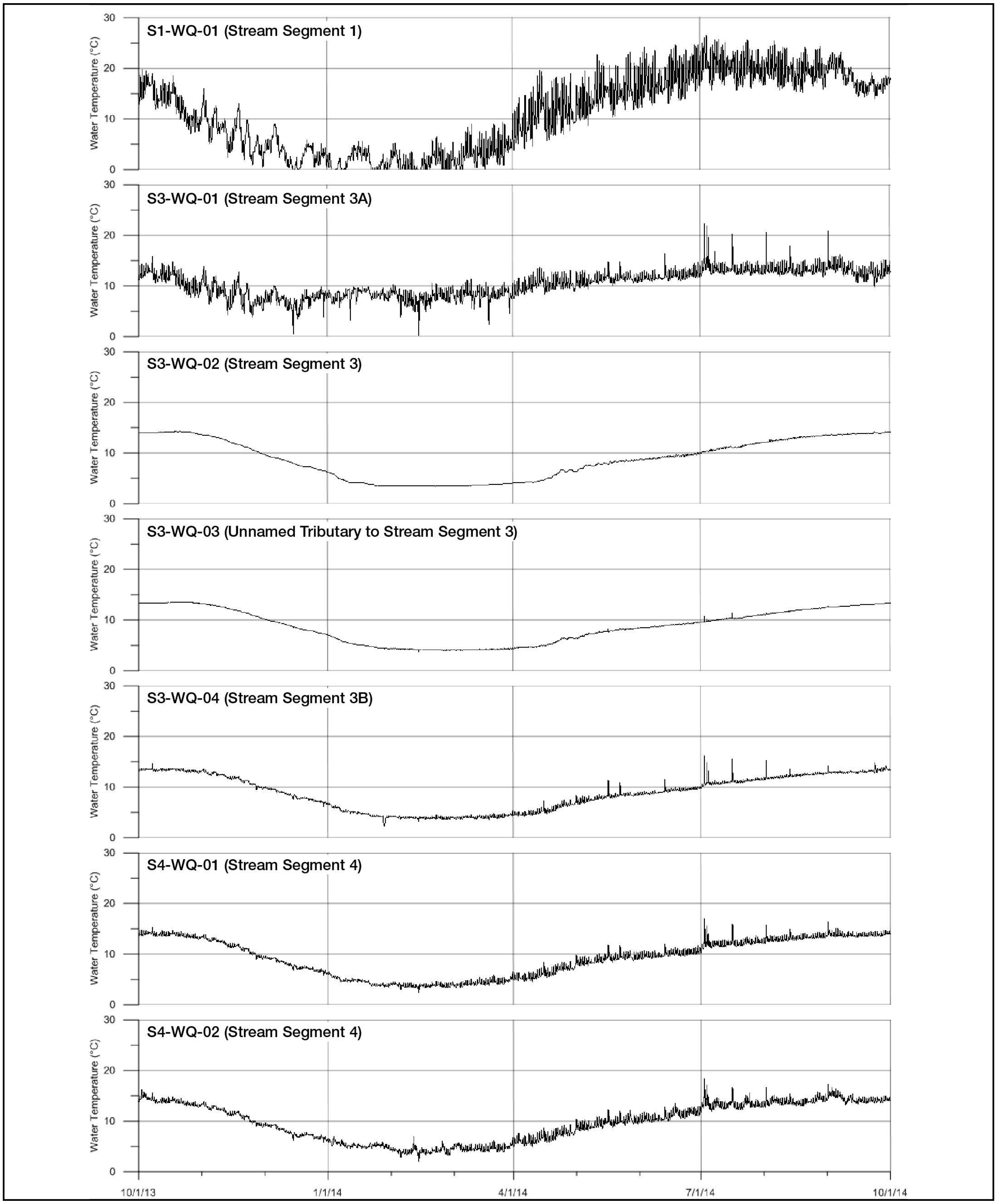


Figure 11.9-64: Water Temperature Time Series for Water Year 2014

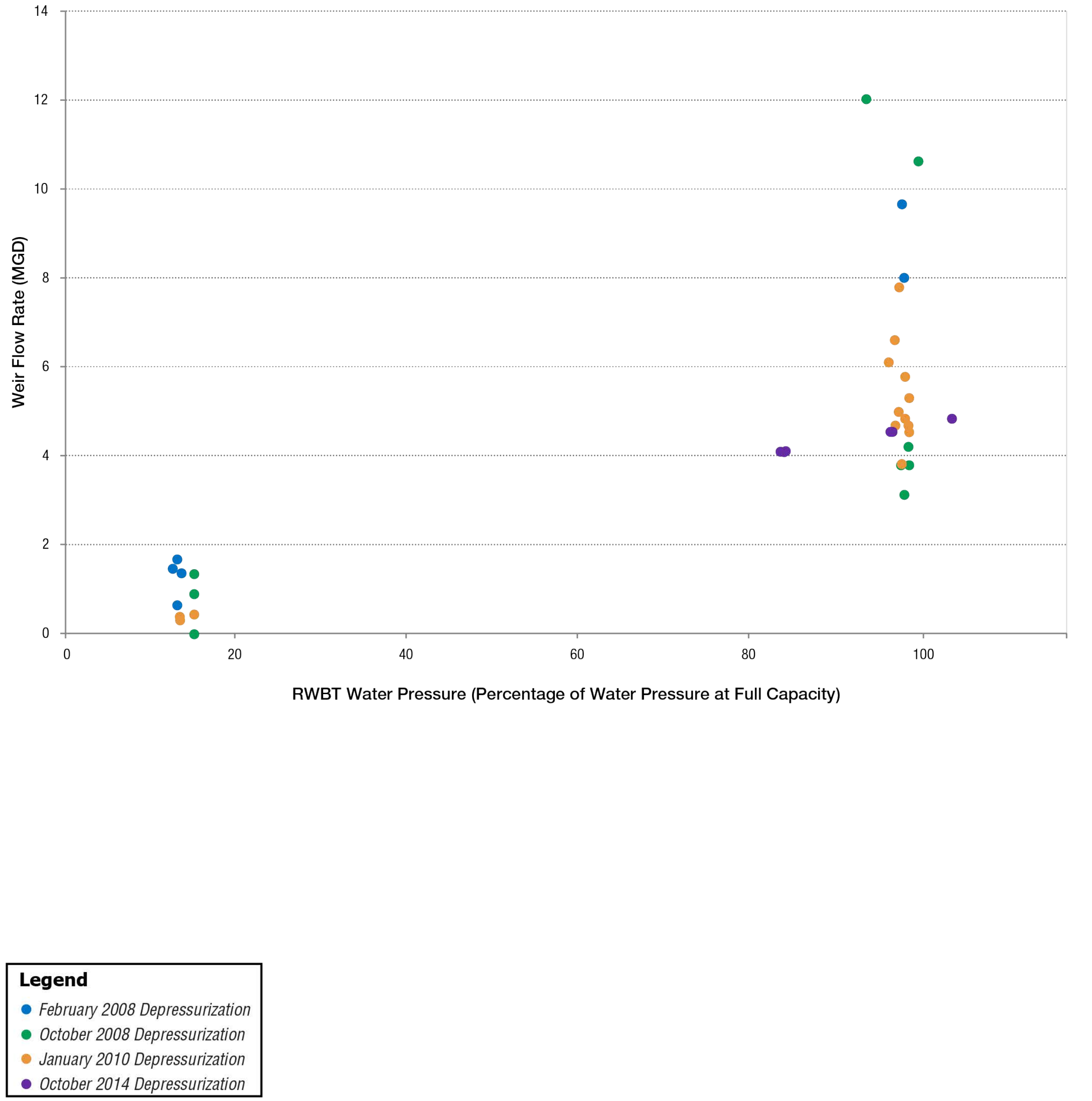


Figure 11.9-65: Relationship Between RWBT Water Pressure and Weir Flow Rate

October/November 2008 Depressurization of the RWBT

A second depressurization, blow-off, and refill event occurred between October 25 and November 26, 2008. An expanded set of 10 locations, including a water seep, a ponded surface expression, and multiple springs, was monitored during this depressurization.

Water level and water quality data indicated a strong connection between RWBT water pressure and observed conditions at the previously noted ponded surface expression and weir, as well as a location upstream of the weir identified as the Four Foot Spring. These results confirmed the findings from an earlier dye test in which dye released into the aqueduct was detected at the ponded surface expression after a travel time of approximately 4 hours and at the Four Foot Spring after a travel time of approximately 70 minutes. Observations at three other monitored surface expressions, referred to as the Rock Base Spring, Roadside Spring, and Hudson River Spring 1, indicated potential hydraulic connections to the RWBT, while those at the Tank Farm Spring, Hudson River Spring 2, Two Foot Spring, and the Rosebush surface expression were either uncorrelated to the depressurization or inconclusive (see **Figure 11.9-6**).

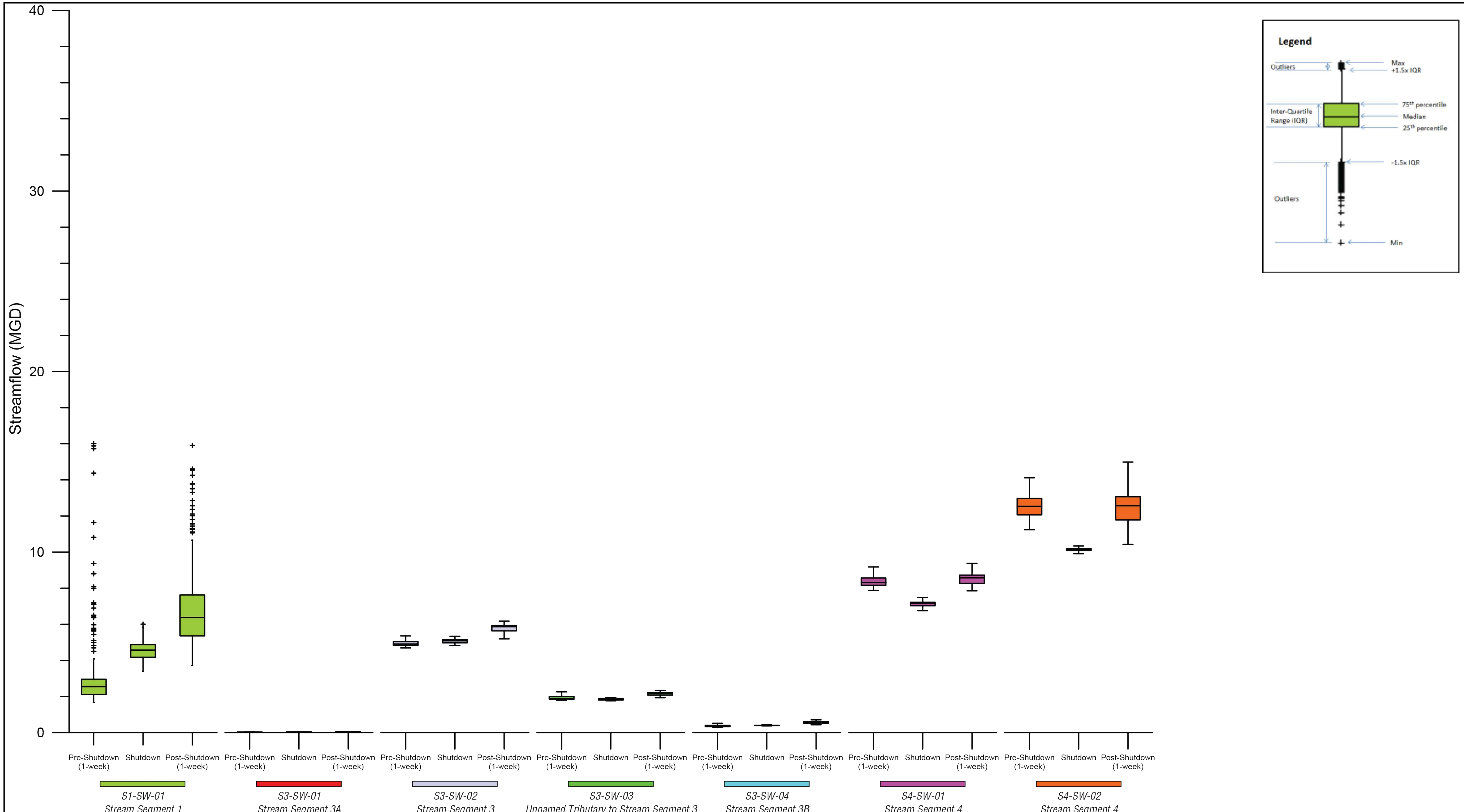
November 2009 to January 2010 Depressurization of the RWBT

A series of three depressurizations, blow-offs, and refill events occurred during the period of November 2009 to January 2010 (November 5 to November 15, December 4 to December 16, 2009 and January 13 to January 26, 2010). The monitoring network associated with this series of depressurizations was again expanded to include several additional locations. Flow rate and water level observations confirmed a strong relationship to RWBT water pressure for all three depressurizations at monitored locations, referred to as the Roadside Spring; ponded surface expression; Four Foot Spring; Rockbase Spring I, II, III; Hudson River Spring 1; Wetland Spring; Tank Farm Spring; and one additional location near the Roadside Spring. Observations at the Two Foot Spring also indicated a potential connection to the RWBT but were less conclusive. Locations without correlation to RWBT water pressure included locations referenced as: Rosebush Spring; Cemetery Pond; Hudson River Spring 2; and six industrial plant wells near Wetland Spring.

October 2014 Depressurization of the RWBT

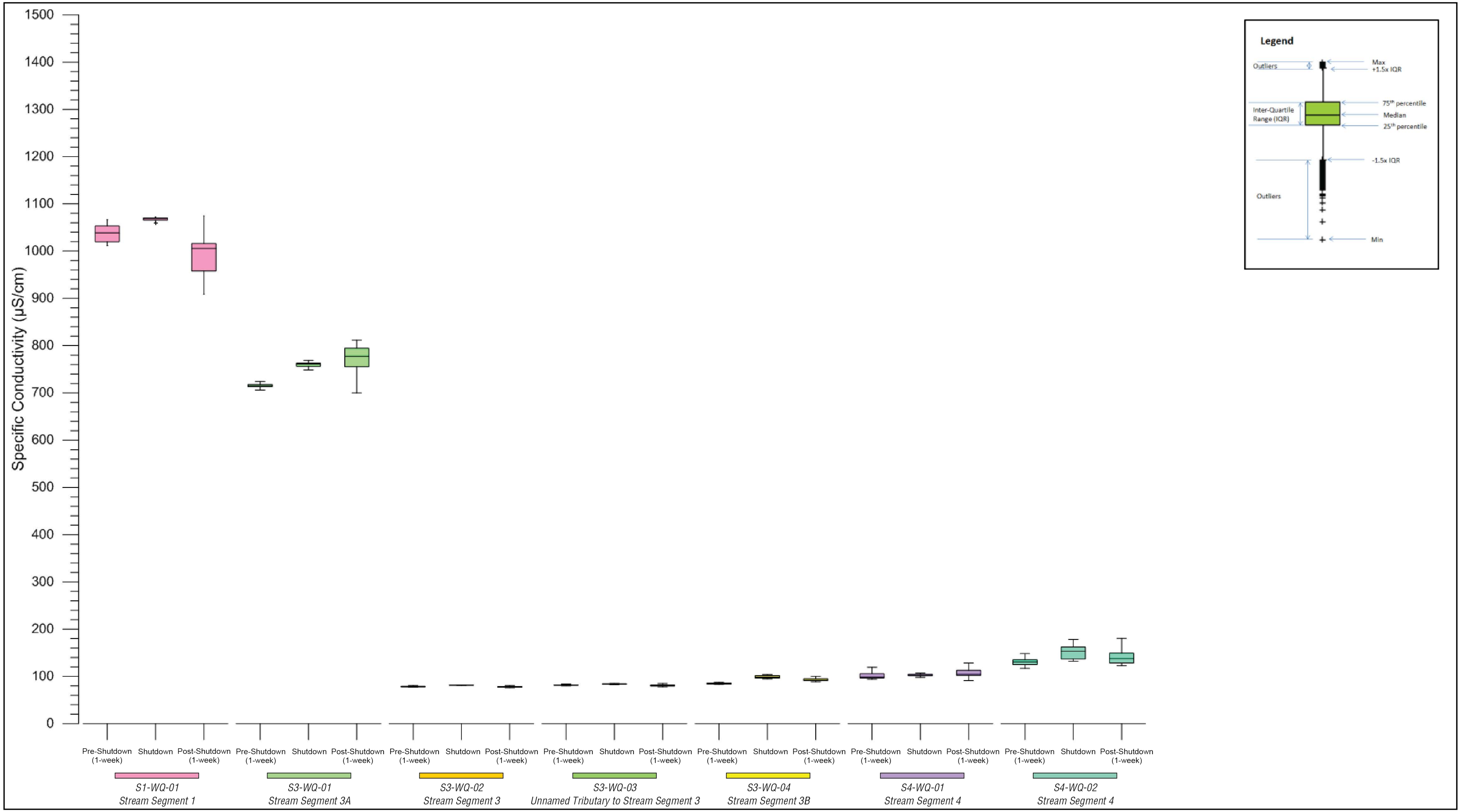
A final depressurization, blow-off, and refill event took place from October 10 to October 27 2014. **Figure 11.9-66** presents distributions for streamflow observations before, during, and after the depressurization ("shutdown") period. Decreases in streamflow during the depressurization are clearly evident for Stream Segment 4 (S4-SW-01 and S4-SW-02), suggesting the influence of leak water at this location. In contrast, streamflow for Stream Segment 1 (S1-SW-01) increases during the depressurization, and then again after the depressurization, suggesting a disconnect from the RWBT. Trends in the data are less conclusive for Stream Segment 3 (S3-SW-02), its unnamed tributary (S3-SW-03), Stream Segment 3A (S3-SW-01), and Stream Segment 3B (S3-SW-04). **Figure 11.9-67** presents stream stage distributions for the depressurization, offering similar results.

Specific conductivity distributions for the October 2014 depressurization are presented on **Figure 11.9-68**. For Stream Segment 3 (S3-WQ-02), its unnamed tributary (S3-WQ-03), and Stream Segment 3B (S3-WQ-04), specific conductivities increase during the depressurization period, implying the influence of leak water, which is lower in conductivity.



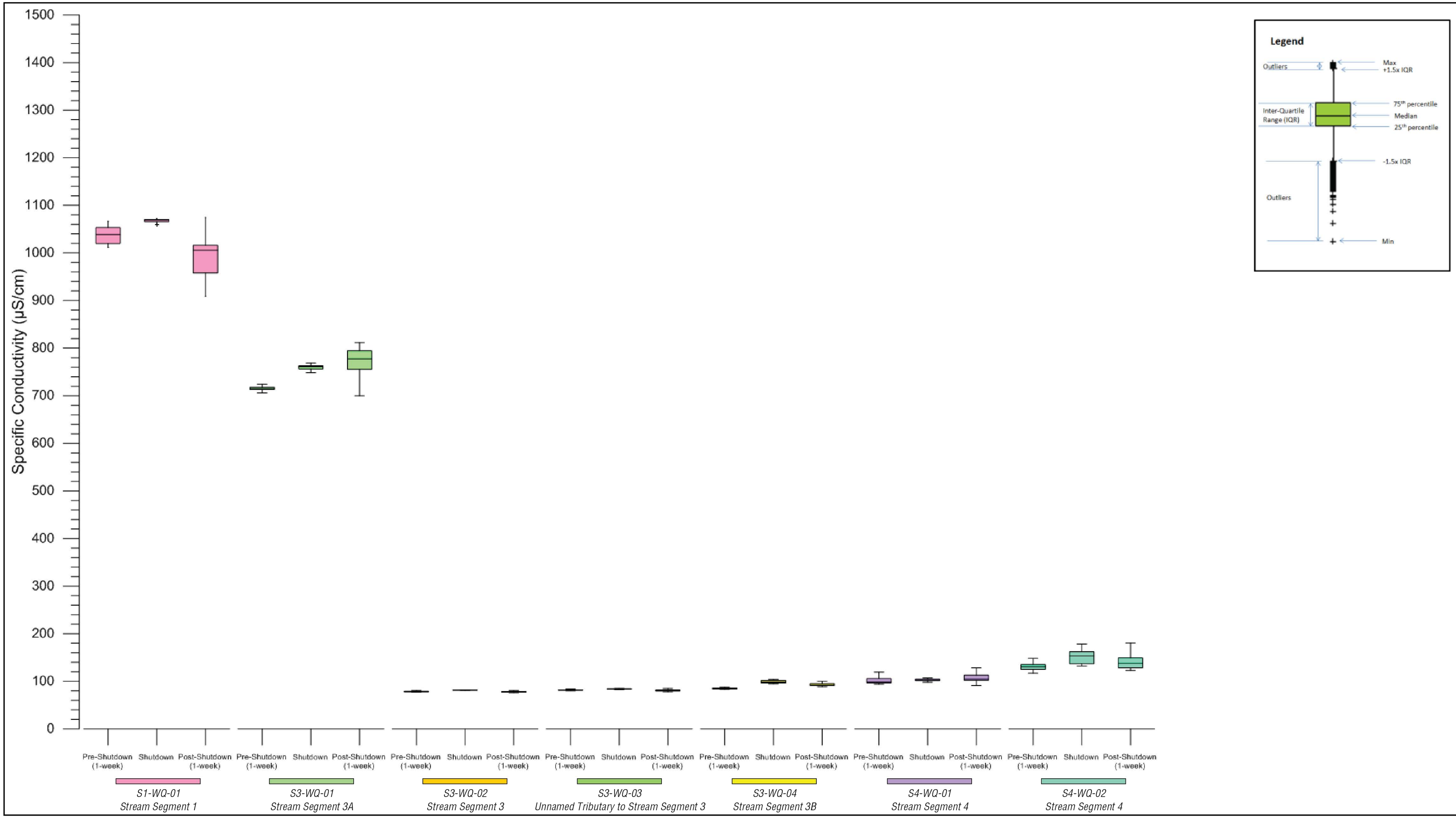
Note: Hourly Average Data for Pre-shutdown (10/10/14 to 10/17/14), Shutdown (10/17/14 to 10/20/14), and Post-shutdown (10/20/14 to 10/27/14)

Figure 11.9-66: Streamflow Distributions for October 2014 Depressurization Shutdown, Pre-Shutdown, and Post-Shutdown



Note: Hourly Average Data for Pre-shutdown (10/10/14 to 10/17/14), Shutdown (10/17/14 to 10/20/14), and Post-shutdown (10/20/14 to 10/27/14)

Figure 11.9-67: Stream Stage Distributions for October 2014 Depressurization Shutdown, Pre-Shutdown, and Post-Shutdown



Note: Hourly Average Data for Pre-shutdown (10/10/14 to 10/17/14), Shutdown (10/17/14 to 10/20/14), and Post-shutdown (10/20/14 to 10/27/14)

Figure 11.9-68: Specific Conductivity Distributions for October 2014 Depressurization Shutdown, Pre-Shutdown, and Post-Shutdown

Similar trends are apparent for Stream Segment 1 (S1-WQ-01) and the downstream portion of Stream Segment 4 (S4-WQ-02), although specific conductivity appears relatively constant for the upstream portion of Stream Segment 4 (S4-WQ-01). For Stream Segment 3A (S3-WQ-01), specific conductivity increases during and after the depressurization, implying a disconnect from the RWBT.

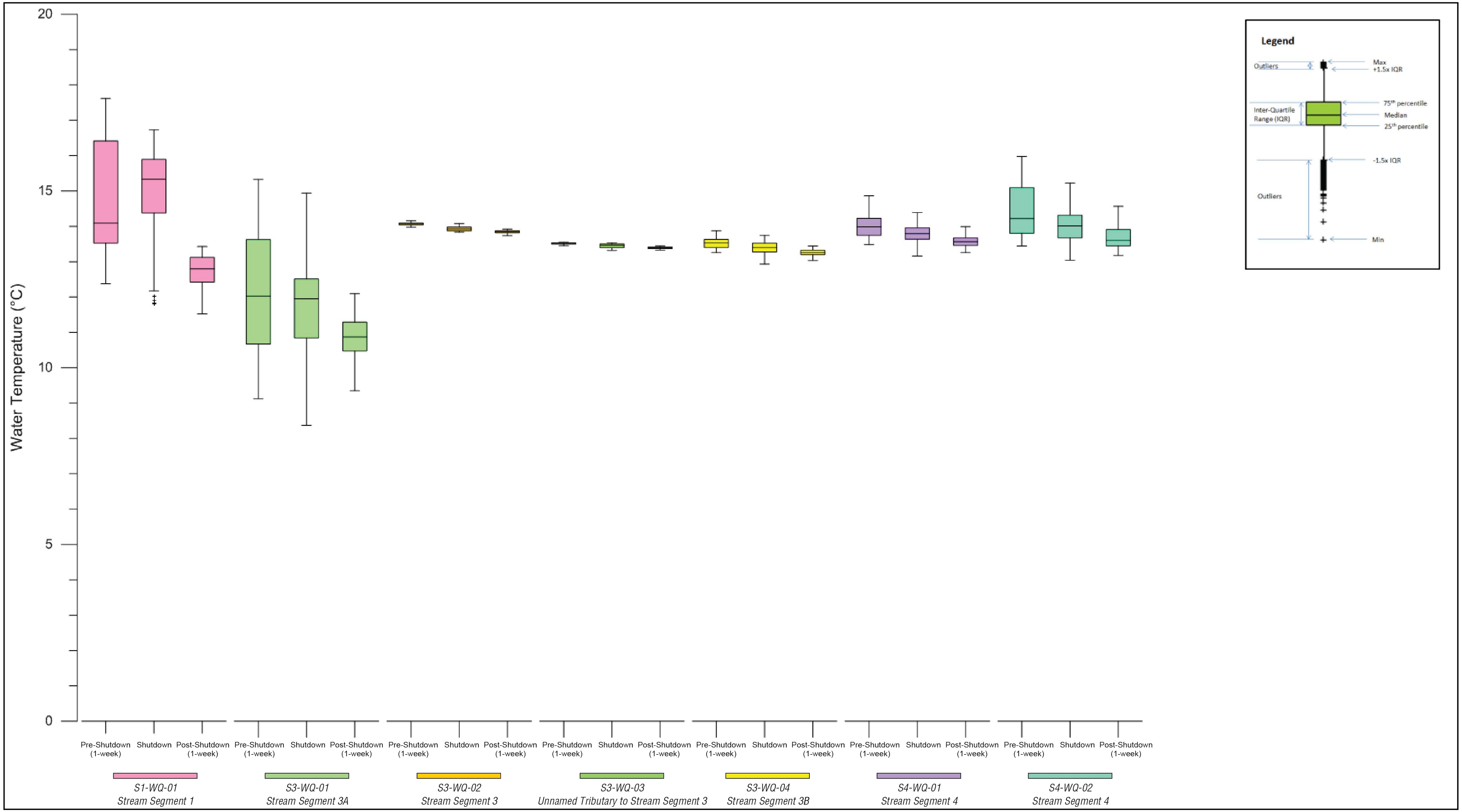
Finally, **Figure 11.9-69** presents distributions for water temperature over the course of the depressurization. Although water temperatures at leak-influenced locations would be expected to increase as the contribution of lower-temperature leak water is removed, the box plots indicate that water temperatures consistently decrease at all seven monitoring locations. It appears that these temperatures were instead dominated by air temperatures, which also decreased during this timeframe.

Streamflow Rating Curves

As described in Section 11.9.5.3, "Surface Water – Methodology," the Manning's equation was used to develop streamflow rating curves for each water level meter station in the monitoring network. The Manning's equation is an empirical formula relating the velocity of a liquid flowing under gravity in an open channel to the level of the liquid within that channel. The velocity is then multiplied by the cross-sectional area of flow to obtain estimates of streamflow. Rating curves are graphs plotting streamflow against stream stage (i.e., water level) at a particular location, allowing observed stream stage data to be converted into estimates of streamflow.

The supporting data used to determine the parameters of the equation and validate the resulting rating curves are summarized in **Table 11.9-30** by station and stream segment (see **Figure 11.9-11** for locations of the water level meter stations). The data are provided for both the purposes of informing the surface water analysis and for supporting future engineering efforts that may be implemented in the area.

Some disparities among the supporting data are noteworthy for their implications for leak water influence. While the watershed areas (row 1) for Stream Segments 1 (S1-SW-01), 3A (S3-SW-01), and 4 (S4-SW-01 and S4-SW-02) range from approximately 170 to 650 acres, those for Stream Segment 3 (S3-SW-02), its unnamed tributary (S3-SW-03), and Stream Segment 3B (S3-SW-04) are two to three orders of magnitude lower (approximately 0.4 to 3.3 acres). According to USGS regional curves, which provide estimates of bankfull discharge based on watershed area and typical values for the region, the bankfull discharges (row 3) for Stream Segment 3, its unnamed tributary, and Stream Segment 3B should likewise be much smaller than they are for Stream Segments 1, 3A, and 4 (a stream's bankfull discharge is equivalent to its capacity when completely full). However, bankfull discharges calculated from the Manning's equation (row 12), which are largely functions of stream cross-sectional geometry and more representative of actual conditions, differ at most by only one order of magnitude among all seven stations (approximately 7 to 117 mgd).



Note: Hourly Average Data for Pre-shutdown (10/10/14 to 10/17/14), Shutdown (10/17/14 to 10/20/14), and Post-shutdown (10/20/14 to 10/27/14)

Figure 11.9-69: Water Temperature Distributions for October 2014 Depressurization Shutdown, Pre-Shutdown, and Post-Shutdown

Table 11.9-30: Supporting Data for Development of Streamflow Rating Curves

	Parameter	Segment 1 (S1-SW-01)	Segment 3A (S3-SW-01)	Segment 3 (S3-SW-02)	Tributary to Segment 3 (S3-SW-03)	Segment 3B (S3-SW-04)	Segment 4 (S4-SW-01)	Segment 4 (S4-SW-02)
1	Watershed Area (acres)[1]	190	170	0.4	0.7	3.3	610	650
2	Bankfull Area from Regional Curve (square feet)	22	20	1.0	1.3	2.8	39	40
3	Bankfull Discharge from Regional Curve (mgd)	24	22	0.4	0.6	1.6	52	54
4	Longitudinal Length used for Low Flow Slope (feet)	48	11	23	10	20	49	17
5	Longitudinal Length used for High Flow Slope (feet)	90	61	35	70	89	78	16
6	Low Flow Slope for Manning's Calculation	0.0002	0.0027	0.0126	0.0110	0.0125	0.0008	0.0024
7	High Flow Slope for Manning's Calculation	0.0013	0.0352	0.0163	0.0132	0.0176	0.0101	0.0173
8	Low Flow N-value for Manning's Calculation	0.078	0.779	0.064	0.058	0.235	0.057	0.073
9	High Flow N-value for Manning's Calculation[2]	0.019	0.085	0.057	0.032	0.031	0.056	0.071
10	Bankfull Area from Cross-Sectional Survey (square feet)	13	10	26	5	3	40	43
11	Bankfull Velocity Using Manning's Equation (feet per second)	3.0	3.5	4.4	3.3	3.6	4.3	4.3
12	Bankfull Discharge Using Manning's Equation (mgd)	25	22	74	11	7	112	117
13	Bankfull Discharge Using Manning's Equation (inches per day)	4.9	4.8	6,800	580	76	6.9	6.7

Table 11.9-30: Supporting Data for Development of Streamflow Rating Curves

	Parameter	Segment 1 (S1-SW-01)	Segment 3A (S3-SW-01)	Segment 3 (S3-SW-02)	Tributary to Segment 3 (S3-SW-03)	Segment 3B (S3-SW-04)	Segment 4 (S4-SW-01)	Segment 4 (S4-SW-02)
14	Maximum Recorded Streamflow (mgd)[3]	32	2	9	7	0.8	47	60
15	Average Velocity from Seepage Study (fps)	0.1	0.04	1.8	1.1	0.3	0.8	1.0
16	Measured Discharge from Seepage Study (mgd)	0.05	0.02	6.2	0.8	0.2	7.3	8.3

Notes:

1 Watershed areas for the first five stations are all independent of each other. However, the watershed area for S4-SW-01 is inclusive of the watershed areas for the first five stations and the watershed area for S4-SW-02 is inclusive of the watershed area for S4-SW-01.

2 The high-flow bankfull n-value was originally calculated as 0.108 using Jarrett's equation. However this was found to underestimate bankfull velocity and flow rate as compared to the USGS regional curve for New York Region 3 (2007), so it was adjusted to 0.085 to provide a better match.

3 Based on Water Year 2014 (October 1, 2013 to September 30, 2014) except for S3-SW-01, which is based on January 1, 2014 to September 30, 2014. Data collected at Station S3-SW-01 prior to January 1, 2014 was reviewed and due to data gaps and outlier values was not included in the analysis.

In summary, the smaller watershed areas for Stream Segment 3, its unnamed tributary, and Stream Segment 3B than for Stream Segments 1, 3A, and 4 suggest that their streamflow capacities should likewise be smaller, but in reality, their streamflow capacities are relatively comparable to those of the latter three stream segments.

The implication is that Stream Segment 3, its unnamed tributary, and Stream Segment 3B would not exist in their current condition without some form of artificial influence. These channels are highly incised with over-widened banks, typically the result of man-made conditions that alter a stream system's hydrologic regime. This point is made clear in row 13, for which bankfull discharges have been divided by their respective watershed areas. Values for Stream Segments 1 (S1-SW-01), 3A (S3-SW-01), and 4 (S4-SW-01 and S4-SW-02) range from 4.8 to 6.9 inches per day, meaning that, at S4-SW-01 for example, its streamflow capacity is equal to the flow rate of water that would result if 6.9 inches of rain fell over its entire watershed area over a 24-hour period (assuming that 100% of the rain became runoff). While seemingly high, 6.9 inches over 24 hours is not completely unreasonable under extreme conditions. These same values, however, range from 76 to 6,800 inches per day (approximately 6 to 560 feet per day) for Stream Segment 3 (S3-SW-02), its unnamed tributary (S3-SW-03), and Stream Segment 3B (S3-SW-04), numbers that are impossibly high and could not occur in nature.

Results of the Baseflow Index Analysis

Once the time series of streamflow observations had been developed from the rating curves, the resulting hydrographs were separated into components of baseflow (streamflow from groundwater inflow) and quickflow (also referred to as direct runoff) using a computer program developed by Wahl and Wahl (Wahl and Wahl 1988). A baseflow index, which represents the percentage of streamflow that is made up of baseflow over a specified period of time, was then computed for each monitoring station. As described in Section 11.9.5.3, "Surface Water – Methodology," baseflow for stream segments affected by leak water would likely decrease following decommissioning, since leak water must enter the stream system through the subsurface. The baseflow index is an important metric for this analysis since it has been demonstrated to be related to the hydrogeologic characteristics of a watershed. Accordingly, baseflow indices were derived for reference streams with similar watershed characteristics in the region of the study area and used to establish a range of baseflow indices that would be typical for the study area under natural, non-leak conditions.

Summary statistics for the reference streams selected for the analysis are provided in **Table 11.9-31**. As described in Section 11.9.5.3, "Surface Water – Methodology," GAGES-II database is a compilation of several hundred watershed characteristics for 9,322 streamflow gauges maintained by the USGS. Fifteen streams were selected from the GAGES-II database (Falcone et al. 2010) based on the selection criteria indicated in the table (one additional parameter, dominant geology, is not listed since all were sedimentary rock, matching that of the study area). An additional eight reference streams were selected from within 20 miles of the Roseton Study Area. **Figure 11.9-70** shows the locations of all 23 reference streams against a background of baseflow indices interpolated from the database (Wolock 2003). While a wide range of baseflow indices exist in the United States as noted in the inset map, the baseflow index in the region of the study area, and the northeast in general, tends to be approximately 50, meaning that, in general, 50 percent of the region's streamflow consists of baseflow, and 50 percent of the region's streamflow consists of quickflow.

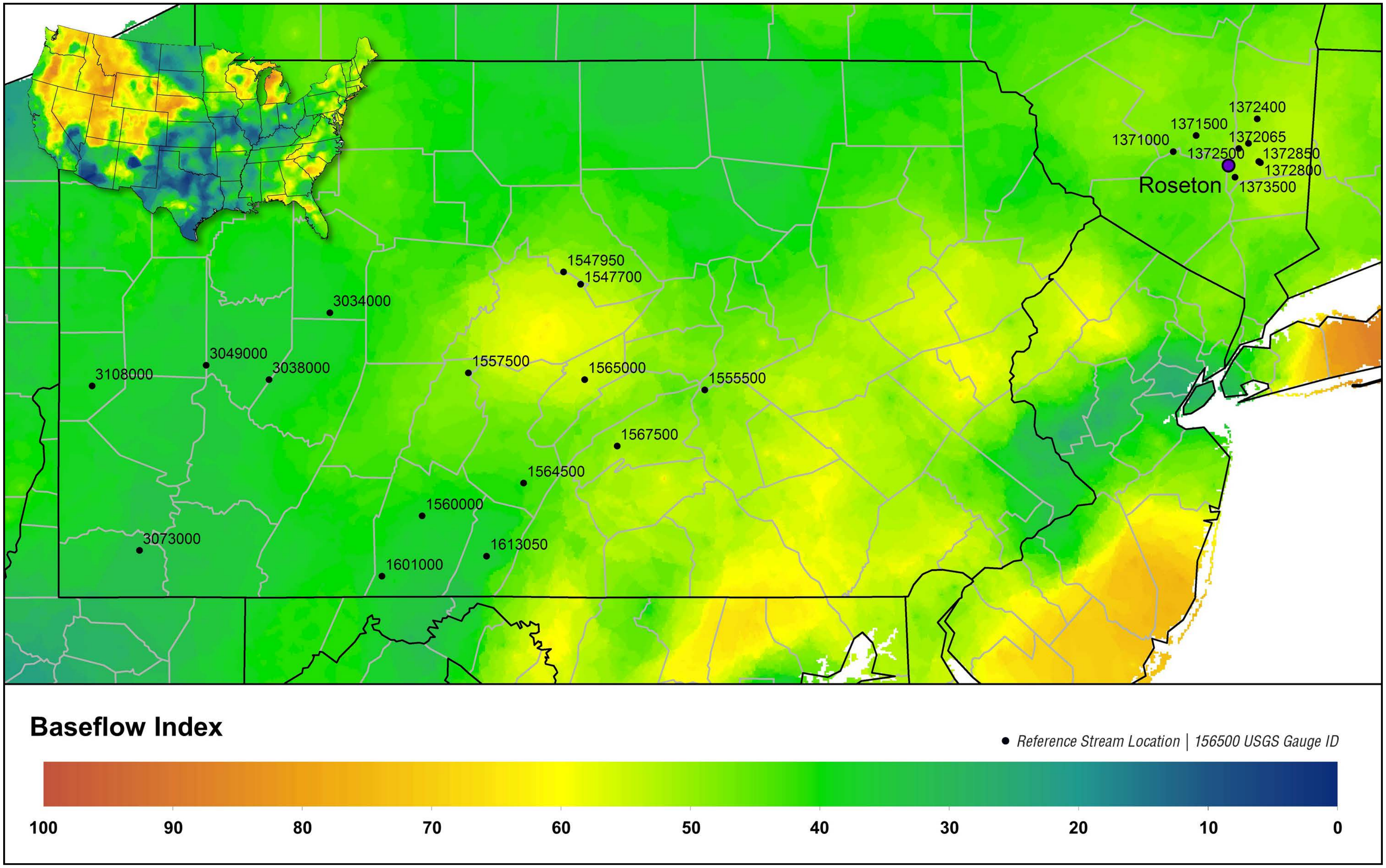
Table 11.9-31: Summary Statistics for the 23 Reference Streams for the Baseflow Index Analysis

Gauge ID	Station Name	Years of Record	Drainage Area (square kilometers)	Urban Land Use (percent)	Forest Cover (percent)	Lakes/ Ponds/ Swamps (percent)	Mean Annual Temperature (°C)	Mean Annual Precipitation (centimeters)	Runoff Ratio (0–1)[1]	Baseflow Index (0–100)[2]
-	Roseton		2.9	5	80	0.1	9.4	100	0.48	
Selection Criteria										
			<500	<15	>50	<2	8-11	80-120	0.4-0.6	
USGS Selections from GAGES Database										
01567500	Bixler Run near Loysville, PA	1954-2015	39	6	51	0.06	11	108	0.50	49
01555500	East Mahantango Creek near Dalmatia, PA	1929-2015	420	7	52	0.2	9	114	0.49	51
03049000	Buffalo Creek near Freeport, PA	1940-2015	360	7	61	0.2	10	106	0.47	36
01565000	Kishacoquillas Creek at Reedsville, PA	1939-2015	420	7	62	0.1	10	110	0.42	55
03108000	Raccoon Creek at Moffatts Mill, PA	1941-2015	460	12	63	0.9	10	99	0.40	38
01560000	Dunning Creek at Belden, PA	1939-2015	440	8	65	0.1	10	104	0.44	41
03034000	Mahoning Creek at Punxsutawney, PA	1938-2015	410	10	67	0.2	8	115	0.52	40
03038000	Crooked Creek at Idaho, PA	1937-2015	490	8	68	0.9	9	114	0.53	38
03073000	South Fork Tenmile Creek at Jefferson, PA	1931-2015	470	9	70	0.1	10	104	0.40	34
01613050	Tonoloway Creek near Needmore, PA	1965-2015	28	5	75	0.04	10	102	0.41	36
01564500	Aughwick Creek near Three Springs, PA	1938-2015	450	6	77	0.1	10	103	0.44	40
01547700	Marsh Creek at Blanchard, PA	1955-2015	110	5	85	0.02	9	105	0.54	55
01601000	Wills Creek below Hyndman, PA	1951-2015	380	4	85	0.1	9	109	0.47	39
01557500	Bald Eagle Creek at Tyrone, PA	1944-2015	120	8	88	0.1	8	108	0.47	51

Table 11.9-31: Summary Statistics for the 23 Reference Streams for the Baseflow Index Analysis

Gauge ID	Station Name	Years of Record	Drainage Area (square kilometers)	Urban Land Use (percent)	Forest Cover (percent)	Lakes/ Ponds/ Swamps (percent)	Mean Annual Temperature (°C)	Mean Annual Precipitation (centimeters)	Runoff Ratio (0–1)[1]	Baseflow Index (0–100)[2]
01547950	Beech Creek at Monument, PA	1968-2015	400	5	93	0.1	8	108	0.52	53
USGS Selections within 20 Miles of Roseton										
01373500	Fishkill Creek at Beacon, New York	1944-1968	490							
01372800	Fishkill Creek at Hopewell Junction, New York	1957-1975	150							
01372850	Whortlekill Creek at Hopewell Junction, New York	1959-1968	19							
01372500	Wappinger Creek near Wappingers Falls, New York	1928-2015	440	9	56	1.5	9	115	0.48	50
01372065	Casper Creek near Wappingers Falls, New York	1969-1975	26							
01372400	Great Spring Creek at Pleasant Valley, New York	1960-1965	40							
01371500	Wallkill River at Gardiner, New York	1924-2015	1900	12	42	1.8	9	119	0.48	45
01371000	Shawangunk Kill at Pine Bush, New York	1924-1992	270							

Notes:
°C: Celsius
1 The runoff ratio is equal to the mean annual runoff divided by the mean annual precipitation.
2 The baseflow index represents the percentage of streamflow that is made up of baseflow over a specified period of time. A baseflow index of 0 indicates that 0% of a stream's streamflow consists of baseflow (and therefore 100% of it consists of quickflow). A baseflow index of 100 indicates that 100% of a stream's streamflow consists of baseflow (and therefore 0% of it consists of quickflow).



Note: The baseflow index represents the percentage of streamflow that is made up of baseflow over a specified period of time. A baseflow index of 100 indicates that 100% of a stream's streamflow consists of baseflow. A baseflow index of 0 indicates that 0% of a stream's streamflow consists of baseflow (and therefore 100% of it consists of quickflow).

Figure 11.9-70: Locations of Reference Streams for Baseflow Index Analysis

Using the Wahl program, long-term baseflow indices were computed for the reference streams to verify those published in the database. Results differed by an average of approximately 2.4 percent, likely due to the extension of streamflow records since the baseflow indices were computed for the database in 2003. This provided a degree of confidence in the methodology and the reliability of the Wahl program. Baseflow indices for the reference streams for January 1, 2014 to September 30, 2014 were computed to be, on average, approximately 1.6 percent higher than their long-term baseflow indices, suggesting that the monitoring period was more or less representative of the long-term. Baseflow indices computed for the seven stations in the study area over this same time period are presented in **Table 11.9-32**.

Table 11.9-32: Baseflow Indices for the Seven Surface Water Monitoring Stations

Station	Stream Segment	Calculated Baseflow Index[1] For January 1, 2014 to September 30, 2014 Monitoring Period
S1-SW-01	1	60
S3-SW-01	3A	67
S3-SW-02	3 above 3A	93
S3-SW-03	Tributary to 3	89
S3-SW-04	3B	87
S4-SW-01	4	89
S4-SW-02	4	87

Note:
[1] The baseflow index represents the percentage of streamflow that is made up of baseflow over a specified period of time. A baseflow index of 0 indicates that 0% of a stream's streamflow consists of baseflow (and, therefore, 100% of it consists of quickflow). A baseflow index of 100 indicates that 100% of a stream's streamflow consists of baseflow (and, therefore, 0% of it consists of quickflow).

The results indicate higher baseflow indices than those for other regional watersheds with similar hydrogeologic characteristics, which are all less than 60 as shown in **Table 11.9-31**. The baseflow indices of 60 and 67 for S1-SW-01 and S3-SW-01 suggest a marginal degree of leak water influence for Stream Segments 1 and 3A, although it is possible that the baseflow index for Roseton Brook under natural conditions is slightly higher than it is for the reference watersheds. However, the high baseflow indices for the other five stations indicate strong contributions from leak water at these locations.

Flow duration curves show relationships between flow rate and frequency, or more specifically, the percentage of time that various flow rates were equaled or exceeded over a specified period of time. They provide another means of examining the degree of streamflow or baseflow variability at a particular location. For the seven stations in the study area, streamflow duration curves based on the monitoring period (Water Year 2014) are provided on **Figure 11.9-71**. The relatively curved shapes of these lines for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01) indicate a variable streamflow regime that is responsive to storm events. Conversely, the flatter shapes of these lines for Stream Segment 3 (S3-SW-02), its unnamed tributary (S3-SW-03), Stream Segment 3B (S3-SW-04), and Stream Segment 4 (S4-SW-01 and S4-SW-02) indicate steadier streamflows that are less responsive to storm events.

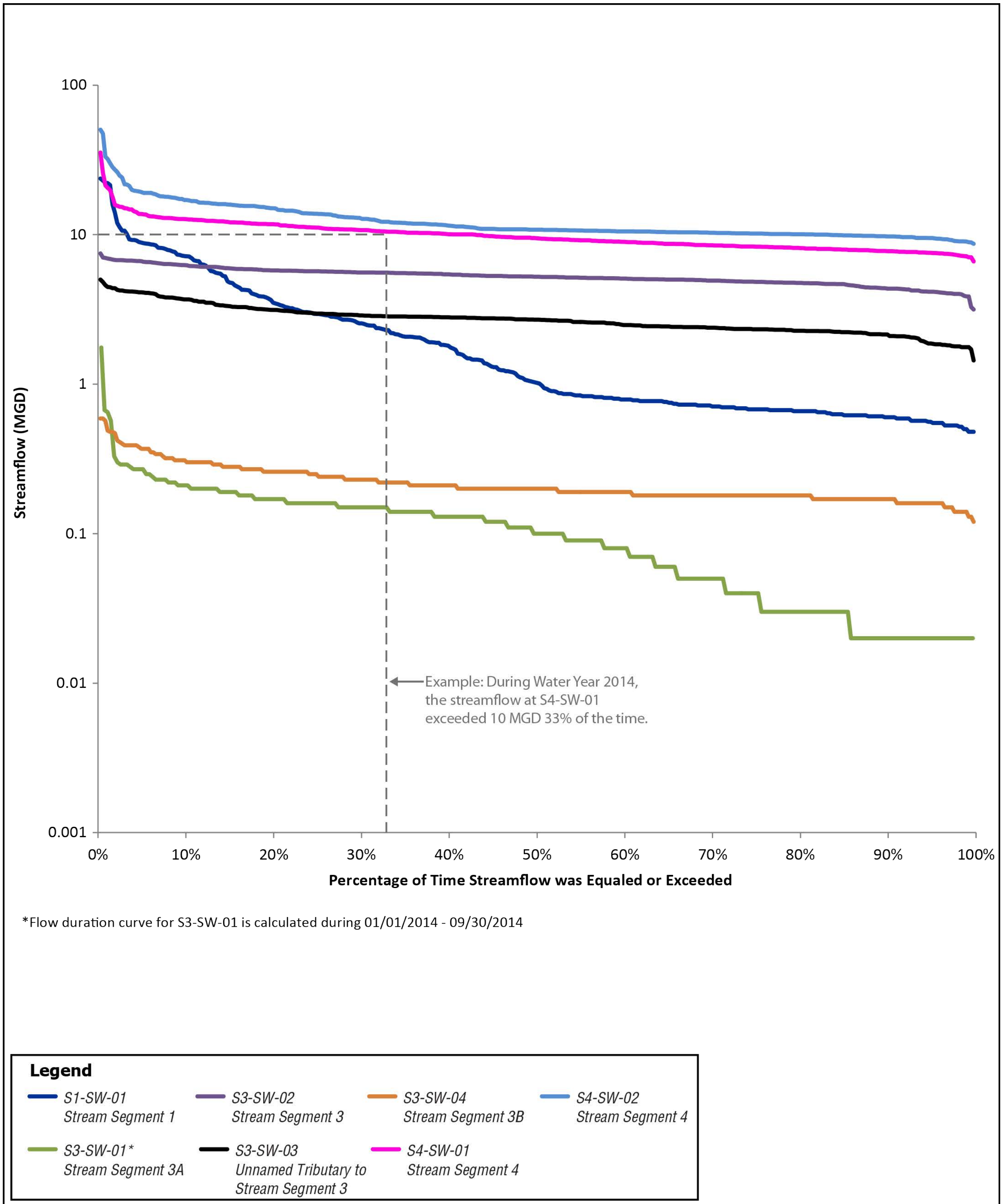


Figure 11.9-71: Streamflow Duration Curves for Water Year 2014 – Natural Resources Study Area

This is consistent with the baseflow indices in **Table 11.9-32**. Curves for Stream Segments 1 and 3A are typical of naturally occurring streams with drainage areas large enough for storm events to result in considerable volumes of runoff. Curves for the other stream segments can be explained by the more consistent influence of leak water and, for Stream Segment 3, its unnamed tributary and Stream Segment 3B, drainage areas that are too small to generate any substantial volumes of runoff. Baseflow duration curves suggest largely similar conclusions (see **Figure 11.9-72**). While its response time is delayed in comparison to streamflow, baseflow is still influenced by storm events through infiltration of rainwater into the groundwater system and subsequent increases in groundwater inflows. Thus, lines with greater curvature, such as those for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01), suggest naturally occurring streams that are responsive to storm events, while lines that are flatter, such as those for Stream Segment 3 (S3-SW-02), its unnamed tributary (S3-SW-03), Stream Segment 3B (S3-SW-04), and Stream Segment 4 (S4-SW-01 and S4-SW-02), indicate the steadier contribution of leak water.

Leak Contribution Estimates

As described in Section 11.9.5.3, "Surface Water – Methodology," mean leak contributions were estimated for each monitoring station by assuming a typical range for its baseflow index under natural, non-leak-influenced conditions. This range was chosen as the middle 90 percent of the distribution of baseflow indices for the reference streams, falling between the values of 36 and 54. The difference in these values of 18 percent generally matches expected standard errors from the baseflow estimation literature (Neff et al. 2005; Stuckey 2006). Results are shown in **Table 11.9-33**.

Table 11.9-33: Mean Leak Contributions Estimated Through the Baseflow Index Analysis

Station	Stream Segment	Calculated Baseflow Index for the January 1, 2014 to September 30, 2014 Monitoring Period	Mean Observed Baseflow for the January 1, 2014 to September 30, 2014 Monitoring Period (mgd)[1]	Estimated Mean Leak Contribution (mgd)	
				Baseflow Index = 54[2]	Baseflow Index = 36[3]
S1-SW-01	1	60	1.9	0.4	1.2
S3-SW-01	3A	67	0.1	< 0.1	0.1
S3-SW-02	3 above 3A	93	5.1	4.7	4.9
S3-SW-03	3 tributary	89	2.4	2.1	2.3
S3-SW-04	3B	87	0.2	0.1	0.2
S4-SW-01	4	89	9.3	7.9	8.6
S4-SW-02	4	87	11.6	9.6	10.6

Notes:
1 Because the observed streamflow distributions are right-skewed, the mean flow rates in this column cannot be directly compared to the median flow rates presented in the rest of this section.
2 A baseflow index of 54 indicates that 54% of a stream's streamflow consists of baseflow (and therefore 46% of it consists of quickflow).
3 A baseflow index of 36 indicates that 36% of a stream's streamflow consists of baseflow (and therefore 64% of it consists of quickflow).

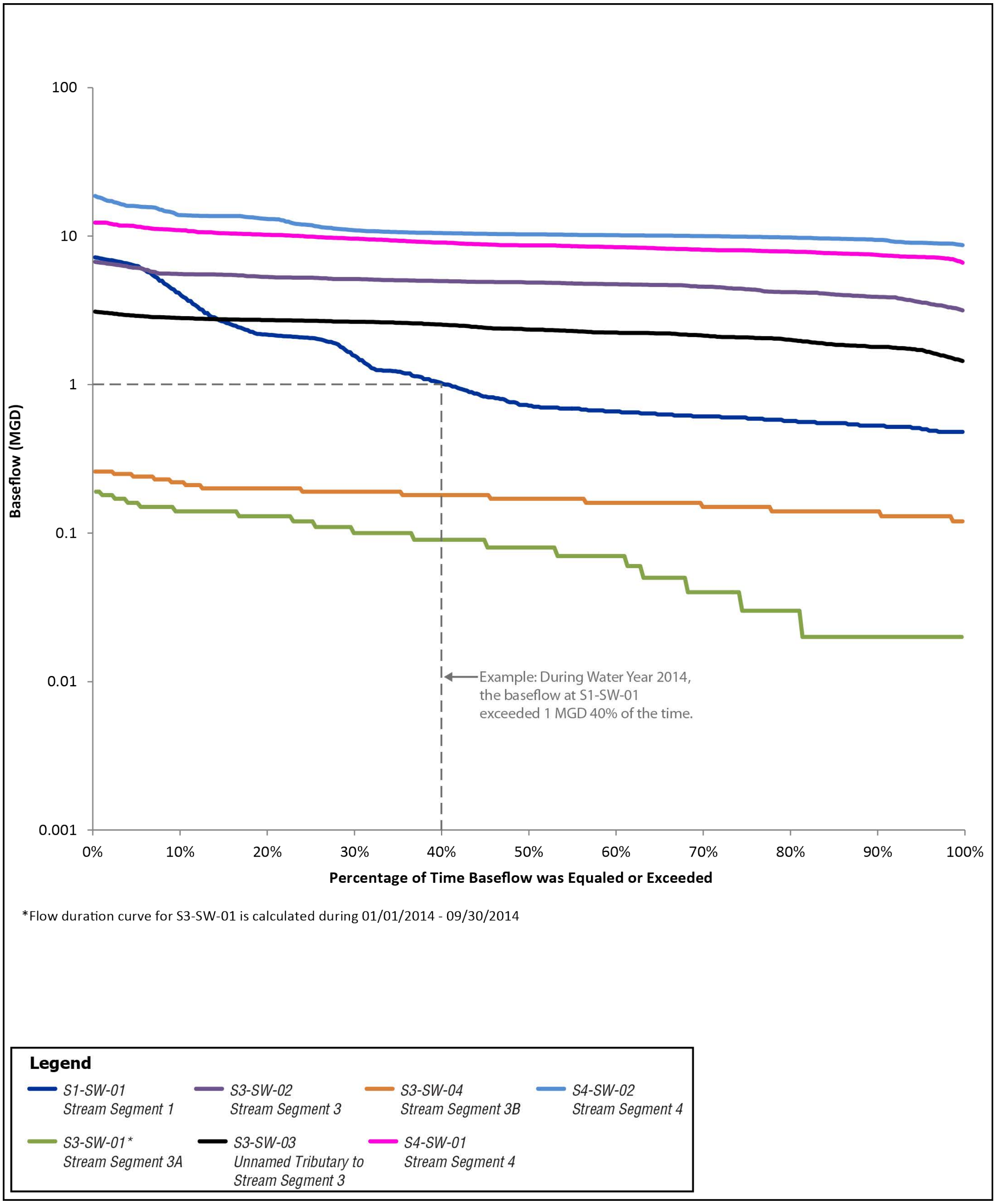


Figure 11.9-72: Baseflow Duration Curves for Water Year 2014 – Natural Resources Study Area

The results suggest a total mean leak contribution of approximately 10 mgd (approximately 9.6 to 10.6 mgd, depending on the baseflow index scenario assumed), as measured at the downstream end of Stream Segment 4 (S4-SW-02). Approximately half of this flow (4.7 to 4.9 mgd, as measured at S3-SW-02) appears to come from the surface expressions along the upstream portion of Stream Segment 3, while roughly one quarter (2.1 to 2.3 mgd, as measured at S3-SW-03) comes from its unnamed tributary. Most of the remainder of the leak water contribution appears to manifest along Stream Segment 4.

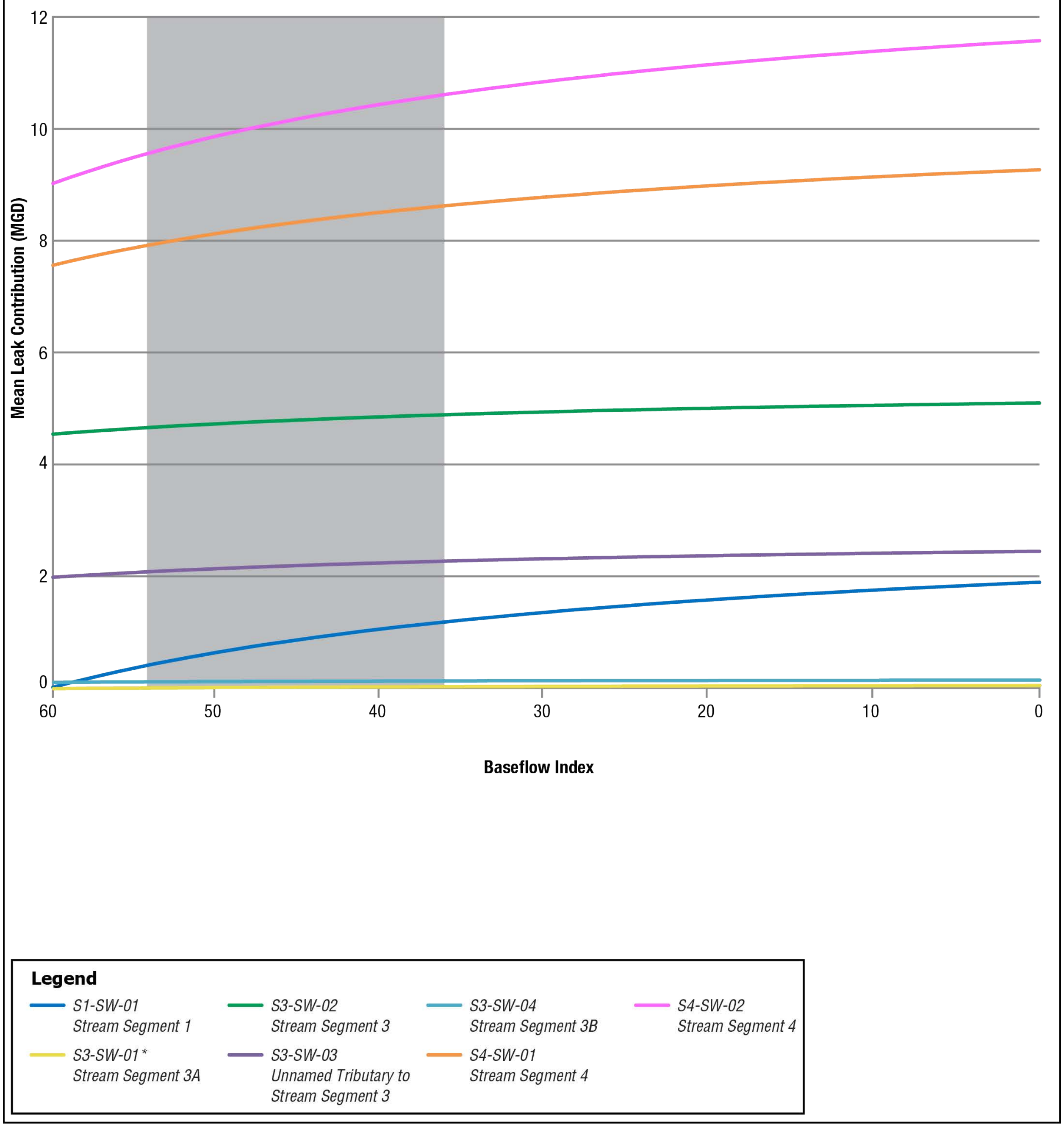
A sensitivity analysis was conducted to demonstrate the effect of a varying baseflow index on the leak contribution estimates. The sensitivity analysis accounted for the possibility that parts of the Roseton Brook System were unaffected by leak water, in which case the lowest baseflow index computed for its stream segments (60, for Stream Segment 1) could be possible under natural, non-leak conditions. It also accounted for the possibility that some stream segments might not exist at all without leak contributions, in which case their natural baseflow index would be zero. The results of this analysis are presented on **Figure 11.9-73**. As shown, expanding the range of baseflow indices does not result in large changes to the leak contribution estimates, with the range of these estimates widening to approximately 9.0 to 11.6 mgd.

The percentage of baseflow assumed to be leak water was also evaluated (see **Figure 11.9-74**). As shown, if the baseflow index at the downstream end of Stream Segment 4 (S4-SW-02) is between 36 and 54 under non-leak-influenced conditions, approximately 83 to 92 percent of its baseflow would be removed from cessation of leaks due to decommissioning.

Results of the Seepage Investigation

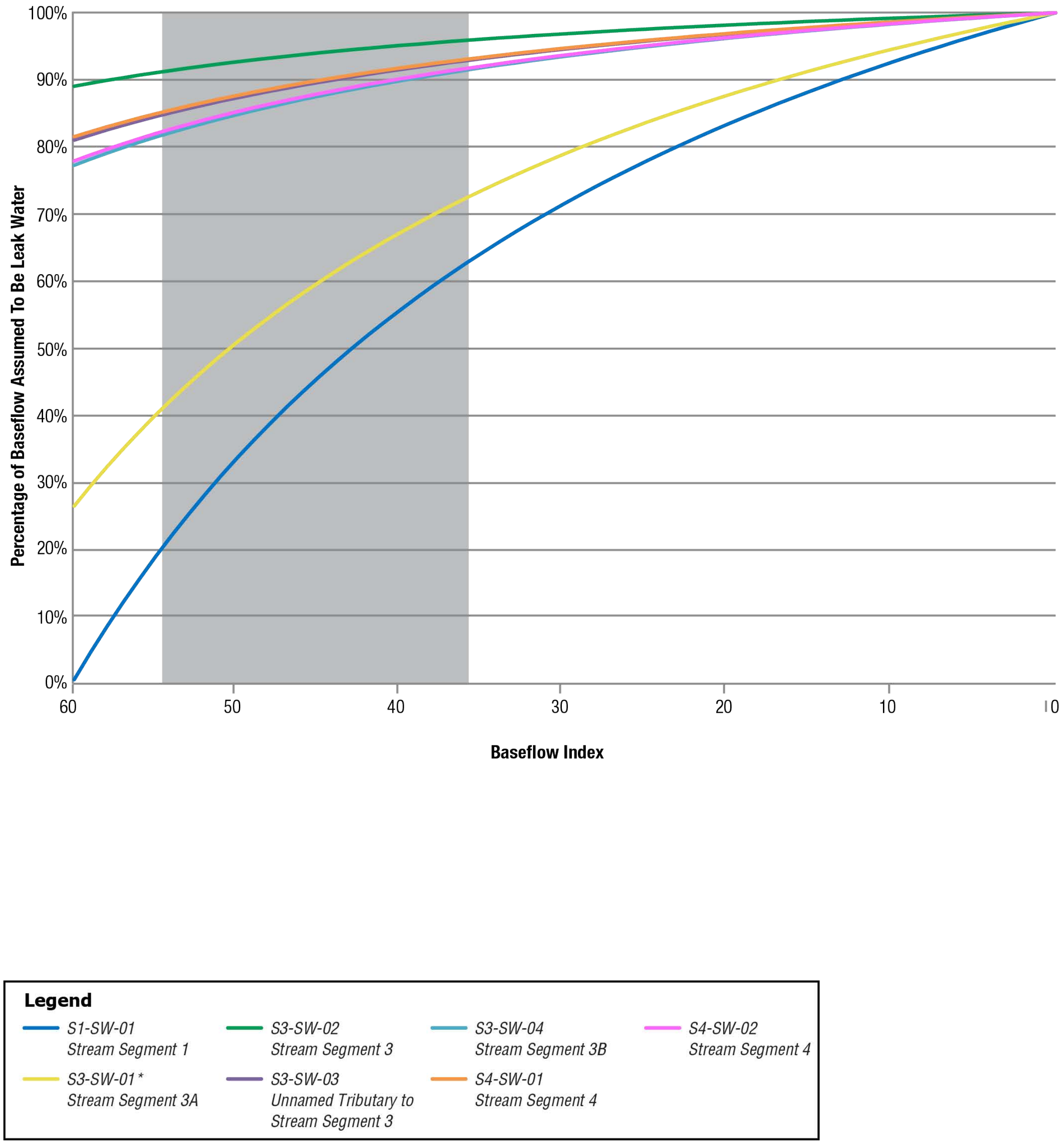
Under the assumption that stream segments with anomalously large gains (with respect to changes in streamflow along other segments of the stream system) could suggest leak water influence, a seepage investigation was conducted to assess streamflow gains and losses throughout the Roseton Brook System. Results of this investigation were used to corroborate the leak contribution estimates from the baseflow index analysis described above.

A network diagram for the seepage investigation is provided on **Figure 11.9-75**, illustrating the flow measurement locations and their connection between stream segments, conveyances (i.e., culverts), and storage features (i.e., ponds). Results are presented on **Figure 11.9-76** and in **Table 11.9-34**, which shows gains and losses in streamflow observed during the field investigation. As shown, there is a relatively large loss of streamflow along the middle reach of Stream Segment 3, a large gain along the lower reach of Stream Segment 3, and a large gain along the lower reach of Stream Segment 4. These reflect the points at which water, the majority of which is presumably leak-based, enters and exits the stream system.



**Note: Gray area represents estimates in the most likely baseflow index range of 36 to 54*
The baseflow index represents the percentage of streamflow that is made up of baseflow over a specified of time. A baseflow index of 60 indicates that 60% of a stream's streamflow consists of baseflow (and therefore 40% of it consists of quickflow). A baseflow index of 0 indicates that 0% of a stream's streamflow consists of baseflow (and therefore 100% consists of quickflow)

Figure 11.9-73: Mean Leak Contributions Under Various Baseflow Index Scenarios



**Note: Gray area represents estimates in the most likely baseflow index range of 36 to 54*
The baseflow index represents the percentage of streamflow that is made up of baseflow over a specified of time. A baseflow index of 60 indicates that 60% of a stream's streamflow consists of baseflow (and therefore 40% of it consists of quickflow). A baseflow index of 0 indicates that 0% of a stream's streamflow consists of baseflow (and therefore 100% consists of quickflow)

Figure 11.9-74: Percentage of Baseflow Assumed to be Leak Water Under Various Baseflow Index Scenarios – Natural Resources Study Area

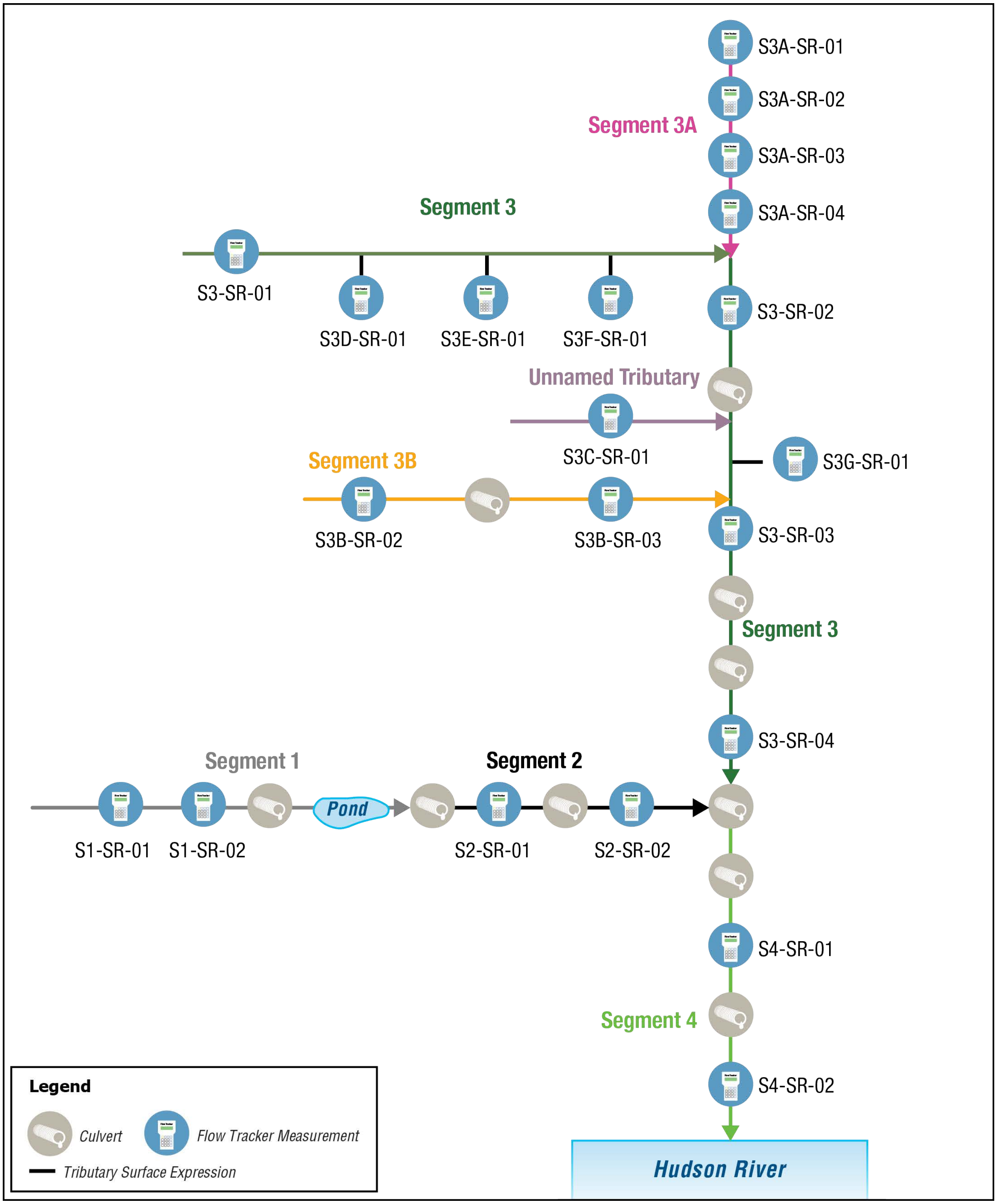


Figure 11.9-75: Seepage Investigation Network Diagram – Natural Resources Study Area

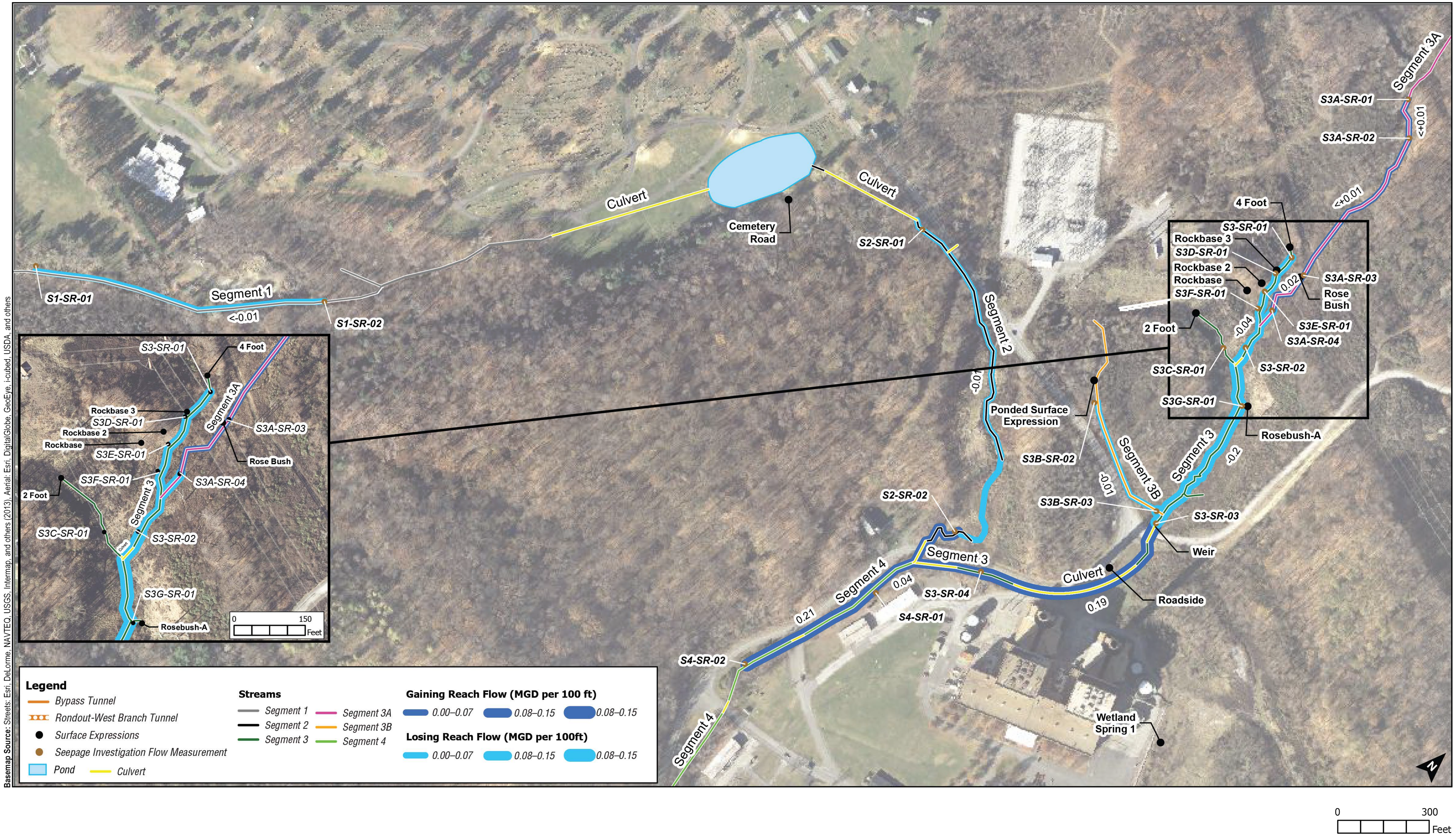


Figure 11.9-76: Seepage Investigation Results – Natural Resources Study Area

Table 11.9-34: Net Changes in Flow from the Seepage Investigation

Seepage Survey Reach	Start Station	End Station	Distance (Feet)	Net Change in Flow (mgd per 100 Feet)
Segment 1	S1-SR-01	S1-SR-02	970	< -0.01
Segment 2	S2-SR-01	S2-SR-02	1,250	-0.01
Segment 3A - Upper	S3A-SR-01	S3A-SR-02	130	< +0.01
Segment 3A - Mid	S3A-SR-02	S3A-SR-03	590	< +0.01
Segment 3A - Lower	S3A-SR-03	S3A-SR-04	170	+0.02
Segment 3 - Upper	S3-SR-01	S3-SR-02	420	-0.04
Segment 3 – Mid	S3-SR-02	S3-SR-03	720	-0.20
Segment 3 - Lower	S3-SR-03	S3-SR-04	700	+0.19
Segment 3B	S3B-SR-02	S3B-SR-03	430	-0.01
Segment 4 - Upper	S3-SR-04	S4-SR-01	390	+0.04
Segment 4 - Lower	S4-SR-01	S4-SR-02	480	+0.21

Stream Segment 3 originates from a surface expression flowing from a rock face (Four Foot Spring), picking up flow from several smaller surface expressions along its upper reach. Despite these additions to flow, however, there is a net loss of approximately 0.2 mgd per 100 feet along its middle reach, suggesting that Stream Segment 3 is an atypical watercourse with little to no hydraulic connectivity to shallow groundwater that might otherwise infiltrate the stream along its banks. However, along its lower reach, Stream Segment 3 has a net gain of approximately 0.19 mgd per 100 feet, which is likely due to the influence of another surface expression, the Roadside Spring. There is also the potential that the weir at which streamflow was measured for the upstream point of the lower reach is allowing the flow of water through the permeable soils under and beside the weir (hyporheic flow) to pass undetected. This would result in a lower measured flow and exaggerated gain along this reach.

Results for Stream Segment 4 indicate a nominal gain along its upper reach but a large gain of approximately 0.21 mgd per 100 feet along its lower reach, for a total gain along this 480-foot reach of approximately 1 mgd. The mean leak contribution calculated in the baseflow index analysis (under an assumed baseflow index of 54) is approximately 7.9 mgd for the upstream end of Stream Segment 4 and approximately 9.6 mgd for the downstream end of Stream Segment 4, implying that Stream Segment 4 gains 1.7 mgd of leak water along its length. The results of the seepage investigation are thus fairly consistent with the results of the baseflow index analysis. The gain may also be influenced by stormwater or process water outfalls that discharge to Stream Segment 4 from the power plant located to the east, potentially undocumented surface expressions, or tidal inflow as the streambed drops rapidly along this reach (at least one of the groundwater wells in the vicinity has been confirmed to be tidally influenced).

As shown in **Table 11.9-35**, several water quality parameters were also measured during the seepage investigation. There is no discernible difference in dissolved oxygen and pH measurements obtained from the various stream segments. However, there is a difference in water temperature between Stream Segments 1 and 2 and Stream Segments 3, 3A, 3B, and 4. The water temperatures for Stream Segments 3, 3A, 3B, and 4 are lower than they are for Stream Segments 1 and 2, which are more typical of streams receiving lower inputs of groundwater or with ponded or standing water in their flowpaths. There is also a large difference in specific conductivity between Stream Segments 1, 2, and 3A and Stream Segments 3, 3B, and 4. The much lower values measured for the latter three are consistent with the notion that these segments are sourced almost entirely by leak water, which is lower in mineral content and conductivity than water in the natural environment. In addition, with the exception of contributions from the Roadside Spring described above, Stream Segment 3 loses water along its flowpath and so is uninfluenced by groundwater typically higher in mineral content and conductivity.

Table 11.9-35: Water Quality Parameters Measured during the Seepage Investigation

Stream Segment	Survey Station	Streamflow (mgd)	Water Temp (°C)	Dissolved Oxygen (mg/L)	Specific Conductivity (µs/cm)	pH
1	S1-SR-01	0.08	19	5.5	800	7.4
	S1-SR-02	0.05	19	5.9	700	7.6
2	S2-SR-01	0.22	19	4.4	680	8.3
	S2-SR-02	0.09	18	7.3	670	7.9
3A	S3A-SR-01	0.02	12	9.5	720	7.7
	S3A-SR-02	0.02	13	8.1	720	7.8
	S3A-SR-03	0.02	14	8.6	670	8.1
	S3A-SR-04	0.06	15	9.9	680	8.1
3	S3-SR-01	5.58	14	7.5	76	7.2
	S3-SR-02	5.61	14	8.2	80	7.6
	S3-SR-03	5.77	14	9.3	86	7.4
	S3-SR-04	7.07	14	9.4	91	7.3
	S3D-SR-01	0.05	14	6.8	86	7.5
	S3E-SR-01	0.09	14	7.0	85	7.2
	S3F-SR-01	0.01	14	7.5	83	7.1
	S3C-SR-01	0.78	13	8.8	79	7.3
	S3G-SR-01	0.65	14	7.5	83	7.1
3B	S3B-SR-02	0.24	14	5.8	84	7.4
	S3B-SR-03	0.19	14	9.8	89	7.4
4	S4-SR-01	7.31	14	9.4	110	7.5
	S4-SR-02	8.35	15	9.6	120	7.4

Notes:
ºC: Celsius
mg/L: Milligrams per liter
µS/cm: Microsiemens per centimeter

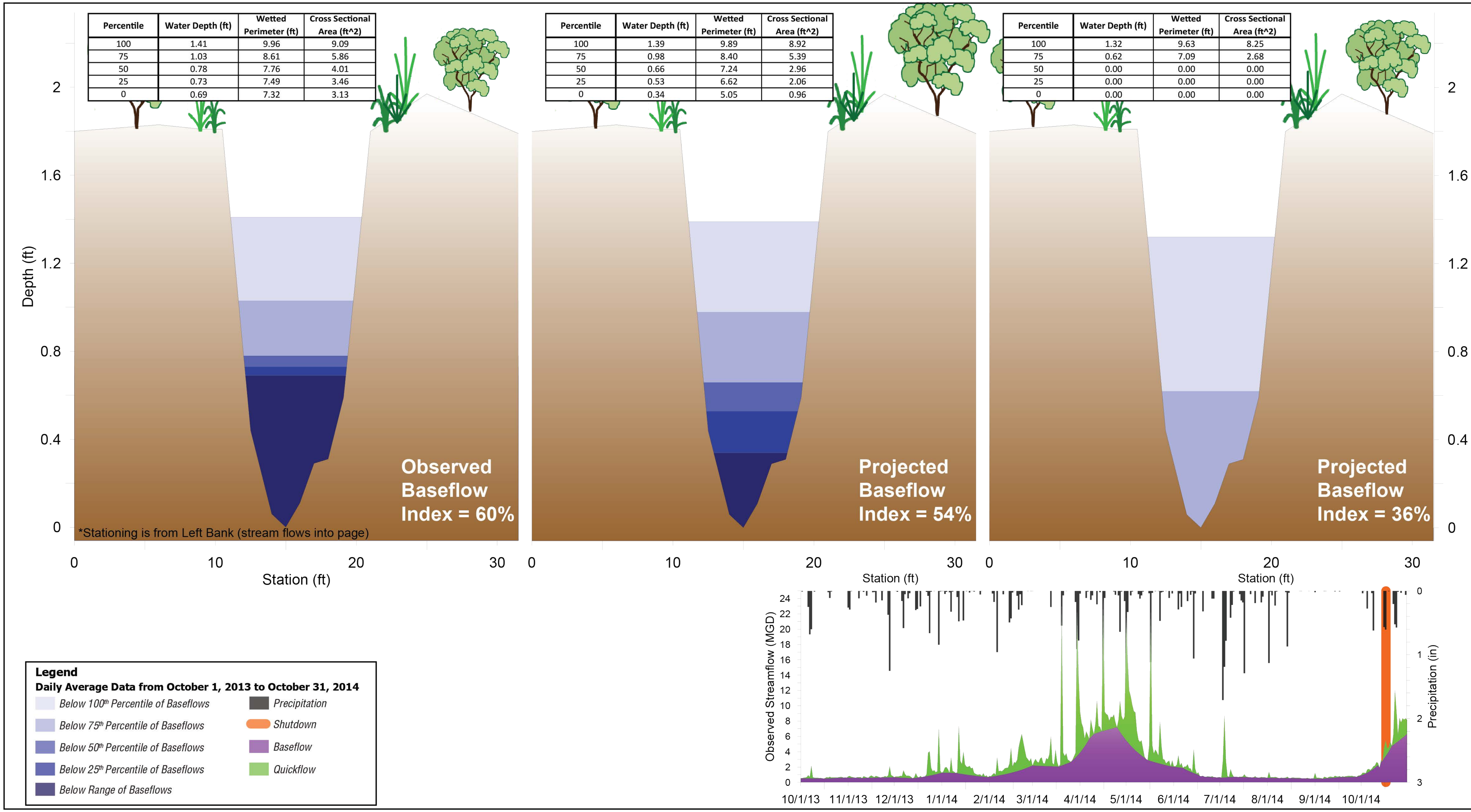
Potential Impacts to Surface Water Quantity

To estimate potential impacts to streamflow, hydrographs were developed for projected conditions following leak cessation from decommissioning. Since the RWBT pressure profile showed little variation over the monitoring period, and thus had little effect on leak flow rates, leak contributions to the stream system were assumed to be constant. For Stream Segments 1, 3A, and 4 (S1-SW-01, S3-SW-01, S4-SW-01, and S4-SW-02), these contributions were subtracted from observed baseflow hydrographs to develop projected baseflow hydrographs that could result from leak cessation. For Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04), observations suggested strong leak water influence with no hydraulic connectivity to shallow groundwater that would otherwise sustain baseflows in the absence of leak water. For these locations, it was assumed that all baseflow would be eliminated as a result of decommissioning.

To illustrate potential changes to submerged areas and wetted perimeters that could result from decommissioning, baseflow hydrographs for Stream Segments 1, 3A, and 4 (S1-SW-01, S3-SW-01, S4-SW-01, and S4-SW-02) were converted into time series of stream stages using the rating curves developed via the Manning’s equation. The 0th, 25th, 50th, 75th, and 100th percentiles of the stream stage distributions were then plotted on stream segment cross-sections as shown on **Figure 11.9-77** to **Figure 11.9-83**. Cross-sections are also shown for Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04), even though streambeds at these locations would be dry in the absence of leak water.

As shown in these figures, a lowering of surface water levels would occur in several stream segments as a result of leak cessation from decommissioning. Under a baseflow index of 54, median baseflow depths for Stream Segment 1 (S1-SW-01) and Stream Segment 3 (S3-SW-01) would decrease by about an inch, from approximately 9 inches to 8 inches and 6 inches to 5 inches, respectively. Median baseflow depths under a baseflow index of 36 would be zero, meaning that there would be no groundwater contribution to these segments at least 50 percent of the time. Drops in water levels under a baseflow index of 54 would be greater at the upstream end of Stream Segment 4 (S4-SW-01), where median baseflow depths would decline by 18 inches from 27 inches to 9 inches, and at the downstream end of Stream Segment 4 (S4-SW-02), where median baseflow depths would decline by 13 inches from 19 inches to 6 inches. Here again, there would be no groundwater contribution at least 50 percent of the time under a baseflow index of 36. For Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04), groundwater would not contribute to the flow regime following decomissioning.

Streamflow hydrographs under projected, non-leak conditions were developed by adding projected baseflow hydrographs to observed quickflow hydrographs, since, as stated previously; quickflow would not change as a result of leak cessation from decommissioning. As for baseflow, the distributions of the corresponding streamflow stages were plotted on stream segment cross-sections to illustrate potential changes to submerged area and wetted perimeter that could result from decommissioning, as shown on **Figure 11.9-84** to **Figure 11.9-90**.



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.41	9.96	9.09
75	1.03	8.61	5.86
50	0.78	7.76	4.01
25	0.73	7.49	3.46
0	0.69	7.32	3.13

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.39	9.89	8.92
75	0.98	8.40	5.39
50	0.66	7.24	2.96
25	0.53	6.62	2.06
0	0.34	5.05	0.96

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.32	9.63	8.25
75	0.62	7.09	2.68
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Figure 11.9-77: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 1 (S1-SW-01)

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.72	4.94	2.22
75	0.61	4.52	1.76
50	0.53	4.05	1.43
25	0.41	3.49	1.01
0	0.34	3.22	0.79

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.67	4.76	2.02
75	0.53	4.08	1.44
50	0.42	3.52	1.04
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.62	4.55	1.78
75	0.42	3.56	1.06
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

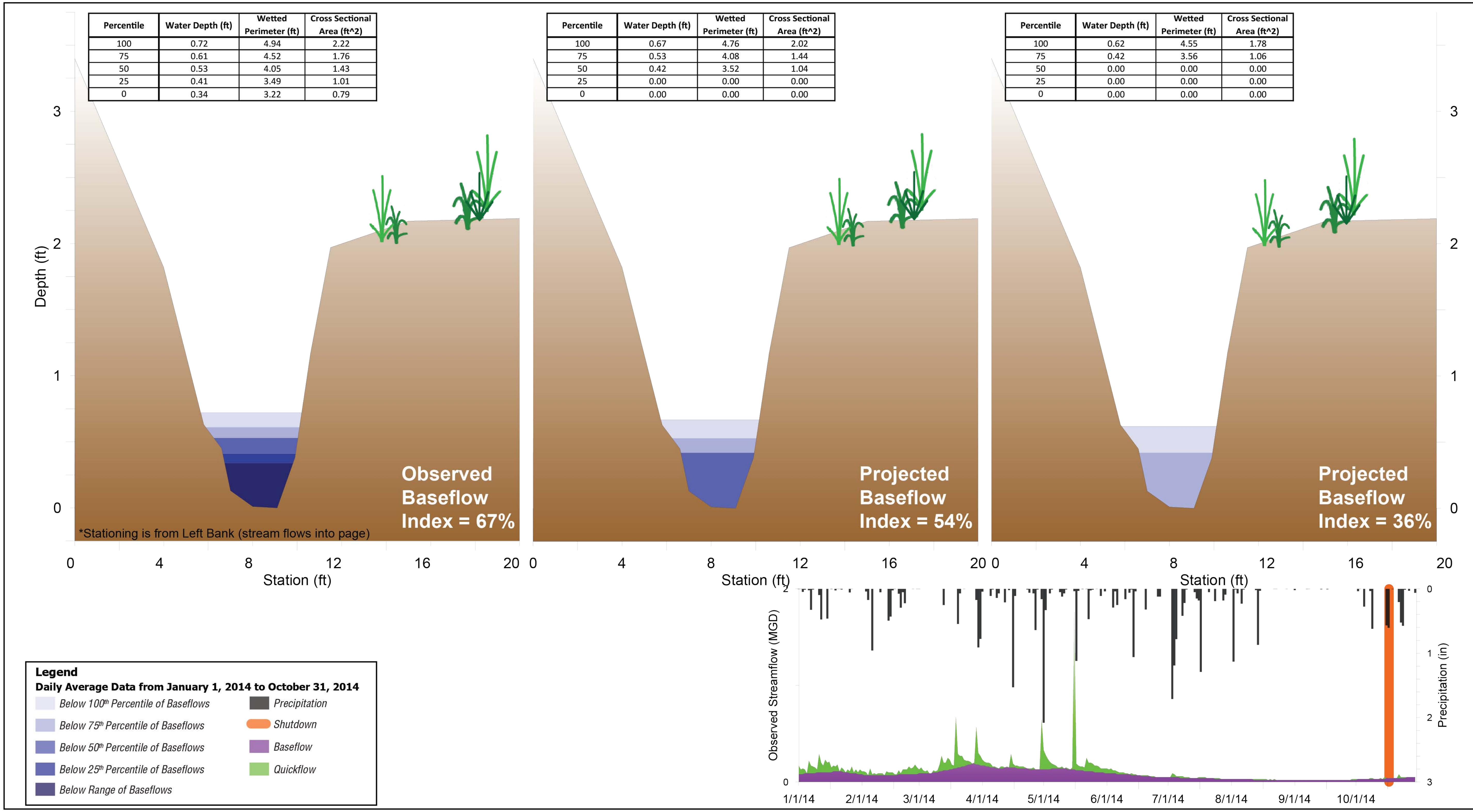
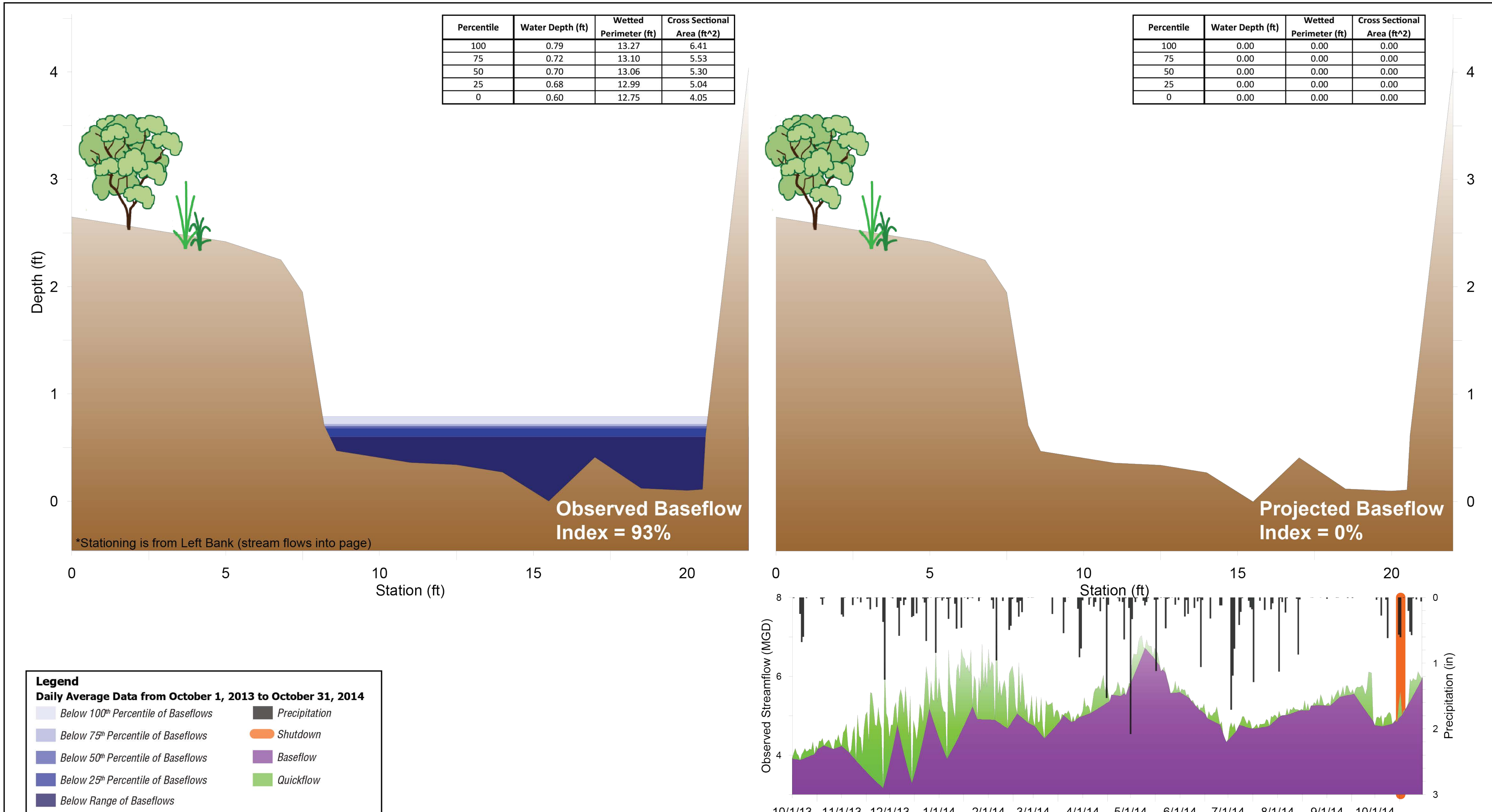


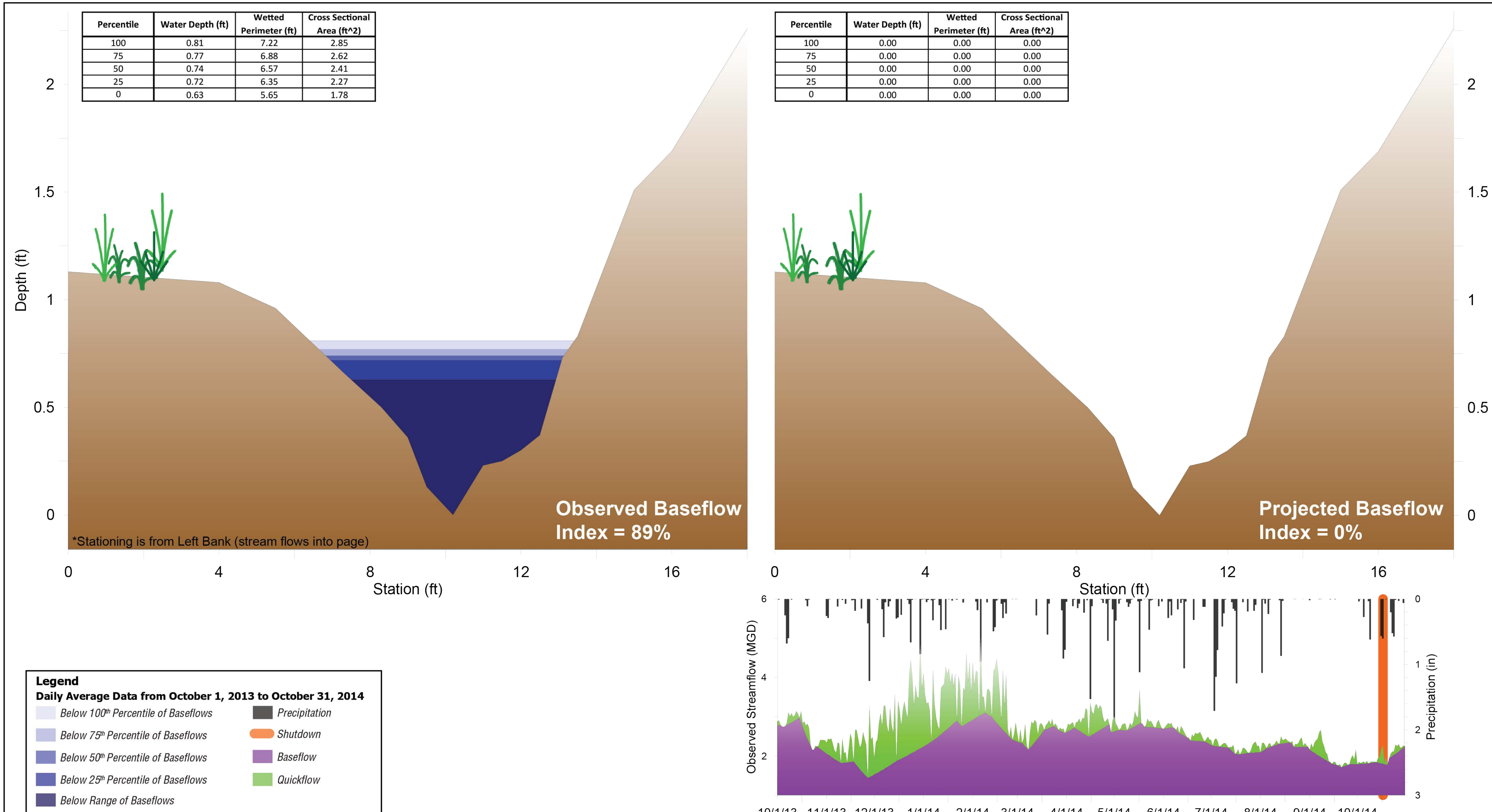
Figure 11.9-78: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 3A (S3-SW-01)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.79	13.27	6.41
75	0.72	13.10	5.53
50	0.70	13.06	5.30
25	0.68	12.99	5.04
0	0.60	12.75	4.05

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.00	0.00	0.00
75	0.00	0.00	0.00
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

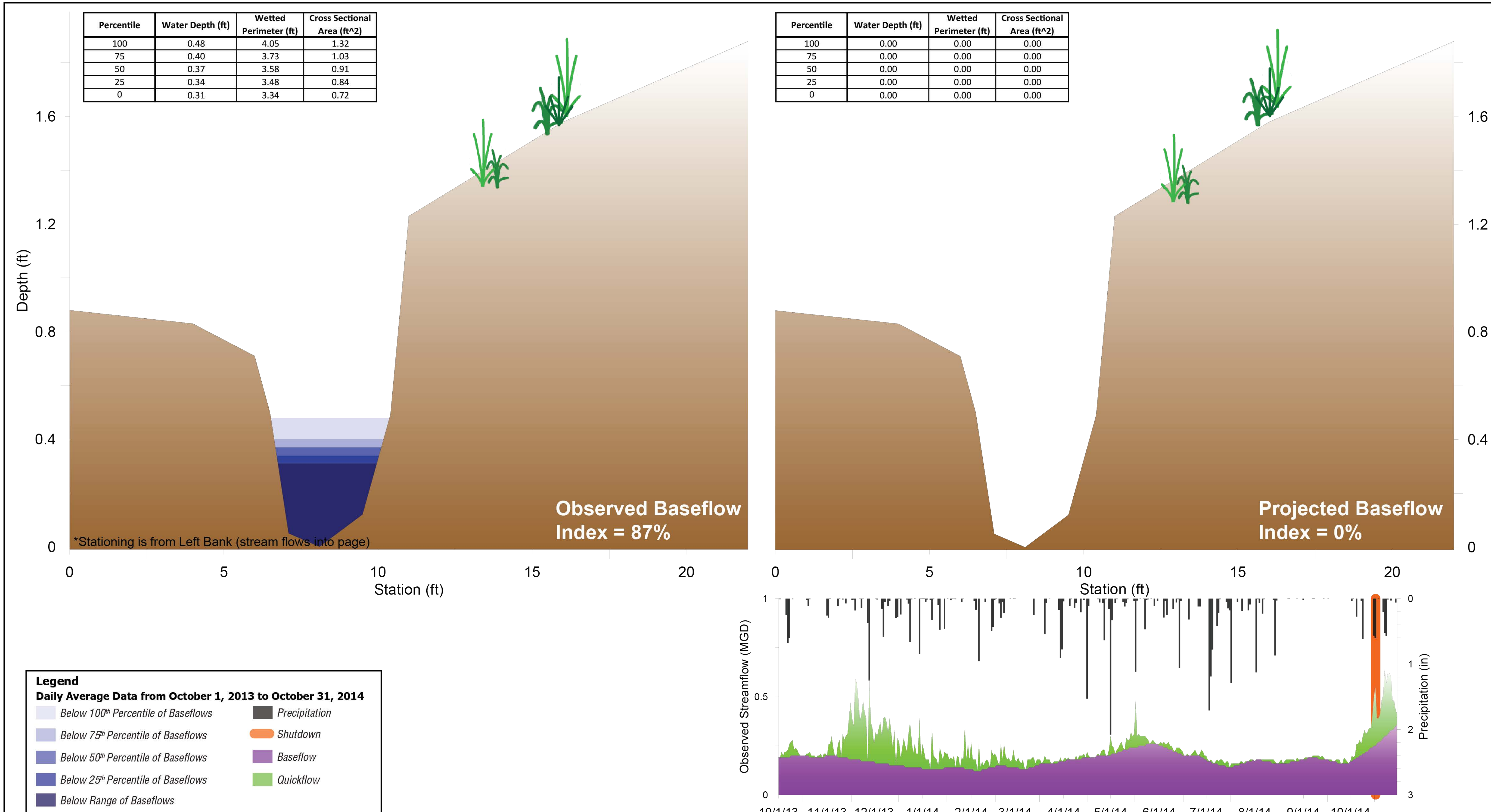
Figure 11.9-79: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 3 (S3-SW-02)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.81	7.22	2.85
75	0.77	6.88	2.62
50	0.74	6.57	2.41
25	0.72	6.35	2.27
0	0.63	5.65	1.78

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.00	0.00	0.00
75	0.00	0.00	0.00
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Figure 11.9-80: Baseflow Distributions under Observed and Projected Conditions for the Unnamed Tributary to Stream Segment 3 (S3-SW-03)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.48	4.05	1.32
75	0.40	3.73	1.03
50	0.37	3.58	0.91
25	0.34	3.48	0.84
0	0.31	3.34	0.72

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.00	0.00	0.00
75	0.00	0.00	0.00
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Figure 11.9-81: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 3B (S3-SW-04)

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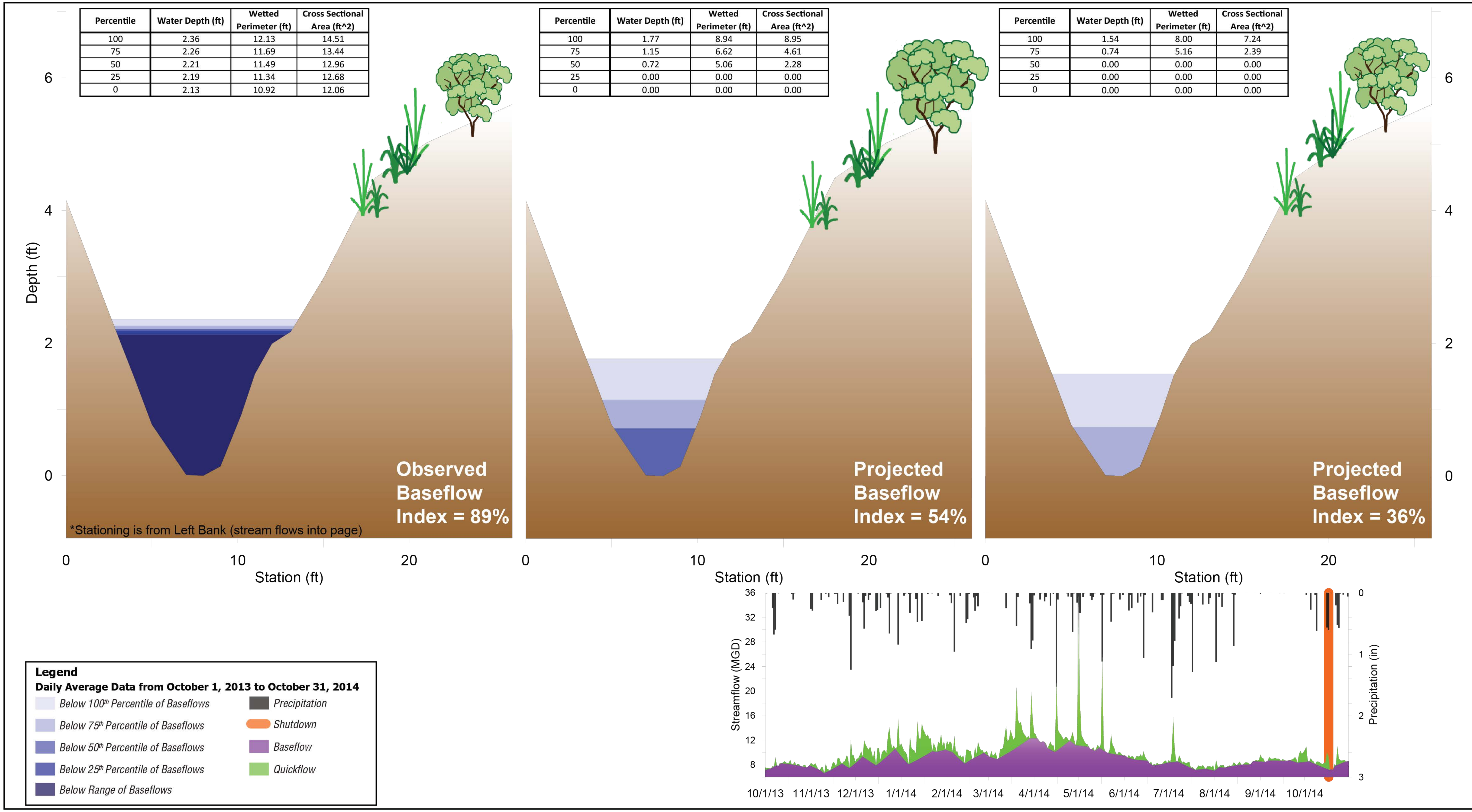
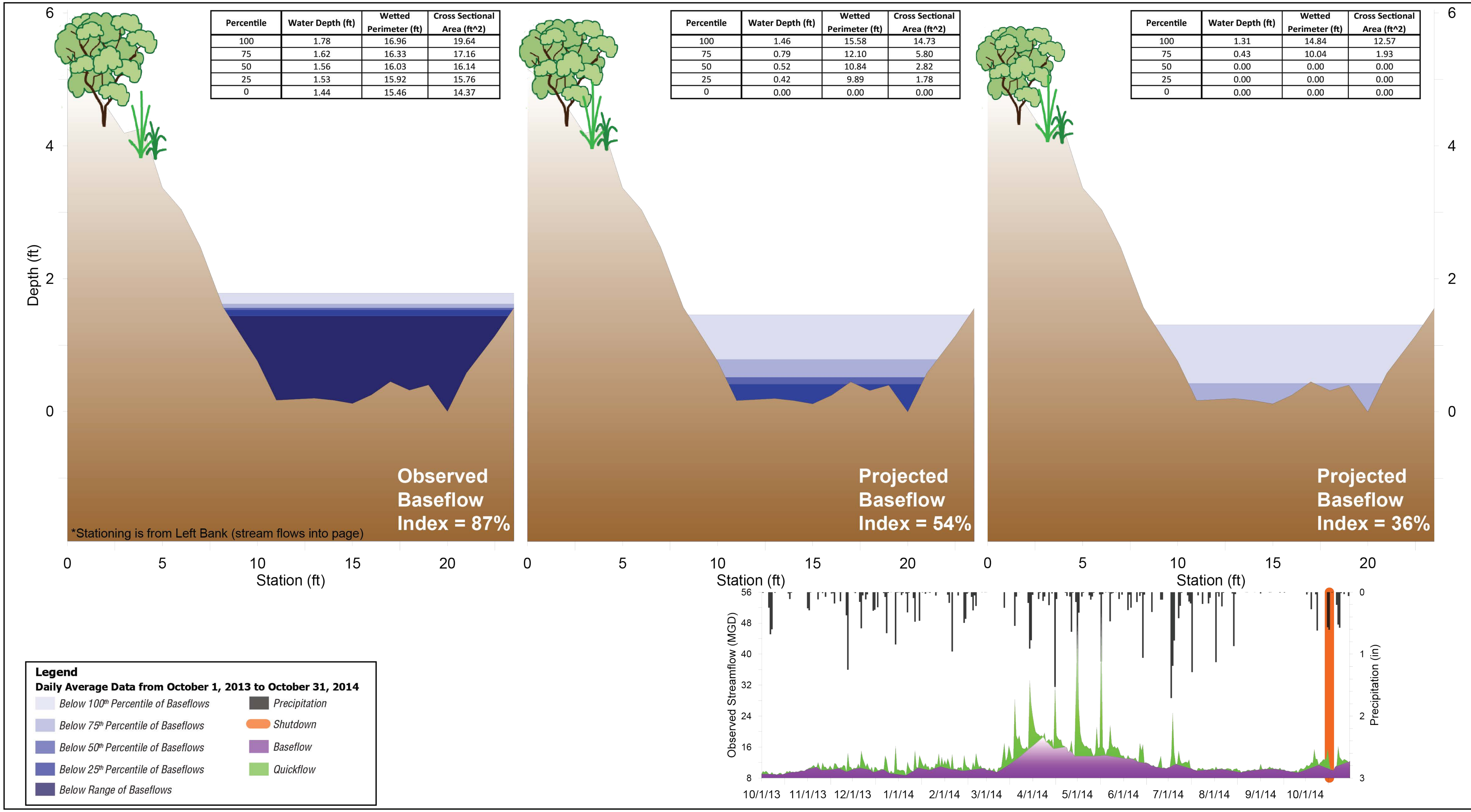


Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.36	12.13	14.51
75	2.26	11.69	13.44
50	2.21	11.49	12.96
25	2.19	11.34	12.68
0	2.13	10.92	12.06

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.77	8.94	8.95
75	1.15	6.62	4.61
50	0.72	5.06	2.28
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.54	8.00	7.24
75	0.74	5.16	2.39
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Figure 11.9-82: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 4 (S4-SW-01)

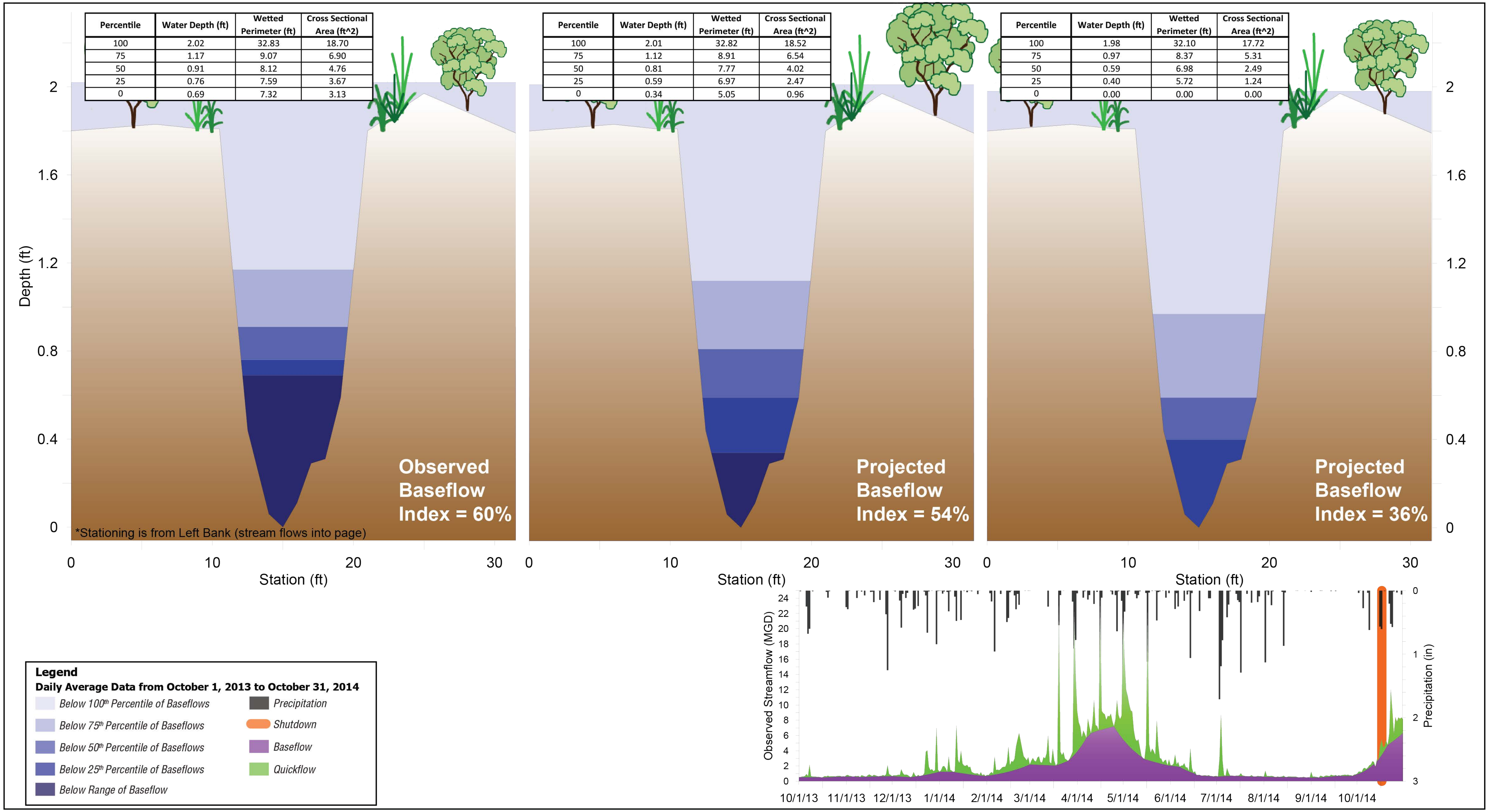


Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.78	16.96	19.64
75	1.62	16.33	17.16
50	1.56	16.03	16.14
25	1.53	15.92	15.76
0	1.44	15.46	14.37

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.46	15.58	14.73
75	0.79	12.10	5.80
50	0.52	10.84	2.82
25	0.42	9.89	1.78
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.31	14.84	12.57
75	0.43	10.04	1.93
50	0.00	0.00	0.00
25	0.00	0.00	0.00
0	0.00	0.00	0.00

Figure 11.9-83: Baseflow Distributions under Observed and Projected Conditions for Stream Segment 4 (S4-SW-02)

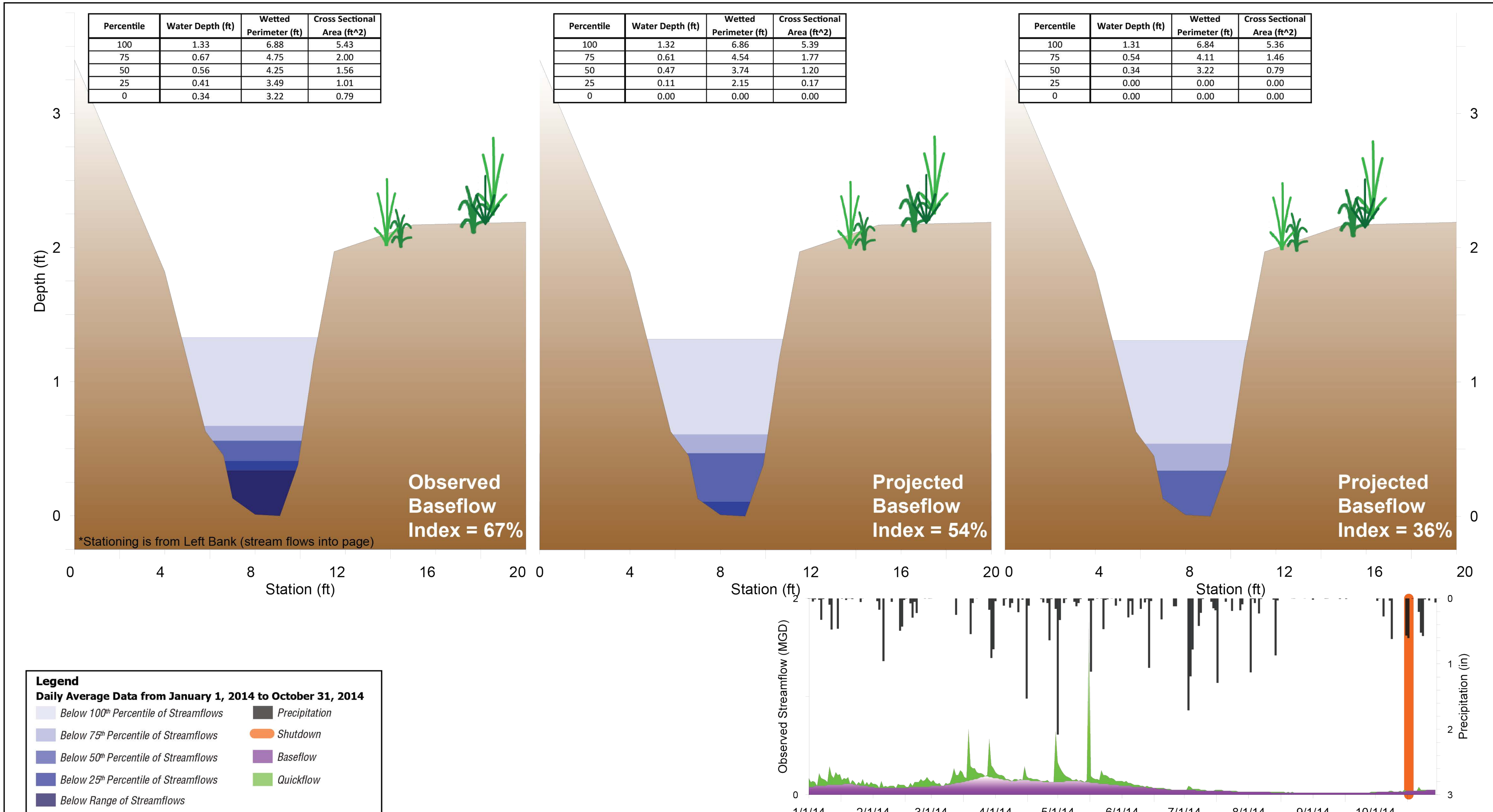


Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.02	32.83	18.70
75	1.17	9.07	6.90
50	0.91	8.12	4.76
25	0.76	7.59	3.67
0	0.69	7.32	3.13

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.01	32.82	18.52
75	1.12	8.91	6.54
50	0.81	7.77	4.02
25	0.59	6.97	2.47
0	0.34	5.05	0.96

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.98	32.10	17.72
75	0.97	8.37	5.31
50	0.59	6.98	2.49
25	0.40	5.72	1.24
0	0.00	0.00	0.00

Figure 11.9-84: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 1 (S1-SW-01)

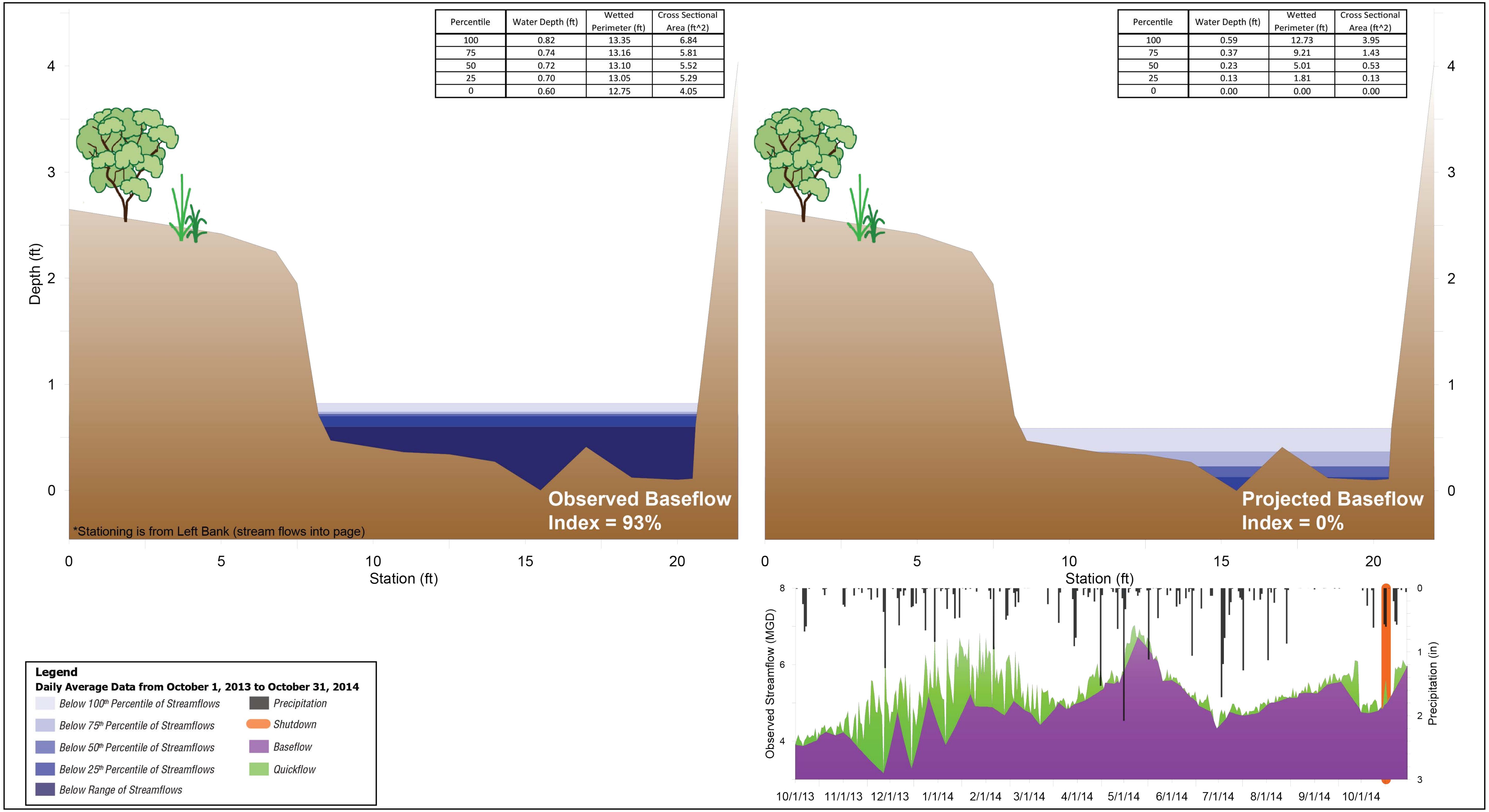


Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.33	6.88	5.43
75	0.67	4.75	2.00
50	0.56	4.25	1.56
25	0.41	3.49	1.01
0	0.34	3.22	0.79

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.32	6.86	5.39
75	0.61	4.54	1.77
50	0.47	3.74	1.20
25	0.11	2.15	0.17
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	1.31	6.84	5.36
75	0.54	4.11	1.46
50	0.34	3.22	0.79
25	0.00	0.00	0.00
0	0.00	0.00	0.00

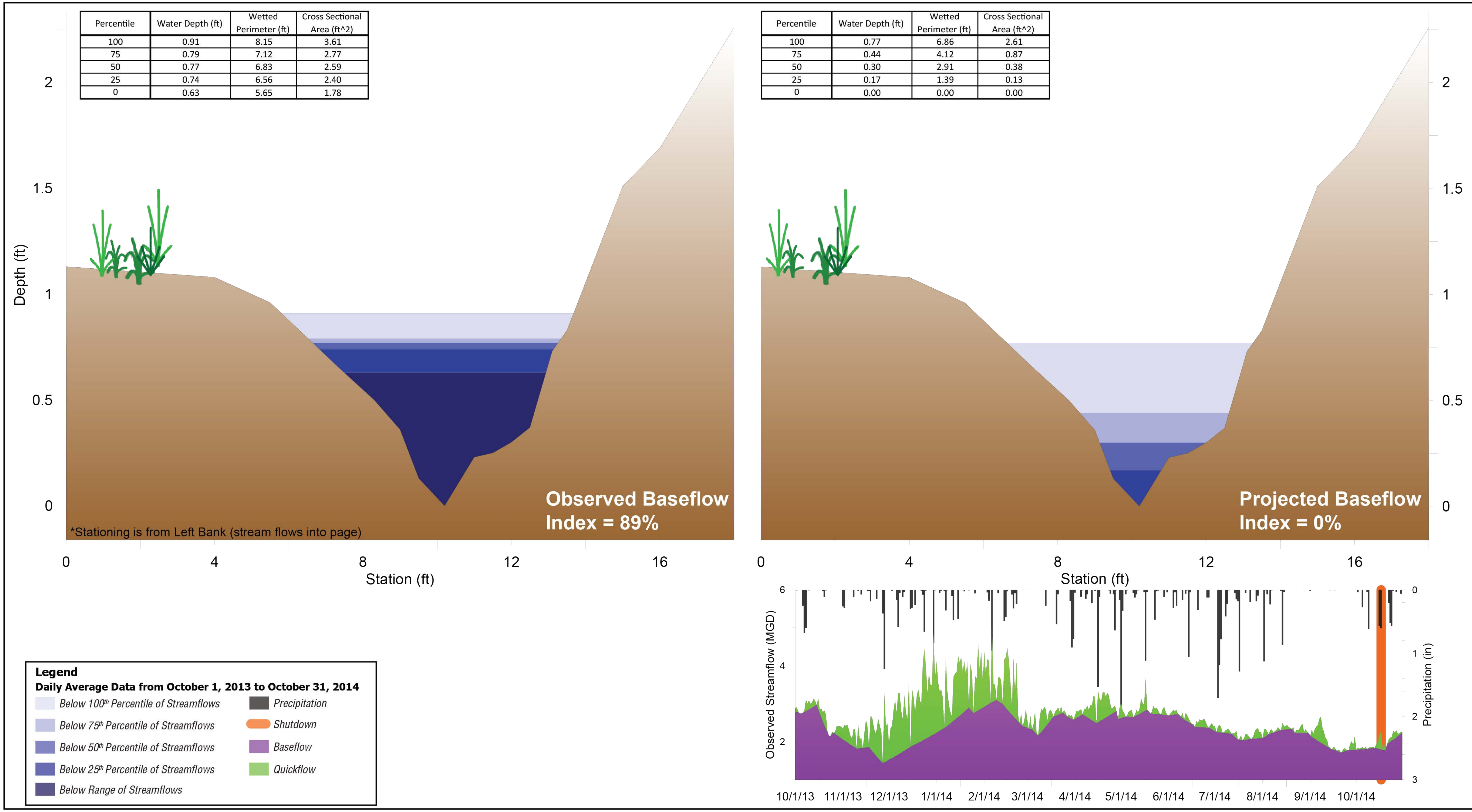
Figure 11.9-85: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 3A (S3-SW-01)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.82	13.35	6.84
75	0.74	13.16	5.81
50	0.72	13.10	5.52
25	0.70	13.05	5.29
0	0.60	12.75	4.05

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.59	12.73	3.95
75	0.37	9.21	1.43
50	0.23	5.01	0.53
25	0.13	1.81	0.13
0	0.00	0.00	0.00

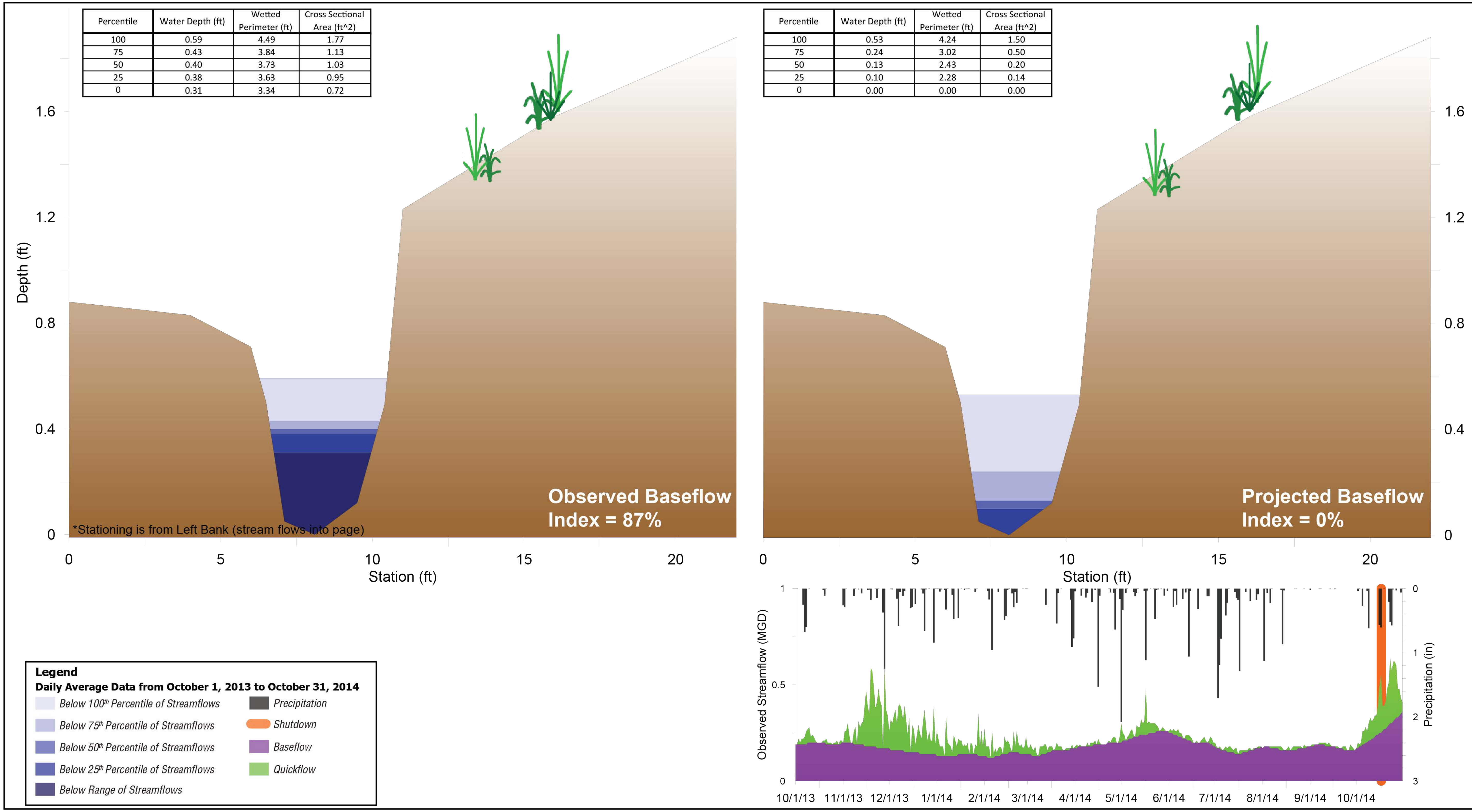
Figure 11.9-86: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 3 (S3-SW-02)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.91	8.15	3.61
75	0.79	7.12	2.77
50	0.77	6.83	2.59
25	0.74	6.56	2.40
0	0.63	5.65	1.78

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.77	6.86	2.61
75	0.44	4.12	0.87
50	0.30	2.91	0.38
25	0.17	1.39	0.13
0	0.00	0.00	0.00

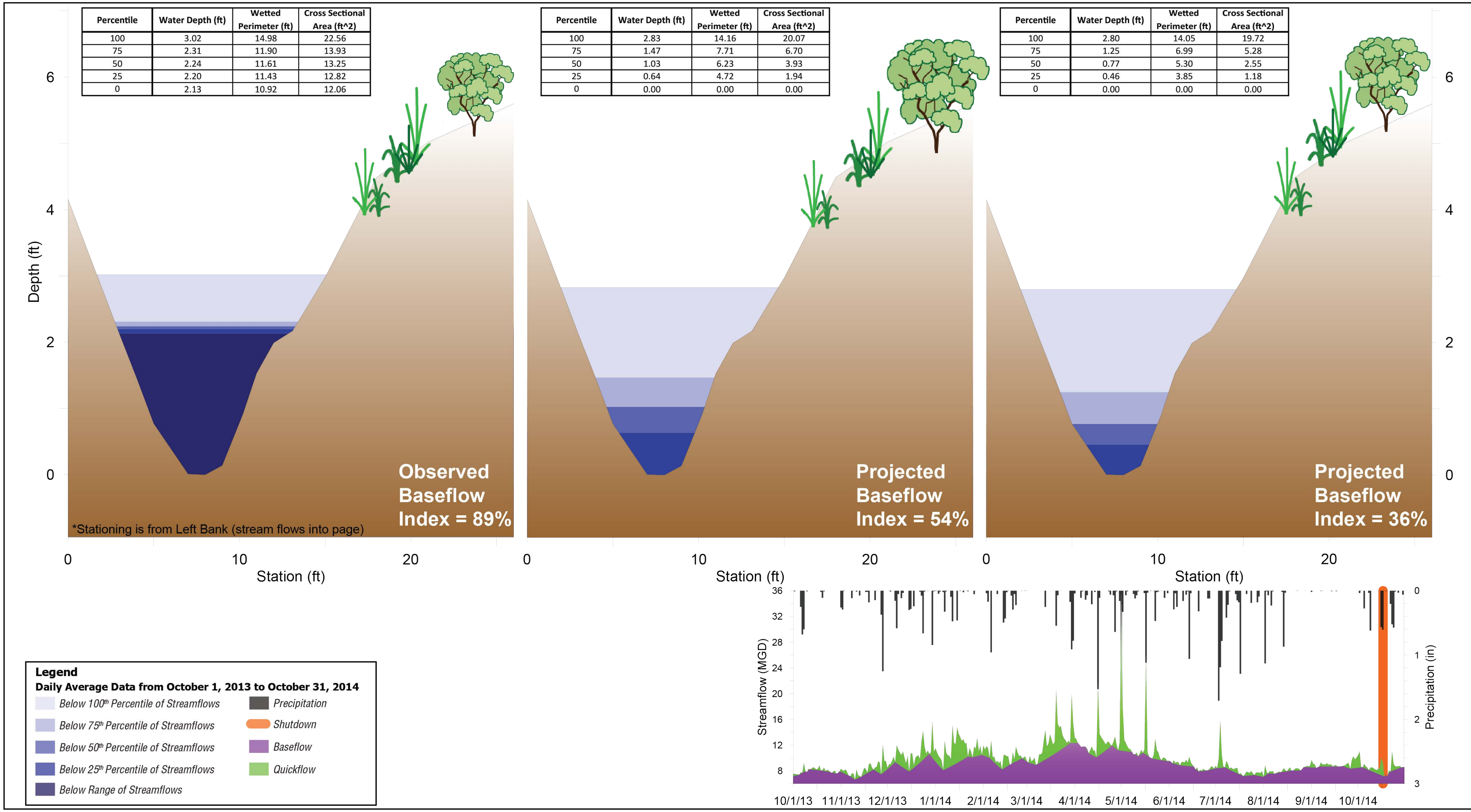
Figure 11.9-87: Streamflow Distributions under Observed and Projected Conditions for the Unnamed Tributary to Stream Segment 3 (S3-SW-03)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.59	4.49	1.77
75	0.43	3.84	1.13
50	0.40	3.73	1.03
25	0.38	3.63	0.95
0	0.31	3.34	0.72

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	0.53	4.24	1.50
75	0.24	3.02	0.50
50	0.13	2.43	0.20
25	0.10	2.28	0.14
0	0.00	0.00	0.00

Figure 11.9-88: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 3B (S3-SW-04)

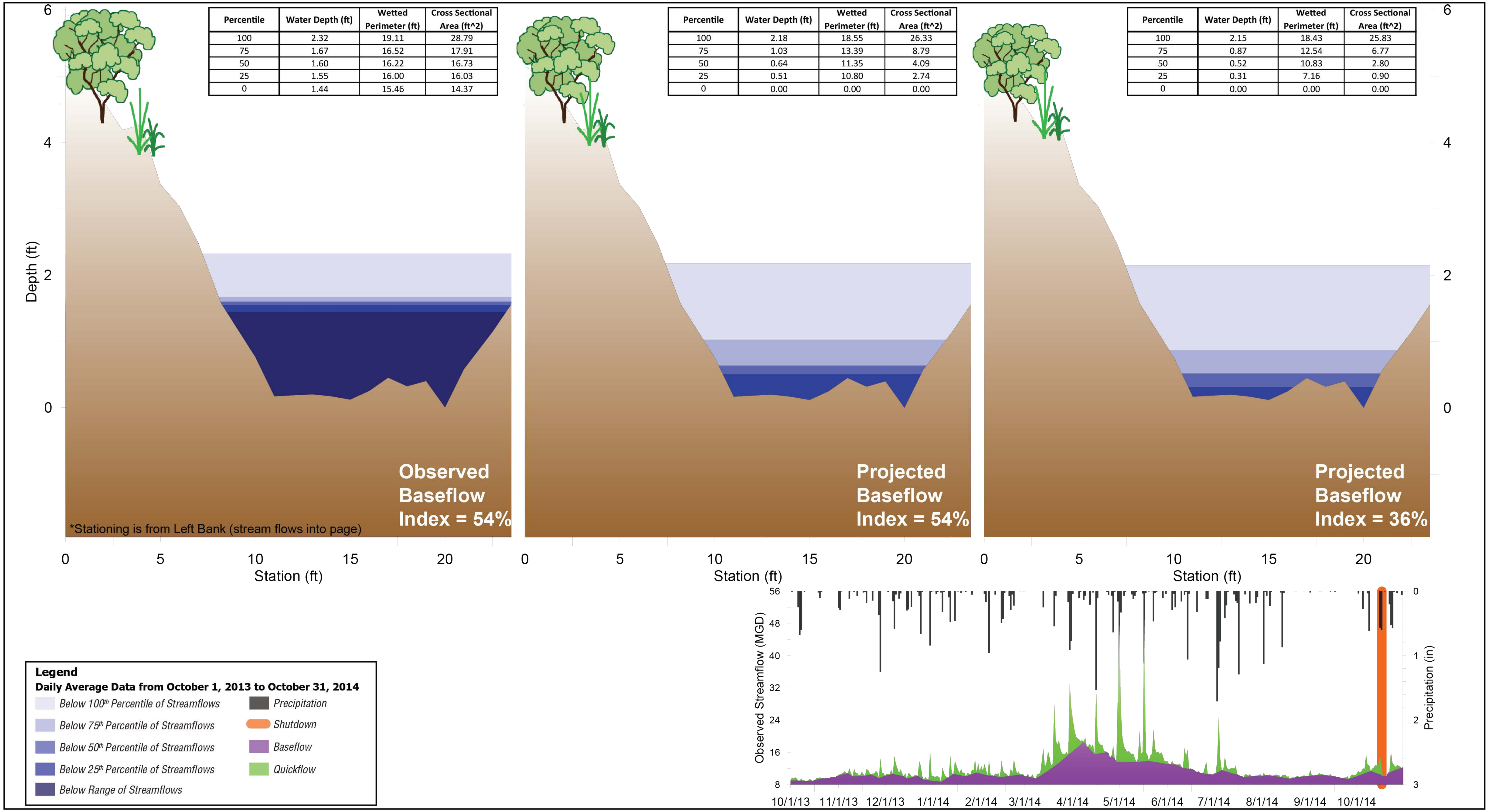


Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	3.02	14.98	22.56
75	2.31	11.90	13.93
50	2.24	11.61	13.25
25	2.20	11.43	12.82
0	2.13	10.92	12.06

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.83	14.16	20.07
75	1.47	7.71	6.70
50	1.03	6.23	3.93
25	0.64	4.72	1.94
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.80	14.05	19.72
75	1.25	6.99	5.28
50	0.77	5.30	2.55
25	0.46	3.85	1.18
0	0.00	0.00	0.00

Figure 11.9-89: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 4 (S4-SW-01)



Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.32	19.11	28.79
75	1.67	16.52	17.91
50	1.60	16.22	16.73
25	1.55	16.00	16.03
0	1.44	15.46	14.37

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.18	18.55	26.33
75	1.03	13.39	8.79
50	0.64	11.35	4.09
25	0.51	10.80	2.74
0	0.00	0.00	0.00

Percentile	Water Depth (ft)	Wetted Perimeter (ft)	Cross Sectional Area (ft^2)
100	2.15	18.43	25.83
75	0.87	12.54	6.77
50	0.52	10.83	2.80
25	0.31	7.16	0.90
0	0.00	0.00	0.00

Figure 11.9-90: Streamflow Distributions under Observed and Projected Conditions for Stream Segment 4 (S4-SW-02)

As shown in these figures, quickflow has the effect of moderating projected decreases in median streamflow depths from decommissioning. Decreases in median streamflow depths for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01), which were observed during the monitoring period to be 11 inches and 7 inches, could be anywhere from marginal (approximately an inch under a baseflow index of 54) to moderate (3 to 4 inches under a baseflow index of 36). For Stream Segment 4 (S4-SW-01 and S4-SW-02), median streamflow depths ranging from approximately 19 to 27 inches would decline to approximately 6 to 12 inches. Even under a baseflow index of zero, projected median streamflow depths for Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04) would be up to 4 inches, since streamflow would still be present following rain events.

At the extremes, observed minimum (0th percentile) streamflow depths are greater than zero for all seven locations, indicating that there was always at least some streamflow in these segments during the monitoring period. However, with decommissioning, minimum streamflow depths would be greater than zero for only Stream Segment 1 (S1-SW-01) under a baseflow index of 54 and nowhere under a baseflow index of 36. This indicates that conditions would be completely dry for all stream segments at least part of the year, which is more typical of natural conditions for first-order streams in the region. In contrast, maximum (100th percentile) streamflow depths would change very little under projected conditions, dropping at most by about 3 inches and indicating that baseflows, which would decline somewhat substantially, make only a minor contribution to peak streamflows.

Finally, **Table 11.9-36** summarizes projected changes in the seasonal variability of streamflow. As expected from the results presented above, seasonal variability of observed streamflow is greatest for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01), nominal for Stream Segment 4 (S4-SW-01 and S4-SW-02), and practically nonexistent for Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04). Under a baseflow index of 54, seasonal variability would increase for all locations, both in absolute terms (inches) and as a percentage of the overall streamflow depth, to a level more typical of natural conditions. Under a baseflow index of 36, increases in seasonal variability would be even greater. Seasonal variability for Stream Segment 3, its unnamed tributary, and Stream Segment 3B (S3-SW-02, S3-SW-03, and S3-SW-04) would also increase under a baseflow index of zero. Changes in seasonal variability would be greatest for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01).

Ultimately, flow conditions in the stream system would be likely to revert to those of Stream Segments 1, 2, and 3A, which are estimated to have the least amount of leak water influence and most representative of non-leak-influenced (natural) conditions. With decommissioning, baseflow rates would decrease to zero for Stream Segment 3, its unnamed tributary, and Stream Segment 3B, lowering water levels and changing the flow regime from primarily leak-water-fed to a rainfall-runoff dominated system. Consequently, the storm capacity of the stream system would be increased, and wetted stream perimeters would decrease, exposing areas that are currently inundated. Over time, substrate for Stream Segments 3, 3B, and 4 would likely change from sand, cobble, and gravel to a silty mud more typical of Stream Segments 1, 2, and 3A. With the decreased flow rate in Stream Segment 4, there is a potential for the Class A tidal portion of that stream to migrate further upstream.

Table 11.9-36: Median Streamflow Depths Based on Daily Data Over October 1, 2013 to October 31, 2014

Station	Observed			Projected					
				Baseflow Index = 54			Baseflow Index = 36		
	Overall (inches)	Difference during Growing Season (inches)	Difference during Non-Growing Season (inches)	Overall (inches)	Difference during Growing Season (inches)	Difference during Non-Growin g Season (inches)	Overall (inches)	Difference during Growing Season (inches)	Difference during Non-Growing Season (inches)
S1-SW-01	11	-1.3	+1.4	10	-2.0	+1.8	7	-1.6	+2.2
S3-SW-01[1]	7	-1.4	+1.1	6	-2.8	+1.6	4	-4.1	+2.1
S3-SW-02[2]	9	0.0	0.0	3	-0.5	+1.3			
S3-SW-03[2]	9	-0.2	+0.2	4	-0.9	+1.3			
S3-SW-04[2]	5	0.0	0.0	2	-0.3	+0.9			
S4-SW-01	27	-0.3	+0.5	12	-3.3	+3.6	9	-2.3	+4.0
S4-SW-02	19	-0.1	+0.1	8	-0.4	+0.3	6	-0.9	+0.7

Notes:

[1] Time period of analysis for S3-SW-01 is January 1, 2014 to October 31, 2014.

[2] Projected values given for baseflow index of zero only.

Potential Impacts to Surface Water Quality

Decommissioning would allow leak-affected stream segments to return to a more variable regime typical of non-leak-influenced conditions for both specific conductivity and water temperature. For Stream Segment 3 (S3-SW-02), its unnamed tributary(S3-SW-03), Stream Segment 3B (S3-SW-04), and Stream Segment 4 (S4-SW-01 and S4-SW-02), all suspected to be leak influenced to some degree, specific conductivities would increase in variability to ranges closer to those observed for Stream Segments 1 (S1-SW-01) and 3A (S3-SW-01), which are at best marginally leak influenced. Water temperatures would also revert to a diurnal pattern similar to those monitored for Stream Segments 1 and 3A, and seasonal fluctuations would be more pronounced without the moderating influence of leak water. More precise changes in temperatures would depend on additional environmental factors such as shading and, to a lesser extent, substrate type.

Surface Water Quantity Impact Analysis Conclusions

Based on the analysis described above, overall conclusions on potential changes from decommissioning to the quantity of surface water in the Natural Resources Study Area are:

- **Leaks contribute an average of approximately 9.6–10.6 mgd of water to the Roseton Brook System.** These estimates are based on the amount of baseflow that would need to be removed to result in baseflow indices of 36 to 54, which are more typical of naturally occurring streams with similar watershed conditions to the study area.

- **Decommissioning would change the current baseflow-dominant hydrologic regime to a flashier regime dominated by rainfall-runoff processes.** The frequency and rapidity of short-term changes in streamflow in response to storm events would increase as a result of decommissioning.

- **Decommissioning could have a marginal impact on Stream Segments 1, 2, and 3A.** Stream segments 1, 2, and 3A are marginally leak influenced, if at all. Observed water temperatures and specific conductivities for these segments are typical of those found under natural conditions. Baseflow indices, though somewhat high in comparison to streams with similar watershed characteristics, are also fairly typical for the region. Depending on these baseflow indices under non-leak conditions, decreases in median streamflow depths, which are currently about 7 to 11 inches, could be anywhere from an inch to 3 to 4 inches).

- **Decommissioning would likely eliminate all baseflow from the upstream portion of Stream Segment 3 and the entire length of Stream Segment 3B.** Stream Segments 3 and 3B are estimated to have large leak-water contributions. The seasonal and diurnal variability of observed water temperatures and specific conductivities is diminished for these segments, suggesting the moderating influence of leak water. Baseflow indices are anomalously high, and their small drainage areas suggest that they would not exist without the leaks. Once the leaks cease due to decommissioning, the downstream portion of Steam Segment 3 would see only a small amount of baseflow from Stream Segment 3A and a nominal amount of streamflow following a storm event.

- **Decommissioning would result in considerable reductions in baseflow for Stream Segment 4.** Stream Segment 4 is highly leak influenced, with water temperatures and specific conductivities that are diminished in variability and baseflow indices that are anomalously high. Results of the analysis suggest that, following leak cessation, 83 to 92 percent of the baseflow in Stream Segment 4 would be eliminated. Decommissioning would reduce median streamflow depths in Stream Segment 4, currently approximately 19 to 27 inches, to approximately 6 to 12 inches.

- **Decommissioning would have a variable impact on streamflow extremes.** On the low side, all of the stream segments, which were never observed to be dry during the monitoring period, would be dry at least part of the year under projected conditions. Peak streamflows, on the other hand, would change little.

- **Decommissioning would increase seasonal streamflow variability for all stream segments.** Increases in seasonal streamflow variability would be largest at Stream Segment 3A, for which streamflows are currently the smallest, and smallest at Stream Segment 4, for which streamflows are currently the largest.

With these potential changes to surface water quantity, the streamflow of the surface water of the Natural Resources Study Area would return to the typical flow for the region that existed prior to the RWBT leak influence. Therefore, decommissioning would not result in significant adverse impacts to the surface water within the Natural Resources Study Area.

Surface Water Quality Impact Analysis Conclusions

Based on the analysis described above, overall conclusions on potential changes from decommissioning to the quality of surface water in the Natural Resources Study Area are:

- **Decommissioning would result in water temperatures reverting to a more typical seasonal and diurnal regime.** The seasonal variability of water temperatures would increase, and diurnal patterns would once again emerge.

- **Decommissioning would result in increases in specific conductivity for Stream Segment 3, its unnamed tributary, Stream Segment 3B, and Stream Segment 4.** The variability of specific conductivity would also increase due to the elimination of the more stable influence of the leak water.

With these potential changes to surface water quality, the surface water of the Natural Resources Study Area would return to the typical water quality for the region that existed prior to the RWBT leak influence. With these changes, decommissioning would not result in significant adverse impacts to the quality of surface water in the Natural Resources Study Area.

11.9.5.28 Wetlands – Probable Impacts With Decommissioning

Decommissioning is expected to permanently stop the leaks that contribute to the shallow groundwater and wetland resources within the Natural Resources Study Area. Based on the methodology described in Section 11.9.5.4, Wetlands – Impact Analysis Methodology," an analysis of potential impacts from decommissioning to shallow groundwater and wetlands within the Natural Resources Study Area is summarized below.

The predicted change to shallow groundwater hydrology has the potential to impact both the wetland extent and vegetation composition within the Natural Resources Study Area. The analysis of potential for impacts to wetlands due to decommissioning considered the changes in shallow groundwater levels and surface expressions that could result from cessation of the leaks. This analysis was based on shallow groundwater monitoring data and development of a wetland water budget that used baseline shallow groundwater monitoring data to calibrate estimated changes to shallow groundwater levels and changes to wetland extent from decommissioning. The analysis also considered the results of the groundwater flow model that was used to estimate groundwater level changes in the bedrock and unconsolidated aquifers that could result from cessation of the leaks. As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," the estimates from the groundwater flow model of changes in the shallow groundwater elevation in the unconsolidated aquifer could vary. Because the model was developed using local geology and conditions in the Natural Resources Study Area and calibrated based on monitoring data, groundwater flow model results were used in the analysis of the spatial extent of changes to shallow groundwater.

The estimated changes to wetland extent and shallow groundwater levels were used in conjunction with species data and other observations collected during the field wetland delineations to qualitatively assess potential impacts to wetland vegetative composition from decommissioning. When the shallow groundwater levels are affected from cessation of leaks, impacts to three components of some wetlands would occur, including alteration of water table elevations (hydrology), changes in soil conditions (hydric soils), and shifts in plant species assemblages (hydrophytic vegetation). Impacts to wetlands would occur on a scale of months to years after decommissioning and following the establishment of a new stabilized hydrologic regime.

Potential Impacts to Shallow Groundwater

Using the wetland water budgets prepared for Wetlands A, B, C, D, E, G, and I for the growing season period from April 23, 2014 to September 30, 2014 (see Section 11.9.5.4, Wetlands – Impact Analysis Methodology,") the estimated change in average shallow groundwater level during the growing season from decommissioning was calculated by assuming the removal or reduction of the surface water baseflow (inflow) to wetlands. The analysis for Wetlands A, B, D, and E assumed that decommissioning would remove the baseflow portion attributed to the leaks. These wetlands are located adjacent to Stream Segments 3 and 3B, which are leak influenced and likely to see substantially reduced streamflows as described in Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning." The analysis for Wetlands C, G, and I assumed that the baseflow component would be reduced to reflect a baseflow index of 36, which is near the lower end of the baseflow index for streams in the region. This baseflow index was selected for the analysis of Wetlands C, G, and I, as these wetlands are located adjacent to Stream Segments 1, 2, and 3A, which are not thought to be substantively leak influenced. Thus the analysis using a baseflow index of 36 is a conservative estimate of the potential impacts to baseflow and wetland hydrology from decommissioning. Also, as described further in Section 11.9.5.10, "Groundwater – Baseline Conditions," due to complex geology in the study area, the subsurface hydraulic connectivity of the shallow groundwater and leak water is spatially variable. Therefore, the deep groundwater inflow and outflow associated with each wetland from decommissioning was assumed to remain the same. Water budgets were not created for Wetlands F, K, and KA as field observations of wetland hydrology indicated these wetlands are naturally occurring with no observed surface expressions or known connection to the RWBT leak. While Wetland F is in close proximity to Stream Segment 3, the wetland is at a considerably higher elevation than the stream, and the source of wetland hydrology is surface water runoff from the adjacent hill slope.

The results of the wetland water budget analysis and estimated decrease in shallow groundwater levels that could result from decommissioning are shown in **Table 11.9-37** below. The analysis indicates a range of expected changes to average shallow groundwater levels during the growing season from 0 to approximately 0.7 feet. As expected, the largest decrease in shallow groundwater levels from decommissioning is estimated to occur at Wetlands A, B, D, and E that are adjacent to leak influenced Stream Segments 3 and 3B. Wetlands C, G, and I are expected to have minimal to no reduction in the average shallow groundwater level. The estimation of a larger decrease in shallow groundwater level at Wetlands A, B, D, and E is a reflection of the varying contributions from different hydrologic inputs. These wetlands are dependent on large inputs of leak water received through surface expressions, as they receive limited storm flow inputs due to the very small drainage areas for each wetland.

Time series plots that show the observed shallow groundwater levels for the 2014 growing season and the estimated changes to the shallow groundwater levels resulting from decommissioning for subsequent growing seasons are shown for each wetland on **Figure 11.9-91** to **Figure 11.9-95**. Some difference between the 2014 observed and 2014 estimated shallow groundwater time series is expected, as the wetland water budgets do not capture all of the parameters that are driving wetland hydrology. However, they are intended to reflect the range of potential groundwater levels, and adequately estimate the average shallow groundwater level during the 2014 growing season (see **Table 11.9-37**).

Table 11.9-37: Observed[1] and Estimated Changes to Average Shallow Groundwater Levels in the Natural Resources Study Area as a Result of Decommissioning

Wetlands Included in Water Budget	Observed Baseline Average Depth to Shallow Groundwater (Feet)[1]	Estimated Baseline Average Depth to Shallow Groundwater (Feet)	Estimated Average Depth to Shallow Groundwater Following Decommissioning (Feet)	Estimated Decrease in Average Shallow Groundwater Level Following Decommissioning (Feet)
Wetlands A, D, E	0.4	0.4	1.1	0.7
Wetland B	2.0	2.0	2.7	0.7
Wetland C	0.8	0.8	0.8	0.0
Wetland G	0.5	0.4	0.5	0.1
Wetland I	1.5	1.6	1.7	0.1

Note:
[1] Average shallow groundwater levels observed from April 23 to September 30, 2014.

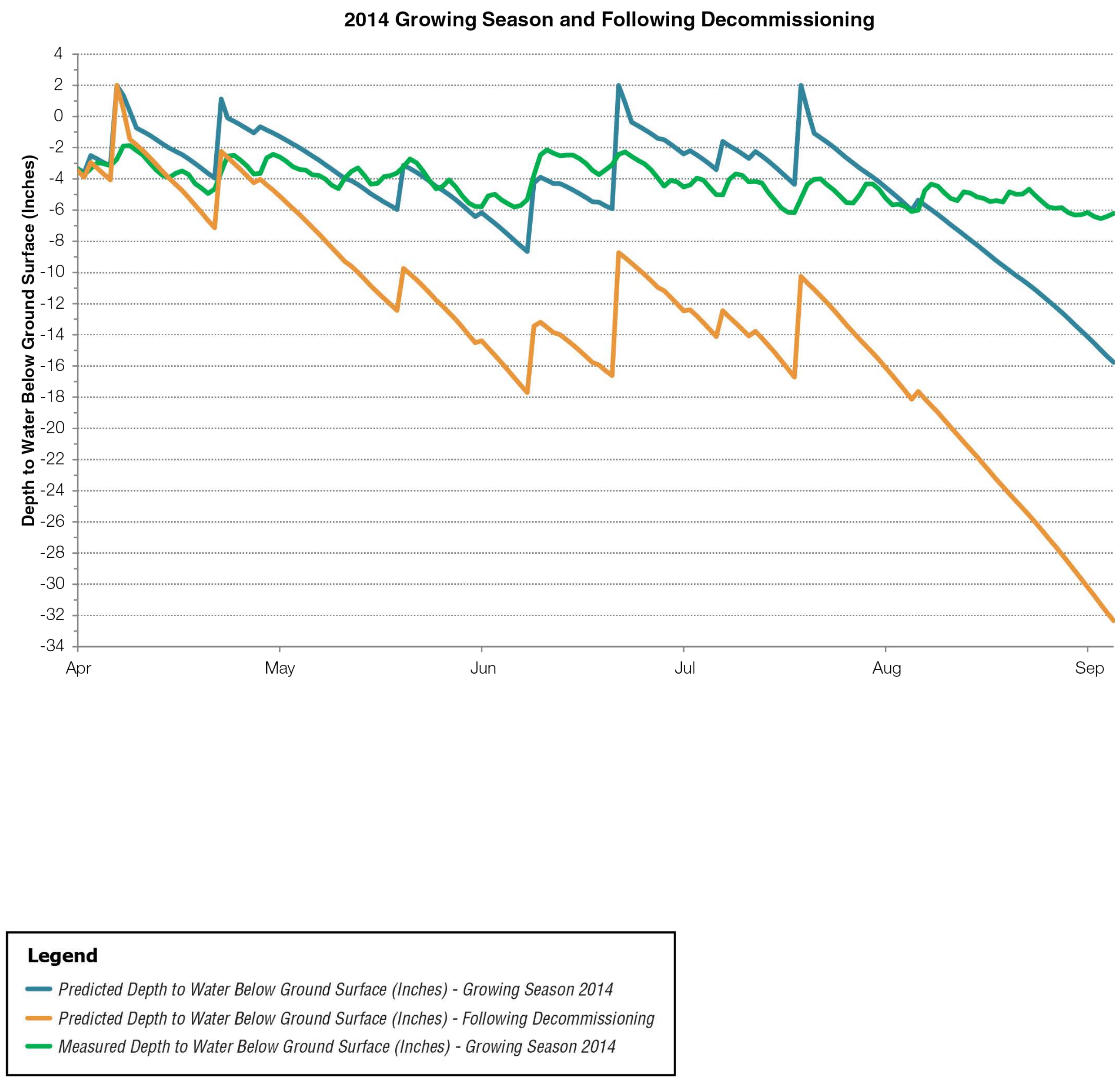


Figure 11.9-91: Measured and Predicted Depth to Shallow Groundwater Wetland A, D, and E – Natural Resources Study Area

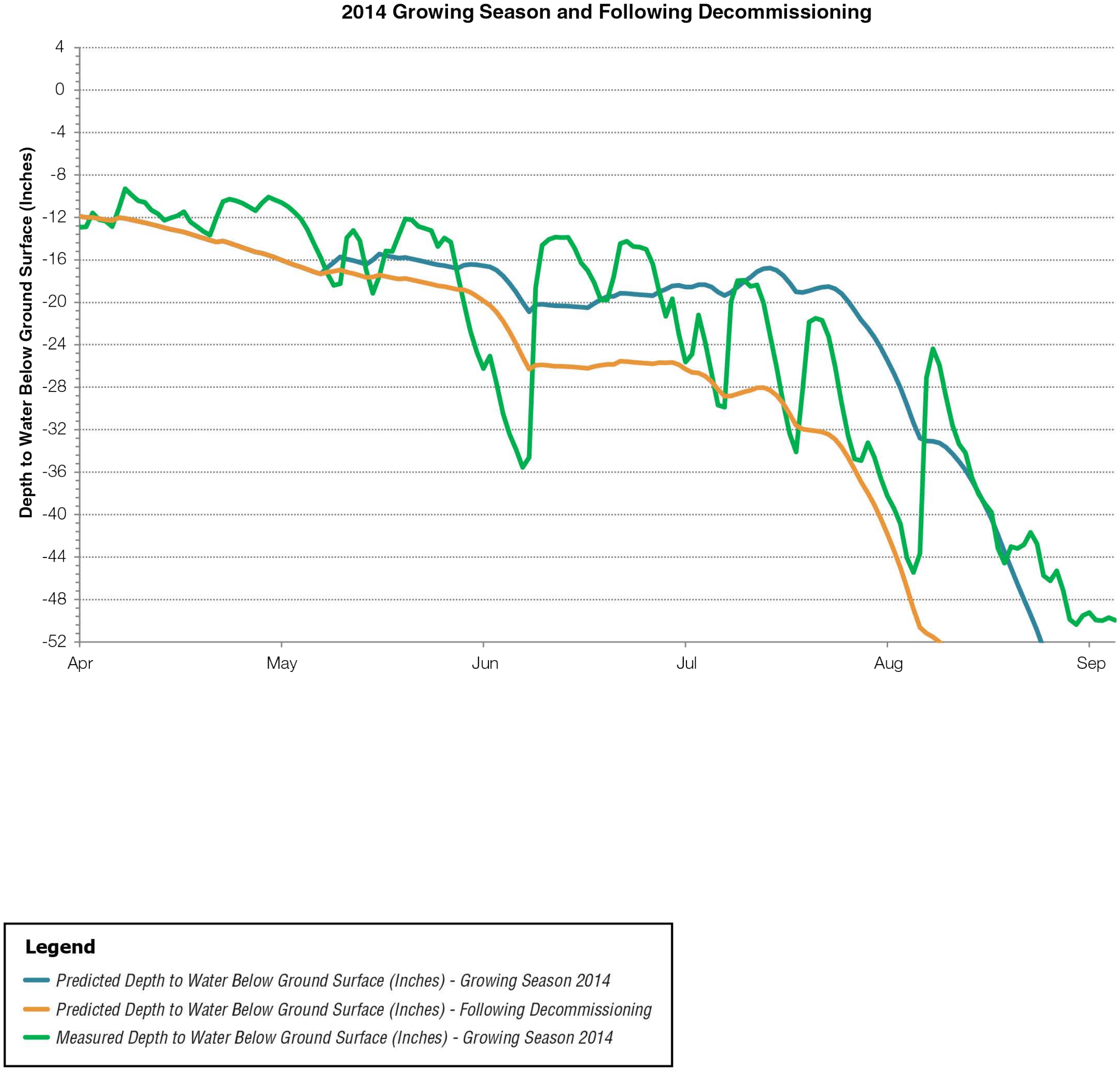


Figure 11.9-92: Measured and Predicted Depth to Shallow Groundwater Wetland B – Natural Resources Study Area

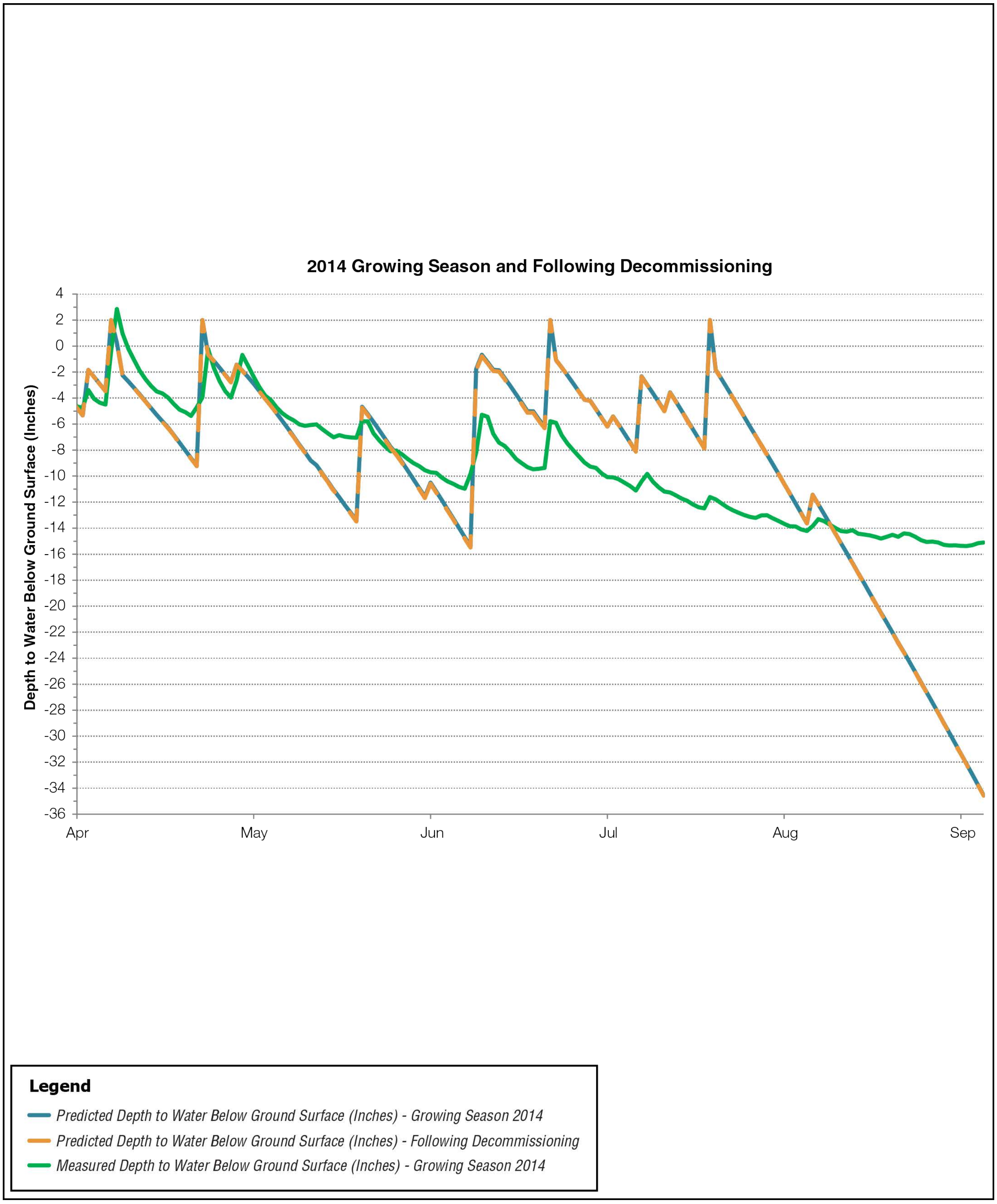


Figure 11.9-93: Measured and Predicted Depth to Shallow Groundwater Wetland C – Natural Resources Study Area

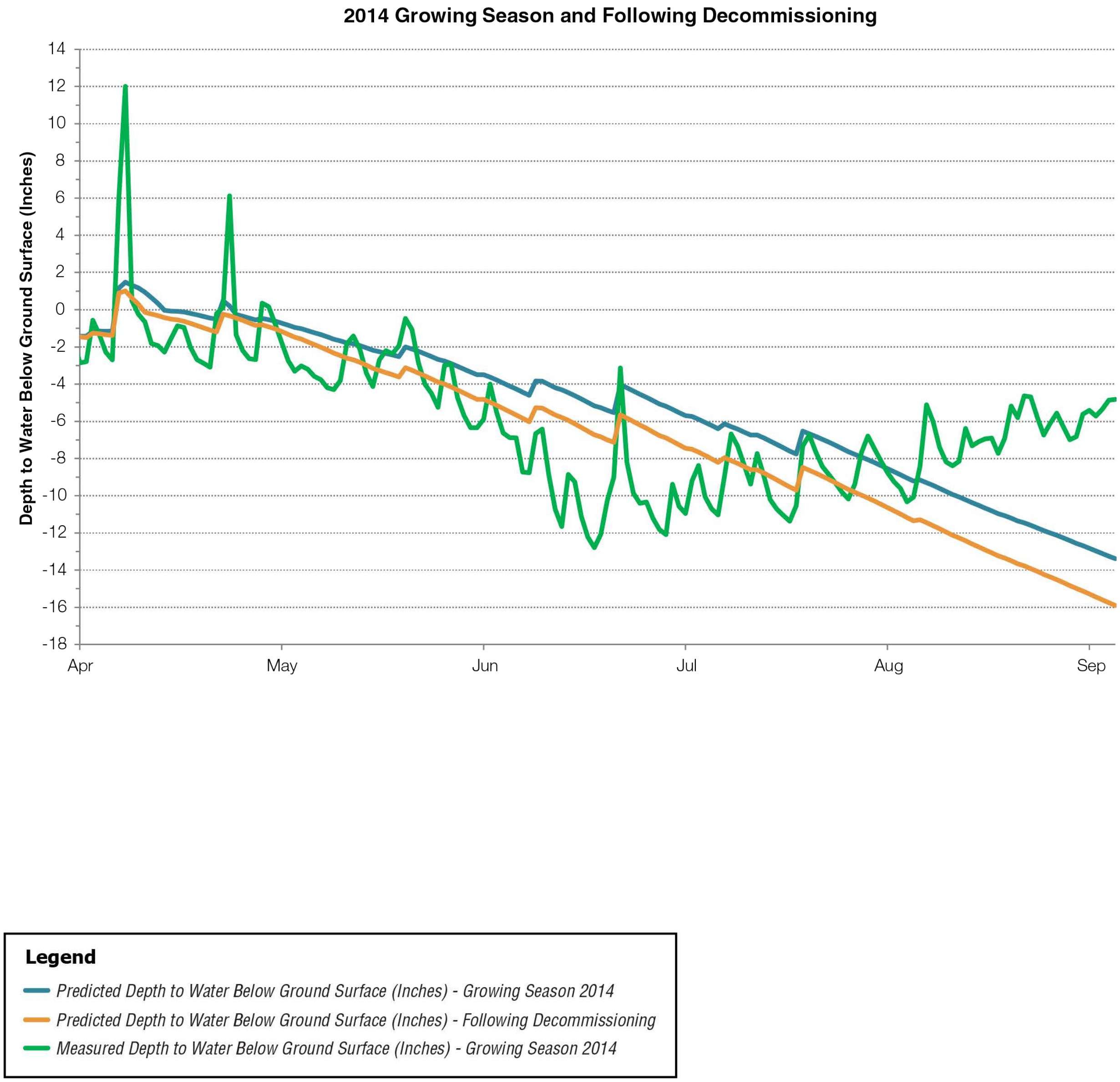


Figure 11.9-94: Measured and Predicted Depth to Shallow Groundwater Wetland G – Natural Resources Study Area

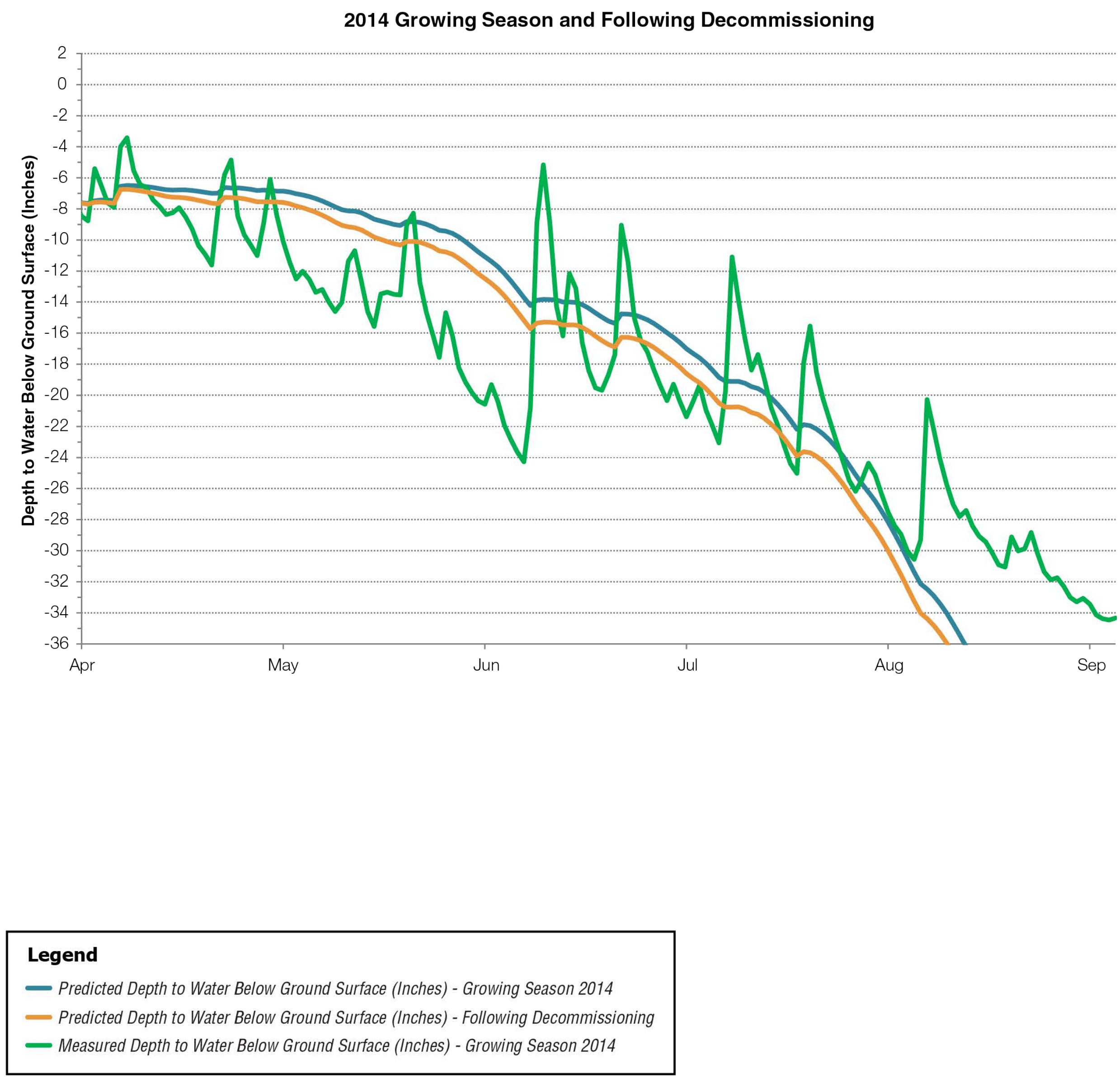


Figure 11.9-95: Measured and Predicted Depth to Shallow Groundwater Wetland I – Natural Resources Study Area

The wetland time series plots present monitoring data for one representative wetland location, and as topography varies throughout the wetlands the depth to shallow groundwater is assumed to be variable across each wetland and among wetlands. For example, groundwater monitoring data from one location within Wetland A was used to develop the water budget for the rest of Wetland A, as well as Wetlands D and E. Because these wetlands abut Stream Segment 3 and receive similar hydrologic inputs, the changes in depth to groundwater are expected to be consistent. A comparison of shallow groundwater data between these wetlands shows Wetland D with a higher average depth to shallow groundwater during the growing season. This difference is due to the monitoring well location, which is upslope and may not have as much interaction with Stream Segment 3 as the Wetland A monitoring location. In this instance the Wetland A monitoring location is representative of the leak-influenced hydrologic regime and was used for the analysis of Wetlands A, D, and E. Using the estimated shallow groundwater changes over the long term after decommissioning, the percentage of the growing season that groundwater is expected to be within 1 foot of the ground surface was calculated The results were compared to the percentage of the 2014 growing season that groundwater was observed to be within 1 foot of the ground surface. The results indicate a substantial decrease in shallow groundwater levels for Wetlands A, B, D, and E (see **Table 11.9-38**).

The estimate for Wetland B suggests that portions of the site may not meet the minimum requirements to maintain wetland hydrology, vegetation, and soils. The estimated change for Wetlands C, G, and I compared to the 2014 data is within the range of variability that can be expected for the wetland water budget approach.

Table 11.9-38: The Percentage of the 2014 Growing Season and the Estimated Percentage of the Growing Season following Decommissioning, that Groundwater was within One Foot of the Ground Surface at Wetlands Located in the Natural Resources Study Area

Wetlands Included in Water Budget	Percentage of the 2014 Growing Season that Shallow Groundwater was within One Foot of Ground Surface At Monitoring Well Location	Estimated Percentage of the Growing Season with Shallow Groundwater within One Foot of Ground Surface At Monitoring Well Location following Decommissioning
Wetlands A, D, E	100	43
Wetland B	14	2
Wetland C	69	75
Wetland G	98	84
Wetland I	27	39

The groundwater flow model is limited in its estimate of changes in the shallow groundwater elevation at specific locations. However, it is an appropriate tool to assess the spatial extent of changes to shallow groundwater. The wetlands estimated to be affected by decommissioning using the water budget analysis (Wetlands A, B, D, and E) are within the area of potential change to groundwater head that was estimated by the groundwater flow model. The estimated change to wetland extent due to decommissioning is further discussed below.

Potential Impacts to Wetland Extent

As discussed in Section 11.9.5.4, Wetlands – Impact Analysis Methodology," the results of the wetland water budgets and shallow groundwater analysis were used to estimate the potential change to wetland extent that may result from decommissioning. This analysis was based on:

- The percentage of time during the 2014 growing season that shallow groundwater level was observed to be within 1 foot of the soil surface; and
- A comparison to the percentage of time the shallow groundwater is estimated to be within 1 foot following decommissioning.

This metric was assumed to be representative of conditions for suitable wetland hydrology. It is a conservative approach to estimate potential wetland impacts when compared to the USACE regulatory wetland definition. USACE regulatory definition indicates that the root zone (within 1 foot of ground surface) must be seasonally saturated or inundated for more than 12.5 percent of the growing season to provide suitable conditions for establishment of wetland vegetation and anaerobic soil conditions (Environmental Laboratory; USACE 1992).

Table 11.9-39 shows the estimated loss of wetland area, and **Figure 11.9-96** to **Figure 11.9-101** show the estimated wetland change that could occur within the Natural Resources Study Area due to decommissioning. A total of approximately 1.2 acres of existing delineated wetlands are estimated to be lost as a result of effects on surface water and shallow groundwater levels that are the source of water to these wetlands, including Wetlands A, B, D, and E. The southern extent of Wetland C (Southern C), the portion that is adjacent to Wetland A, also has the potential to be affected as this may be hydrologically connected to the surface expressions along Stream Segment 3. As a result of estimated changes to wetland hydrology, the wetland vegetation community type also has the potential to change, further discussed in the following section.

Table 11.9-39: Existing Wetland Area and the Estimated Loss of Wetland Area in the Natural Resources Study Area

Wetland ID	Total Delineated Wetland Area (Acres)	Total Estimated Loss of Wetland Area Following Decommissioning (Acres)	Total Estimated Loss of Wetland Area from Decommissioning as Percentage of Existing Area (%)
Wetland A	0.34	0.2	59
Wetland B	1.98	0.6	30
Wetland C	0.63	0.0	0
Wetland D	0.62	0.2	32
Wetland E	0.42	0.2	48
Wetland F	0.08	0.0	0
Wetland G	1.13	0.0	0
Wetland I	10.39	0.0	0
Wetland K	0.44	0.0	0
Wetland KA	0.07	0.0	0
Totals	16.10	1.2	

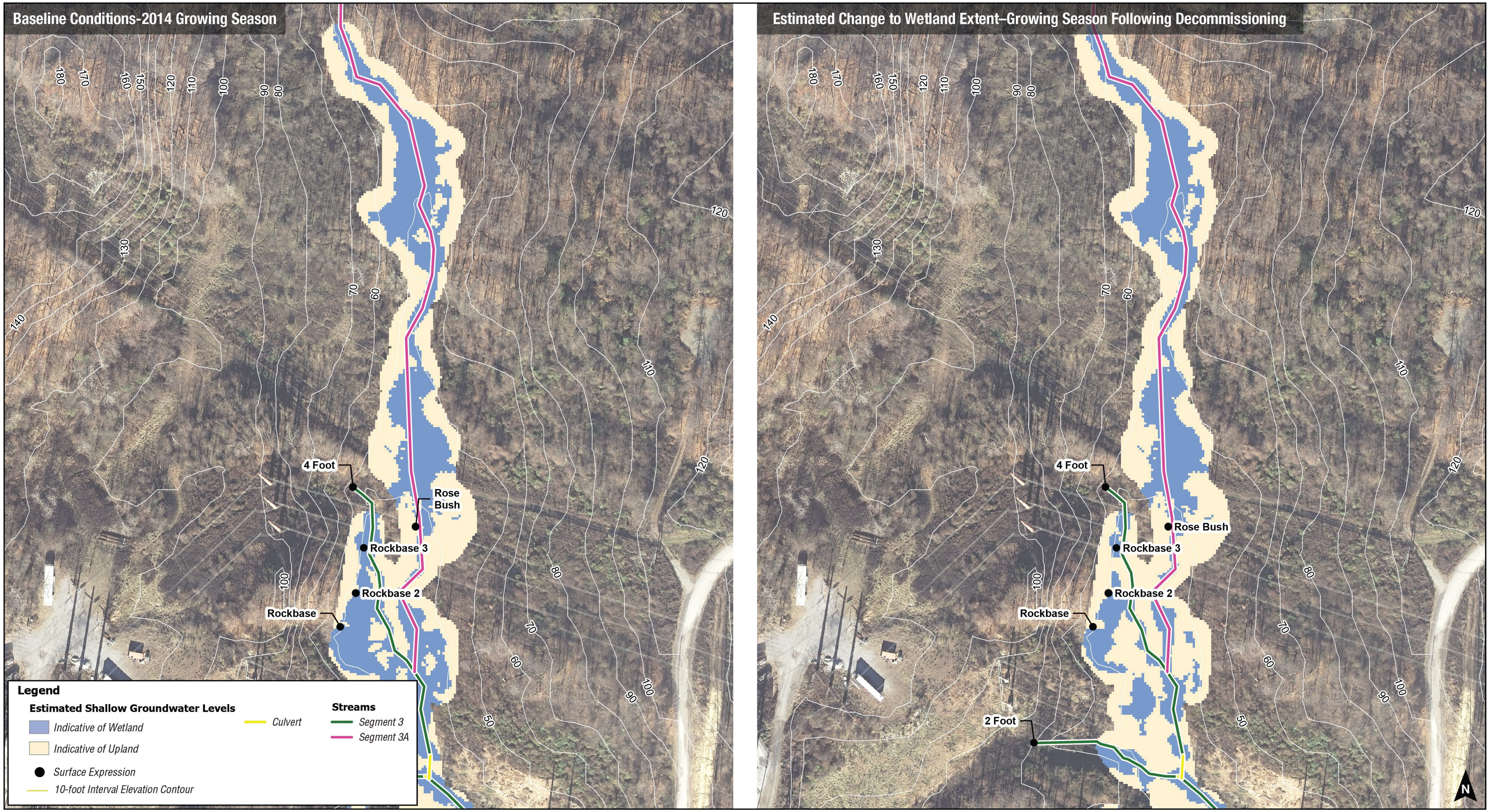


Figure 11.9-96: Estimated Wetland Change - Wetland C North – Natural Resources Study Area

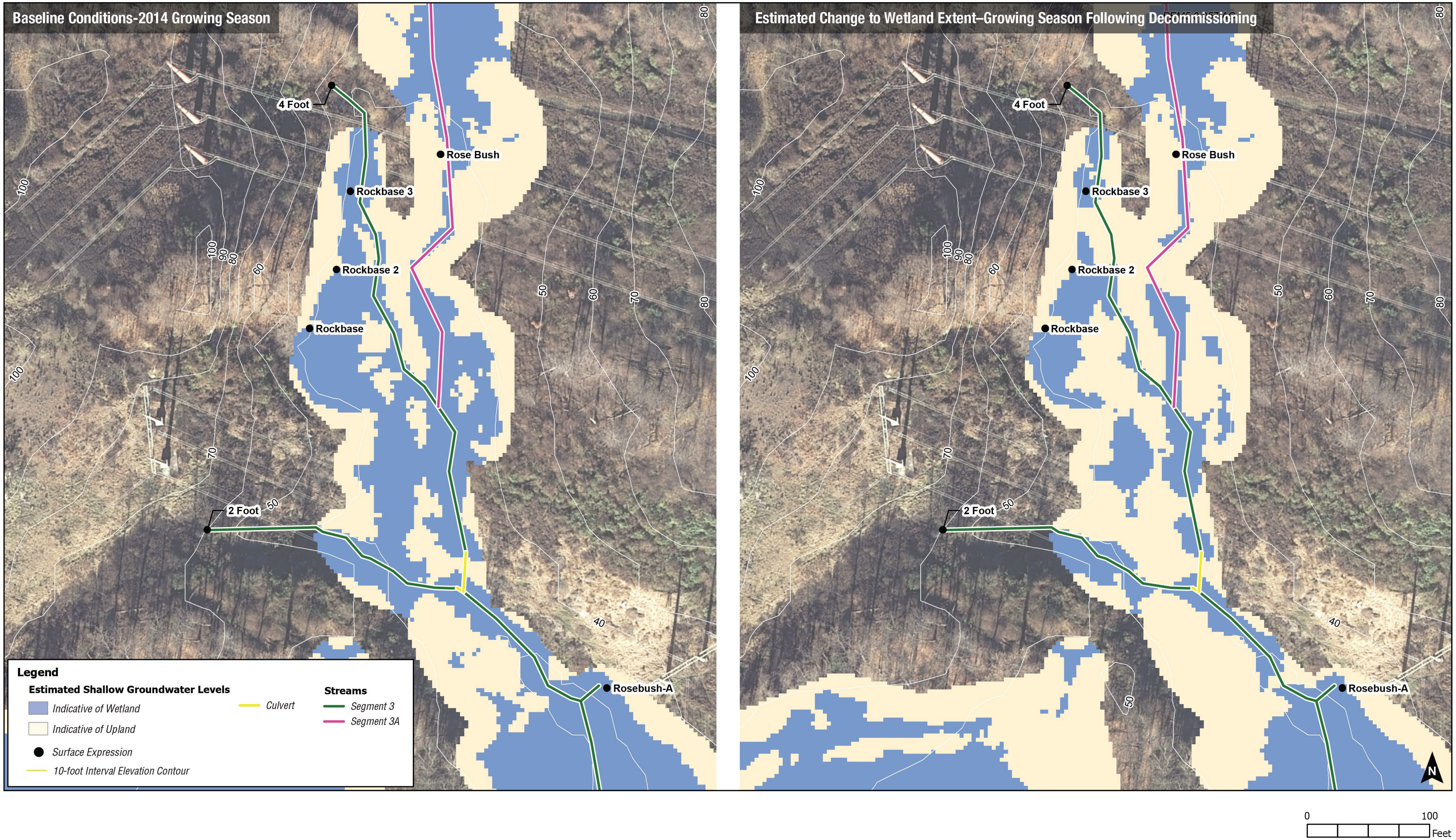


Figure 11.9-97: Estimated Wetland Change - Wetlands A and Southern C – Natural Resources Study Area

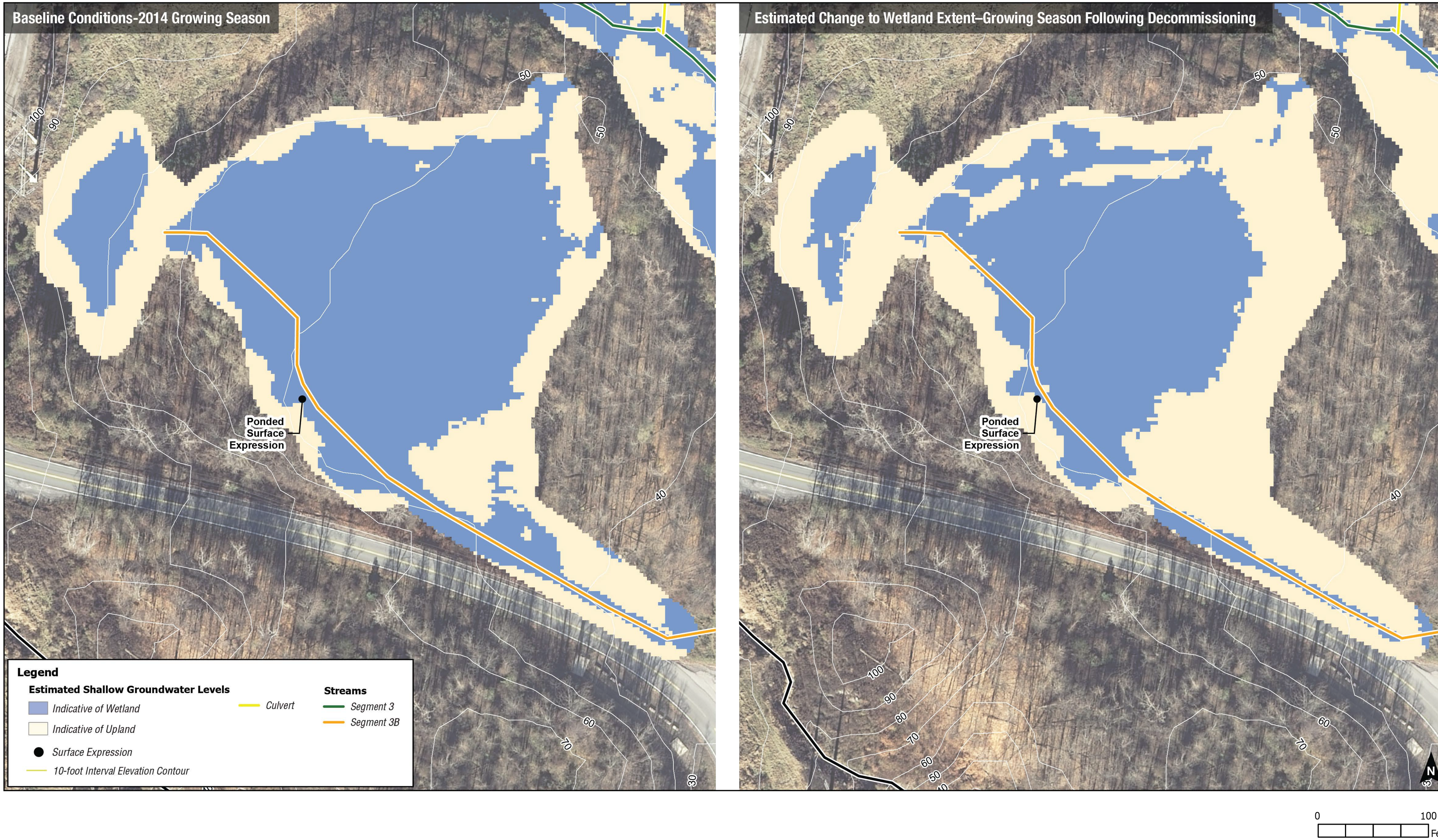


Figure 11.9-98: Estimated Wetland Change – Wetland B – Natural Resources Study Area

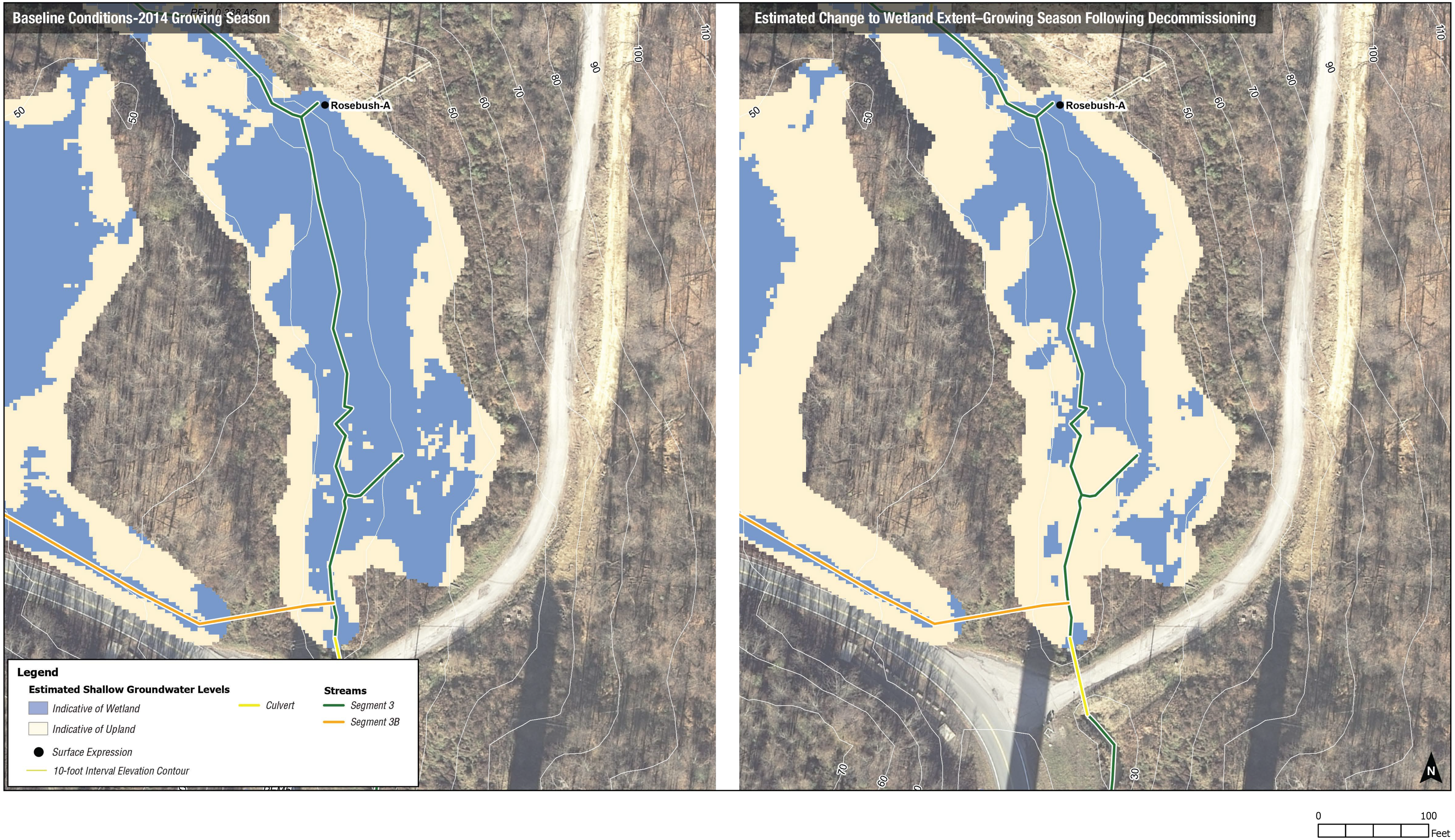


Figure 11.9-99: Estimated Wetland Change – Wetlands D and E – Natural Resources Study Area

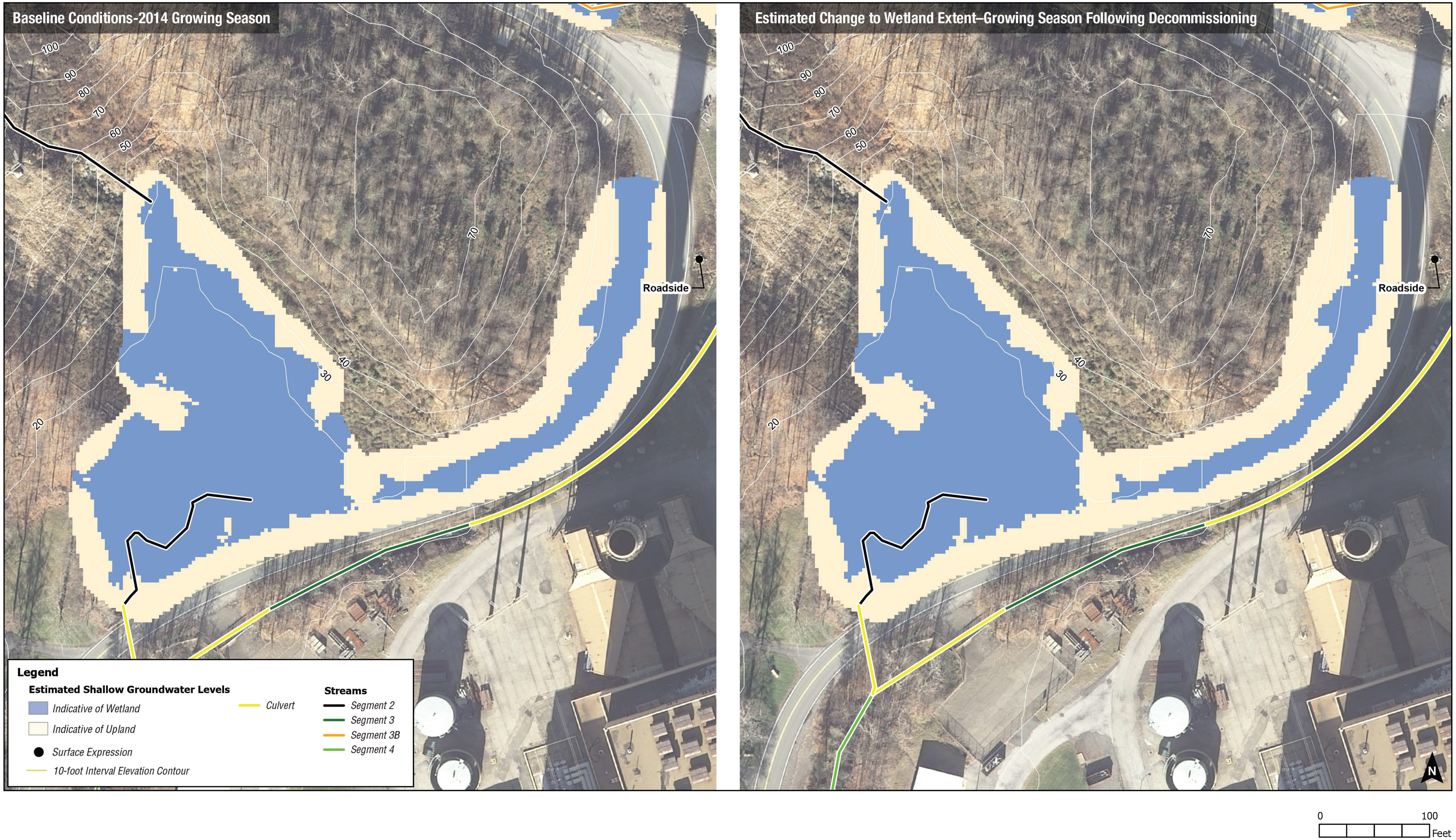


Figure 11.9-100: Estimated Wetland Change – Wetland G – Natural Resources Study Area

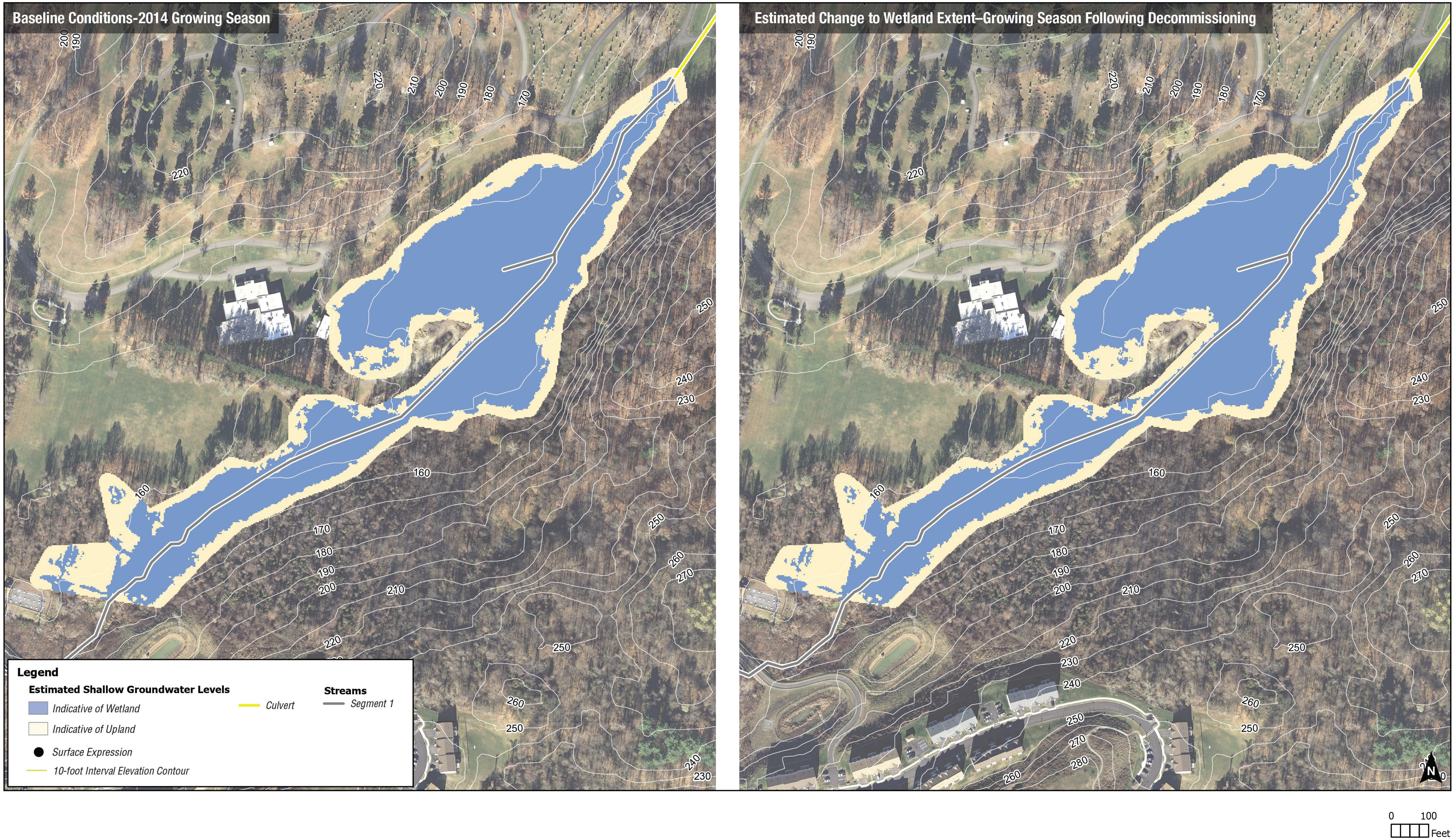


Figure 11.9-101: Estimated Wetland Change – Wetland I – Natural Resources Study Area

Potential Impacts to Wetland Type

Decommissioning would result in cessation of the leaks, thereby initiating the process of returning some non-regulated wetlands within the Natural Resources Study Area to a more naturally occurring ecological community typical of this region of the State. These wetlands are not regulated by NYSDEC or USACE. When the shallow groundwater levels are affected from cessation of leaks, impacts to three components of some non-regulated wetlands (Wetlands A, B, Southern C, D, and E) would occur, including alteration of water table elevations (hydrology), changes in soil conditions (hydric soils), and shifts in plant species assemblages (hydrophytic vegetation).

In general, the reduction in shallow groundwater levels has the potential to result in changes to wetland vegetation and possibly localized soil conditions. The estimated change to the wetland hydrologic regime (seasonal pattern of wetland water level) could decrease the duration of anaerobic conditions within the root zone of existing wetlands and may also affect soil quality (i.e., organic matter content, pH, cation exchange capacity (CEC), and nutrient concentrations) that would influence plant species composition. Removal of a wetland hydrologic regime could cause a shift to an upland plant community, while decreasing the duration of anaerobic conditions in the root zone may cause a shift in wetland plant species composition. These changes to wetlands would occur on a scale of months to years after decommissioning and following establishment of a new stabilized hydrologic regime. Following decommissioning, it is anticipated that the new shallow groundwater elevations would be established within 1 year. Changes to soils and vegetation within wetland communities would change over a period of multiple years following decommissioning. A discussion of the impacts from decommissioning to each of the field delineated wetlands in the Natural Resources Study Area in terms of loss or changes to the habitat is provided below.

- **Wetland A –** Wetland A would experience a decline in average shallow groundwater levels of approximately 0.7 feet during the growing season, which could lead to a loss of approximately 0.2 acre of wetland area. The portion of the growing season in which the water table is within 1 foot of the soil surface would decrease from approximately 100 to 43 percent. Wetland A is located at the base of a slope that does not have a large drainage area, so most hydrologic inputs are leak influenced. The palustrine emergent (PEM) wetland area contains a diverse herbaceous wetland community (sedges, broadleaf and narrowleaf cattail) that is likely to change to a less diverse community with the potential for expansion of nearby wetland (common reed and purple loosestrife) and upland species (such as tatarian honeysuckle and multiflora rose). The wetland also exists in the utility ROW so herbicide treatment and selective cutting of shrubs may further alter the plant community.

- **Wetland B –** Wetland B would experience a decline in average shallow groundwater levels of approximately 0.7 feet during the growing season, which could lead to a loss of approximately 0.6 acre of wetland area. The portion of the growing season in which the water table is within 1 foot of the root zone would decrease from approximately 14 to 2 percent. Wetland B features a moderately dense canopy of European alder which would be expected to survive under the new hydrologic conditions and would hinder expansion of common reed that currently exists within the wetland.

- **Wetland C –** The majority of Wetland C would experience no decline in average shallow groundwater levels, with no change to the duration of shallow groundwater in the root zone during the growing season, and no loss of wetland area or change to wetland vegetation type. The northerly part (PFO and PEM5) of Wetland C is upgradient of the influence of the surface expressions and is not anticipated to be affected by decommissioning. However, a small part of the southerly PEM and PEM5 section of Wetland C (within the utility line ROW) is likely hydrologically connected to Stream Segment 3 and has the potential for lower shallow groundwater levels. This area of southern Wetland C is mainly a common reed monoculture, and is expected to remain such once the leaks cease. Herbicide treatment and selective cutting of shrubs within the utility ROW may further alter the plant community.

- **Wetland D –** Wetland D would experience a decline in average shallow groundwater levels of approximately 0.7 feet during the growing season, which could lead to a loss of approximately 0.2 acre of wetland area. The portion of the growing season in which the water table is within 1 foot of the soil surface would decrease from approximately 100 to 43 percent. The portion of Wetland D near Stream Segment 3 features a diverse wetland community (sedges and speckled alder) that is likely to change to a less diverse community with the potential for expansion of nearby wetland species (common reed and purple loosestrife) and upland species (tatarian honeysuckle and multiflora rose) currently found in upgradient (easterly) portions of this wetland. Herbicide treatment and selective cutting of shrubs within the utility ROW may further alter the plant community.

- **Wetland E –** Wetland E would experience a decline in average shallow groundwater levels of approximately 0.7 feet during the growing season, which could lead to a loss of approximately 0.2 acre of wetland area. The portion of the growing season in which the water table is within 1 foot of the soil surface would decrease from approximately 100 to 43 percent. The portion of Wetland E near Stream Segment 3 features a diverse wetland community (sedges, broadleaf cattail, northern spicebush, and speckled alder) that is likely to change to a less diverse community with the potential for expansion of nearby wetland species (common reed) and upland species (tatarian honeysuckle and multiflora rose).

- **Wetland F –** Wetland F would experience no decline in average shallow groundwater levels, with no change in the duration of shallow groundwater in the root zone during the growing season. These conditions would not result in the loss of wetland area or change to wetland vegetation type.

- **Wetland G –** Wetland G would experience a decline in average shallow groundwater levels of approximately 0.1 feet during the growing season. The portion of the growing season in which the water table is within 1 foot of the soil surface would decrease from approximately 98 to 84 percent. These conditions would not result in a loss of wetland area or change to wetland vegetation type.

- **Wetland I –** Wetland I would experience a decline in average shallow groundwater levels of approximately 0.1 feet, with no change in the duration of shallow groundwater in the root zone during the growing season. These conditions would not result in the loss of wetland area or change to wetland vegetation type.

- **Wetland K –** Wetland K would experience no decline in average shallow groundwater levels, with no change in the duration of shallow groundwater in the root zone during the growing season. These conditions would not result in the loss of wetland area or change to wetland vegetation type.

- **Wetland KA –** Wetland KA would experience no decline in average shallow groundwater levels, with no change in the duration of shallow groundwater in the root zone during the growing season. These conditions would not result in the loss of wetland area or change to wetland vegetation type.

Wetland Impact Analysis Conclusions

- The results of the soil pH and CEC analysis in combination with the review of wetland plant species indicate that unique calcareous wetlands as described by Edinger et al. (2014) do not presently exist within the Natural Resources Study Area.

- The results of the wetland water budget analysis indicates a range of expected lowering of average shallow groundwater levels during the growing season from 0 to approximately 0.7 feet. The largest decrease in shallow groundwater levels from decommissioning would occur at Wetlands A, B, D, and E, while Wetlands C, F, G, I, K, and KA are estimated to experience minimal to no reduction in the average shallow groundwater level.

- For each wetland, the percentage of the 2014 growing season that groundwater was observed to be within 1 foot of the ground surface was compared to that estimated due to decommissioning. The estimates indicated decreases for Wetlands A, B, D, and E. However, all but Wetland B are above the 12.5-percent federal wetland hydrology criterion. The estimated change for Wetlands C, G, and I compared to the 2014 data is within the range of variability that can be expected for the wetland water budget approach.

- The wetlands estimated to be affected by decommissioning using the water budget analysis (Wetlands A, B, D, and E) are within the area of potential change to groundwater head that was estimated by the groundwater flow model.

- Approximately 1.2 acres of non-regulated wetlands may be lost as a result of decommissioning, including portions of Wetlands A, B, D, and E. The southern extent of Wetland C, the portion that is adjacent to Wetland A, also has the potential to be affected as this may be hydrologically connected to the surface expressions along Stream Segment 3.

In general, the reduction in shallow groundwater levels has the potential to result in changes to wetland vegetation and possibly localized soil conditions. The estimated change to the wetland hydrologic regime would alter the presence or duration of anaerobic conditions within the root zone and may also affect soil quality (i.e., organic matter content, pH, CEC, and nutrient concentrations) that could influence plant species composition. These changes to wetlands would occur on a scale of months to years after decommissioning and following establishment of a new stabilized hydrologic regime.

As described above, there is the potential for significant adverse impacts to wetlands, due to a potential loss of approximately 1.2 acres of wetlands, including Wetlands A, B, D, and E in the Natural Resources Study Area. DEP is committed to developing a monitoring program that would be implemented prior to, during, and after the RWBT temporary shutdown to assess and confirm the extent of the impacts to these wetlands, and should permanent impacts be measured, DEP would perform compensatory mitigation. The proposed monitoring program is described further in Section 11.11, "Mitigation."

11.9.5.29 Floodplains - Probable Impacts With Decommissioning

As described in Section 11.9.5.5, "Floodplains – Impact Analysis Methodology," only the tidal inlet area of Stream Segment 4 is subject to inundation by the 1 percent and 0.2 percent annual chance flood hazard. These floodplains are associated with the Hudson River and leak water constitutes a negligible fraction of the Hudson River's streamflow. Therefore, decommissioning would not result in significant adverse impacts to floodplains within the Natural Resources Study Area.

11.9.5.30 Aquatic and Benthic Resources – Probable Impacts With Decommissioning

Decommissioning would induce changes to the aquatic and benthic resources of Stream Segments 3, 3B, and 4 that are influenced by the leaks in the Natural Resources Study Area. Results from the surface water analysis (see Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning") estimated that the baseflow of approximately 10 mgd contributed by the leak to Stream Segments 3 and 3B would be removed, and that the baseflow of approximately 10 mgd in Segment 4 could be reduced by up to 92 percent, to 1 mgd.

Cessation of the leaks would initiate the restoration of the natural hydrologic regime for the affected stream segments and wetlands in the study area. This natural condition is assumed to be typical of the hydrology observed at Stream Segments 1, 2, and 3A, which are thought to receive negligible inputs from RWBT leak water, if at all. Decommissioning would initiate the process of returning the aquatic and benthic resources in Stream Segments 3, 3B, and 4 to a more naturally functioning system found in this region of the State that likely existed in this area before the leak occurred, similar to Stream Segments 1, 2, and 3A. Currently, these affected stream segments and wetlands are supplied with a continuous flow of colder water from the aqueduct that has created artificial temperature and flow regimes.

Also, based on results in Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning," the affected stream segments would experience reduced flows, decreased water levels, and a change in water quality. As water levels drop, the wetted width of affected stream segments would decrease. Based on the methodology described in Section 11.9.5.6, "Aquatic and Benthic Resources – Impact Analysis Methodology," an analysis of the potential for impacts to aquatic and benthic resources in the affected streams due to decommissioning is discussed below.

Fish

The existing coldwater fish community in the leak-affected segments of the Natural Resources Study Area may be affected by the cessation of leaks from decommissioning. Leak water from the RWBT makes up the majority of flow in Segments 3, 3B, and 4. Decommissioning would cause flows to decrease within hours, which would decrease water levels as surface water monitoring and analyses have shown. A decrease in water levels would mean a loss of fish habitat in portions of Stream Segments 3, 3B, and 4. Fish in Stream Segments 3, 3B, and 4 would also be affected by water temperatures that revert back to a typical diurnal and seasonal temperature regime for the region, as the variability of inter-seasonal temperatures would increase following decommissioning.

Brown Trout (Salmo trutta)

As discussed in Section 11.9.5.14, "Aquatic and Benthic Resources – Baseline Conditions," the existing fish community in Segments 3, 3B and 4, which are leak-affected, consists almost entirely of brown trout. They are often found in small headwater streams with brook trout (one brook trout was collected in 2013) and survive best in streams where the summer temperatures are lower than 68°F (20°C; Smith 1985). Upon decommissioning, it would be expected that water temperature change could cause unsuitable thermal conditions. Since decommissioning would occur during the fall, the brown trout population may have more time to respond to reduced water levels and loss of habitat, and migrate from the stream segments into the Hudson River.

Decommissioning could also affect prey availability. Trout, especially juveniles, feed primarily on insects, amphipods, and other crustaceans (Smith 1985). For any trout that remain in these stream segments, lower water levels and flows would result in a loss of benthic habitat and a reduction in food availability. Fish or invertebrate species living in the leak-modified habitat would experience a severe reduction in habitat and food availability.

Although trout and other species may be affected, decommissioning would begin the process of returning the system to a natural-functioning fish community typical of a small stream in this region of the State. With decommissioning, trout could begin to migrate out of the stream into the Hudson River, while any natural migration of trout into the stream for spawning during October and November could be inhibited by reduced flows and loss of habitat.

American Eel (Anguilla rostrata)

American eels may be affected by decommissioning; however, significant adverse impacts are not anticipated due to their life history requirements and because they use all stream segments in the Natural Resources Study Area. American eels can absorb oxygen through their skin as well as their gills, making it possible for them to travel over land, particularly in wet grass or mud, which may help them move around barriers in streams (USFWS 2011). However, there would be a reduction in aquatic habitat in Stream Segments 3, 3B, and 4; these stream segments would be similar to baseline conditions at Stream Segment 2, where eels are established. This change in habitat may cause an insignificant reduction in long-term abundance of eels in these stream segments, but would not affect eel passage. Furthermore, forage species such as young of year and juvenile brown trout could be reduced or eliminated from the system, resulting in the need for American eels to find alternative sources of forage. American eel feed on a wide range of prey, and the new fish assemblage that would develop in Segments 3, 3B, and 4 would provide forage for the reduced eel population.

Warmwater Fisheries, Including Centrarchidae (Bluegill [Lepomis macrochirus], Pumpkinseed [Lepomis gibbosus], Black Crappie [Pomoxis nigromaculatus], and Largemouth Bass [Micropterus salmoides])

Centrarchidae (bluegill, pumpkinseed, black crappie, and largemouth bass) may be affected by decommissioning because of increased susceptibility to avian predation; however, significant adverse impacts are not anticipated. As discussed in Section 11.9.5.27, “Surface Water – Probable Impacts With Decommissioning,” Stream Segments 3, 3B, and 4 would be drawn down to low baseflow with reduced water depth and available habitat. It is likely that under baseline conditions, these centrarchids are transient, originating at the cemetery impoundment pond (washing over the weir) and finding their way downstream to the Hudson River, as evidenced by the locations at which they were collected (Stream Segments 2 and 4). Once the leaks cease, centrarchids that are within Stream Segment 4 would have reduced water depth in which to travel down to the Hudson River. Initially, the reduction in water depth would greatly reduce access for fish to edge habitat where they could find protection among the shoreline vegetation. With the fish confined to the remaining flow in exposed areas, they would be susceptible to predation from herons (and other wading birds) and raptors (bald eagles and osprey), as well as mammalian predators.

While existing fish species may be affected by decommissioning, there would be long-term beneficial impacts to the fish community of the leak-affected stream segments in the Natural Resources Study Area. These effects would occur over the course of months to years (possibly decades) once leaks cease due to decommissioning. Because a baseflow of up to approximately 10 mgd would be lost in Stream Segment 4, and the only remaining baseflow would be that contributed by Stream Segments 1, 2, and 3A, coldwater species, such as brown trout, which currently reside in these water courses, would give way to species typical of natural, thermally fluctuating streams found in the State. These species would gradually become more abundant in the lower reaches of Stream Segment 3 and throughout Stream Segment 4, based on the estimate that the baseflow in Stream Segment 4 would be reduced by up to 92 percent. These species would consist of some mentioned previously that were collected in the tidal reaches of Steam Segment 4 and upstream of Stream Segment 2, along with some species not collected that are typical of watercourses in the study area (see **Table 11.9-40**).

The upstream reaches of Stream Segment 3 may become inaccessible to fish and slower to repopulate with these species because of fish passage upstream through substantial drops and minimal flows through culverts. The species that would populate the streams would depend on the new conditions of the stream (i.e., size, water temperature, flow). For example, if the flow and channel width of a stream are substantially reduced, it is likely that larger fish species (such as catfish and white suckers) would not populate the stream. Species more likely to be found in a smaller, low-flow stream would include small minnow and shiner species (e.g., Cyprinidae). When the stream exhibits the full range of natural temperature fluctuations, it is likely that trout populations would not be able to survive and a warmwater fish assemblage would predominate in the fish community.

Table 11.9-40: Fish Species in the Natural Resources Study Area Expected to Populate Stream Segments 3, 3B, and 4 After Decommissioning[1]

Species	
Blueback Herring (*Alosa aestivalis*) - E/F	Mummichog (*Fundulus heteroclitus*) - E
Alewife (*Alosa pseudoharengus*) - E/F	Channel Catfish (*Ictalurus punctatus*) - F
American Shad (*Alosa sapidissima*) - E	Redbreast Sunfish (*Lepomis auritus*) - F
Rock Bass (*Ambloplites rupestris*) – F	Pumpkinseed (*Lepomis gibbosus*) - E/F[1]
White Catfish (*Ameiurus catus*) – F	Bluegill (*Lepomis macrochirus*) - E/F[1]
Yellow Bullhead (*Ameiurus natalis*) - F[1]	Smallmouth Bass (*Micropterus dolomieu*) - F
Brown Bullhead (*Ameiurus nebulosus*) - E/F[1]	Largemouth Bass (*Micropterus salmoides*) - E/F[1]
Bay Anchovy (*Anchoa mitchilli*) – E	White Perch (*Morone americana*) - E
American Eel (*Anguilla rostrate*) - E/F[1]	Striped Bass (*Morone saxatilis*) - E
Four-spine Stickleback (*Apeltes quadracus*) - E[1]	Golden Shiner (*Notemigonus crysoleucas*) - E/F
Freshwater Drum (*Aplodinotus grunniens*) – E	Spottail Shiner (*Notropis hudsonius*) - E
Atlantic Menhaden (*Brevoortia tyrannus*) – E	Yellow Perch (*Perca flavescens*) - E/F[1]
White Sucker (*Catostomus commersoni*) - E[1]	Bluefish (*Pomatomus saltatrix*) – E
Common Carp (*Cyprinus carpio*) - E/F	Black Crappie (*Pomoxis nigromaculatus*) - F[1]
Gizzard Shad (*Dorosoma cepedianum*) - E	Brown Trout (*Salmo trutta*) - F[1]
Redfin Pickerel (*Esox americanus americanus*) - F	Brook Trout (*Salvelinus fontinalis*) - F[1]
Chain Pickerel (*Esox niger*) – F	Fallfish (*Semotilus corporalis*) – F
Tessellated Darter (*Etheostoma olmstedi*) - E[1]	Hogchoker (*Trinectes maculatus*) – E
Banded Killifish (*Fundulus diaphanus diaphanous*) - E[1]	Central Mudminnow (*Umbra limi*) – F

Notes:
[1] Collected during Roseton fish surveys.
E = Estuarine species
F = Freshwater Species
Source: Table compiled from species collected during Roseton fish surveys and Quassaick Creek Watershed Plan Appendix Table A2.

A contributing source to fish repopulation of the leak-affected stream reaches could be the cemetery pond. During periods of heavy precipitation, water transports fish over the spillway from the cemetery pond down into a culvert at the northern end of Stream Segment 2. From Stream Segment 2, fish can travel through another downstream culvert adjacent to River Road and upstream to Stream Segment 3 or downstream to Stream Segment 4.

The re-establishment of a warmwater fish assemblage typical of natural stream conditions would be part of an overall re-establishment of natural ecological communities in the Roseton Brook area and Natural Resources Study Area. The new fish community would reflect a return to natural hydrological conditions that existed prior to the RWBT leaks when the ecology of the Natural Resources Study Area was influenced by the long-term residential/industrial expansion and development in this watershed. Therefore, although aquatic resources may be affected as a result of decommissioning, significant adverse impacts to fish are not anticipated within the Natural Resources Study Area.

Benthic Macroinvertebrates

The benthic macroinvertebrate community would be affected by the loss of benthic habitat that would result from reduced flows and water levels associated with decommissioning. As water levels drop, wetted width of affected stream segments would decrease. This could cause some immediate mortality in the benthic macroinvertebrate community. Changes to water temperature in the impacted streams could also affect the benthic community, similar to how they affect fish, causing some degree of mortality during the early fall months.

Although the benthic macroinvertebrate community would be affected, decommissioning would initiate the process of returning the system to a naturally occurring community typical of this region under normal hydrological conditions. Similar to the fish community, the benthic macroinvertebrate community of the leak-affected segments would experience long-term changes over the course of months to years following decommissioning, resulting in re-establishment of the benthic assemblage that likely existed before the RWBT began leaking.

Currently, the benthic community in leak-affected streams in the Natural Resources Study Area is dominated by Chironomidae, Gammaridae, and Ephemeroptera. Long-term effects to the benthic community would also be largely dependent on how quickly the benthic substrate would change and the area that would remain dry. Currently, the substrate of the leak-affected segments is made up of gravel and cobble with little fine sediment such as silt and mud. Flows are relatively high, precluding settlement of fine particles. The rate at which the gravel and cobble streambed sediment transitions to fine silt and mud from decommissioning would determine how quickly the benthic invertebrate community would shift to one typical of fine particles, such as those seen in Stream Segments 1, 2, and 3A. Once the hydrologic regime returns to one that experiences a full range of seasonal temperature and flow fluctuations, the benthic assemblage would be expected to begin to resemble the assemblages documented in Stream Segments 1, 2, and 3A. That is, they would experience an increase in flatworms (order Tricladida), bivalve mollusks (order Veneroida), and isopods (family Asellidae). In terms of benthic community metrics of leak-affected segments (see Section 11.9.5.6, “Aquatic and Benthic Resources – Impact Analysis Methodology”), it is expected that overall family and EPT richness levels may decrease, PMA values may decrease, and HBI values may increase.

The re-establishment of a benthic community assemblage typical of natural stream conditions and fine-grained material in the substrate would be part of an overall establishment of natural ecological communities in the Roseton Brook area and Natural Resources Study Area. The new benthic community would reflect a return to natural hydrological conditions that existed prior to the RWBT leaks when the ecology of the Natural Resources Study Area was influenced by the long-term residential/industrial expansion and development in this watershed. Therefore, although benthic resources may be affected as a result of decommissioning, significant adverse impacts to benthic macroinvertebrates are not anticipated within the Natural Resources Study Area.

Odonates

Based on the results of the Odonate survey performed in May 2015, there were no potentially rare or listed species found. Therefore, decommissioning would not result in significant adverse impacts to Odonates within the Natural Resources Study Area.

Aquatic and Benthic Resources Conclusions

Prior to the RWBT leaks occurring in Roseton, the ecology of the Natural Resources Study Area was influenced by the long-term residential/industrial expansion and development in this watershed. Once the leak is repaired, the aquatic habitats of the study area would continue to be influenced by these factors and may return to ecological conditions that likely existed before the RWBT began leaking. Therefore, although aquatic and benthic resources may be affected as a result of decommissioning, significant adverse impacts to aquatic and benthic resources are not anticipated within the Natural Resources Study Area.

11.9.5.31 Terrestrial Resources – Probable Impacts With Decommissioning

Decommissioning would result in cessation of leaks that contribute to the shallow groundwater and wetland resources and would induce changes to stream segments and wetlands that are influenced by the leaks in the Natural Resources Study Area. This has the potential to impact terrestrial resources in the study area. Based on the methodology described in Section 11.9.5.7, “Terrestrial Resources – Impact Analysis Methodology,” an analysis of the potential for impacts from decommissioning to these resources is discussed below.

Ecological Communities

Of the ecological communities discussed previously, the shallow emergent marsh, freshwater tidal swamp, shrub swamp, red maple-hardwood swamp, and marsh headwater stream communities that exist adjacent to Steam Segments 3, 3B, and 4 (Wetlands A, B, Southern C, D, and E) have the potential to be impacted by decommissioning (see Section 11.9.5.28, “Wetlands – Probable Impacts With Decommissioning”). These ecological communities have adapted to the hydrologic conditions as a result of leaks, including elevated groundwater levels and stream baseflows, and thus the communities would be affected by changes to shallow groundwater level and streamflow as a result of decommissioning.

The existing ecological communities adjacent to Steam Segments 3, 3B, and 4 support a wide variety of flora and fauna. Alteration to or reductions in these habitats and the effects on the flora and fauna that inhabit them from decommissioning are discussed below.

Wildlife

Amphibians and Reptiles

Decommissioning would reduce levels and flow of surface water in Stream Segments 3, 3B, and 4, and affect the hydrology of Wetlands A, B, Southern C, D, and E within the Natural Resources Study Area. Many of the amphibians and some of the reptile species summarized in **Table 11.9-25** require surface water or wetlands for at least some stage of their life histories. With the exception of the federal/State Threatened, Endangered, Candidate Species, and State Species of Special Concern (see **Table 11.9-28**) discussed below, many of the species that occur or could occur in the Natural Resources Study Area are common throughout the region. The species observed may experience reduced habitat and increased competition for resources. However, individuals may relocate to other nearby suitable habitats in the Natural Resources Study Area. This would include Stream Segments 1, 2, and 3A, and Wetlands C, F, G, I, K, and KA, which have minimal influence from leak water, if any. Therefore, decommissioning would not result in significant adverse impacts to amphibians and reptiles within the Natural Resources Study Area.

Avian Species

Avian species that occur or have the potential to occur in the Natural Resources Study Area are largely forest-dependent birds, and no impacts to these species are anticipated. The water birds that occur in the study area, such as the Wood Duck (*Aix sponsa*), Mallard (*Anas platyrhynchos*), Great Blue Heron (*Ardea herodias*), Green Heron (*Butorides virescens*), and Black-crowned Night Heron (*Nycticorax nycticorax*), have the potential to lose habitat if the pooled water sources in the study area's leak-affected locations (Stream Segments 3, 3B, and 4 and Wetlands A, B, Southern C, D, and E) experience reductions.

For forest, wetland, and scrub-shrub dwelling bird species, reductions in the water flows may lead to reductions in the reproductive success of aquatic invertebrates, which are important to insectivorous birds. Alterations in vegetation within the ecological communities discussed above also have the potential to reduce foraging habitat for ground-dwelling birds.

Many of the bird species with the potential to occur in the study area that are listed in **Table 11.9-26**, with the exception of those discussed below in Section 11.9.5.16, Endangered, Threatened, and State Species of Special Concern are common to the region. Minor reduction in foraging habitat and invertebrate prey species from decommissioning would not have a significant adverse impact to the regional population levels of these species. Some species of birds that inhabit forest interiors or successional habitats could benefit from reduced flows; reduction in riverine, wetland, and riparian habitat would result in natural succession into other habitat types. Therefore, decommissioning would not result in significant adverse impacts to these bird species within the Natural Resources Study Area.

Mammals

Mammal species that could occur in the Natural Resources Study Area have the potential to be indirectly affected by decommissioning. Some mammal species such as the muskrat or meadow jumping mouse utilize wetland habitats or wetland fringe habitats for foraging or cover. Shifts in vegetation composition may reduce this habitat or may increase it, depending on what new plant species colonize the affected areas (see Section 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning"). Many of the mammal species that could occur in the Natural Resources Study Area are common to the region. Therefore, decommissioning would not result in significant adverse impacts to these mammal species within the Natural Resources Study Area.

Terrestrial Resources Conclusions

Decommissioning would not reduce the habitat suitability for those species which were identified as having the potential to use the Natural Resources Study Area. The estimated loss of approximately 1.2 acres (approximately 8 percent of the total) of wetlands would not eliminate the area's ability to provide suitable habitat. For common species, the ecological communities would remain and the food webs needed to support them would remain intact. Any successional changes from decommissioning would be incremental, and muted by prior and ongoing land uses in the Natural Resources Study Area watershed.

Therefore, decommissioning would not result in significant adverse impacts to terrestrial resources within the Natural Resources Study Area.

11.9.5.32 Federal/State Threatened, Endangered, and Candidate Species, and State Species of Special Concern - Probable Impacts With Decommissioning

Decommissioning would permanently stop the leaks that contribute to the shallow groundwater and wetland resources and would induce changes to stream segments and wetlands that are influenced by the leaks (Stream Segments 3, 3B, and 4 and Wetlands A, B, Southern C, D, and E) in the Natural Resources Study Area. This has the potential to impact federal/State Threatened, Endangered, Candidate Species, and State Species of Special Concern in the study area. Based on the methodology described in Section 11.9.5.8, "Federal/State Threatened, Endangered, and Candidate Species, State Species of Special Concern, and Unlisted Rare and Vulnerable Species – Impact Analysis Methodology," an analysis of the potential for impacts from decommissioning to these resources is discussed below.

Federally Listed Species

Indiana Bat (Myotis sodalis)

The potential roosting and foraging habitat for Indiana bats within the Natural Resources Study Area would not be lost or modified as a result of decommissioning. A reduction in flow to the affected stream segments (Stream Segments 3, 3B, and 4) would not result in modification of the existing forest habitat adjacent to the stream segments or within upland forested habitats where trees that exhibit suitable roosting characteristics would be found. In stream segments where a reduction in flow is anticipated, it is possible that the abundances of forage species (specifically species of flying invertebrates that have aquatic early life stages) may change if the flow, hydrology, or vegetation changes. Some invertebrate species (such as mayflies) that have a multi-year nymphal stage and require perennial flows) may be reduced, while other species such as chironomids may increase in numbers. However, Indiana bats are capable of flying large distances in search of water features (Barclay and Kurta 2007). Therefore any potential reduction in the abundance of forage species in Stream Segments 3, 3B, and 4 is not anticipated to have significant adverse impacts to Indiana bats, as suitable water features would still be available within the Indiana bat foraging territory. As suitable water and upland features (undisturbed wetlands, open understory in forested areas, and utility ROW in the study area) would still be available, bat foraging opportunities would still exist. Therefore, decommissioning would have no effects to Indiana bats within the Natural Resources Study Area.

Northern Long-Eared Bat (Myotis septentrionalis)

The potential roosting and foraging habitat for northern long-eared bats within the study area would not be lost or modified as a result of decommissioning. A reduction in flow to the affected stream segments (Stream Segments 3, 3B, and 4) would not result in modification of the existing forest habitat adjacent to the stream segments or within upland forested habitats where trees that exhibit suitable roosting characteristics would be found. In stream segments where a reduction in flow is anticipated, it is possible that the abundance of forage species (specifically, species of flying invertebrates that have aquatic early life stages) may change if the flow, hydrology, or vegetation changes.

However, northern long-eared bats are not dependent only on aquatic sources for forage. Northern long-eared bats forage over water, but also in upland wooded areas, wooded corridors, and adjacent areas around cleared sites or agricultural fields, as well as wetlands (USFWS 2014b). If there is an impact to forage species along Stream Segment 3, 3B, or 4, there is ample other suitable foraging habitat within the study area to support northern long-eared bats. Any potential reduction in the abundance of forage species in Stream Segment 3, 3B, or 4 would not have significant adverse impacts to northern long-eared bats. Therefore, decommissioning would have no effects to northern long-eared bats within the Natural Resources Study Area.

Bald Eagle (Haliaeetus leucocephalus)

The Hudson River is a common foraging area for Bald Eagles and, as described above, several Bald Eagles were observed foraging adjacent to the study area along the Hudson River, and in Stream Segment 4 during winter 2014. Stream Segment 4 is anticipated to be impacted by decommissioning; however, the tidally influenced portion of this stream would not be affected substantially due to the influence from the Hudson River. Therefore, decommissioning would have no effects to Bald Eagles within the Natural Resources Study Area.

Bog Turtle (Clemmys [= Glyptemys] muhlenbergii)

Decommissioning would potentially affect different stream segments in the study area differently, as discussed in Section 11.9.5.27, “Surface Water – Probable Impacts With Decommissioning,” Stream Segment 1 (Wetland I) and Stream Segment 2 (Wetland G) would not be affected by cessation of leaks due to decommissioning. It is noted that no bog turtles were observed during Phase II surveys conducted in both Wetlands I and G, and no bog turtles were found during the Phase III surveys conducted in Wetland I. No Phase III surveys were conducted in Wetland G because it does not contain sufficient suitable bog turtle habitat to warrant a Phase III survey. Therefore, decommissioning would not impact bog turtles that may be located in the wetlands associated with these streams. A reduction in flow as a result of decommissioning is anticipated in Stream Segment 3 (Wetlands A, Southern C, D, and E), Stream Segment 3B (Wetland B), and Stream Segment 4. However, there is no potential bog turtle habitat associated with Stream Segment 4, as the wetland associated with Stream Segment 4 is influenced by the tides of the Hudson River. The Phase II studies demonstrated that the wetlands associated with Stream Segments 3 and 3B did not contain the habitat factors for bog turtles and would not require further analysis, and Phase III surveys are not warranted in this location.

Reduction of the flows in Stream Segments 3 and 3B from decommissioning would result in changes to vegetation in that stream and wetland areas, but would not impact bog turtles or bog turtle habitat.

No bog turtles were observed or found during the intensive, species-specific studies, and there are no known extant or historical bog turtle sites within the study area or within normal movement distances of bog turtles. Movement corridors in and around the study area are fragmented by roads, developments, and unsuitable habitats. Therefore, decommissioning may affect, but is unlikely to adversely affect, bog turtles within the Natural Resources Study Area.

State Listed Species

Peregrine Falcon (Falco peregrinus)

No suitable nesting sites were observed in the Natural Resources Study Area. There are potential foraging areas for Peregrine Falcons, including large trees and snags along the Hudson River and man-made structures within or near the study area. Stream segments and wetlands within the study area that would experience alterations in hydrology or flows (Stream Segments 3, 3B, and 4 and Wetlands A, B, Southern C, D, and E) as a result of decommissioning would be unlikely to impact Peregrine Falcon foraging habitat. Trees potentially used for perching and foraging would not be affected by decommissioning, and the stream segments in the study area are in mostly wooded environments that would not be suitable foraging areas for Peregrine Falcons. The tidal reach of Stream Segment 4 is the highest quality foraging habitat in the study area, but due to the tidal influence, it is unlikely that any effects to the flow or hydrology of the tidal reach of Stream Segment 4 would be measurable. Therefore, decommissioning would have no effects to Peregrine Falcons within the Natural Resources Study Area.

Sharp-shinned Hawk (Accipiter striatus)

Trees used for perching, nesting, and foraging by Sharp-shinned Hawks, are not anticipated to be affected by decommissioning. Also, Sharp-shinned Hawks almost exclusively prey on small song birds (Hames and Lowe 2008a). While some songbird species have the potential to be affected by wetland and riparian habitat changes from potential reductions in flow to the stream segments and wetlands in the study area (Stream Segments 3, 3B, and 4 and Wetlands A, B, Southern C, D, and E), the population of songbirds in the wooded areas where the Sharp-shinned Hawk is likely to forage, would not be significantly affected. Therefore, decommissioning would have no effects to Sharp-shinned Hawks within the Natural Resources Study Area.

Cooper's Hawk (Accipiter cooperii)

Cooper's Hawks have similar habitat and foraging requirements to those of Sharp-shinned Hawks, but their nesting requirements are more general. While some songbird species have the potential to be affected by wetland and riparian habitat changes from potential reductions in flow to the stream segments and wetlands in the study area, the population of songbirds in the wooded areas where the Cooper's Hawk is likely to forage would not be significantly affected. Therefore, decommissioning would have no effects to Cooper's Hawks within the Natural Resources Study Area.

Red-shouldered Hawk (Buteo lineatus)

Red-shouldered Hawks almost always nest in the immediate vicinity of water such as streams or wetlands (Crocoll 1994) like those found in the Natural Resources Study Area. Leak-affected wetlands (Wetlands A, B, Southern C, D, and E) found in the study area and the associated potential Red-shouldered Hawk habitat would be impacted by reductions in flow or altered hydrology. However, the Red-shouldered Hawk is a foraging generalist, and any individuals affected are capable of utilizing nearby habitat that may not be impacted by leak cessation. Therefore, decommissioning would have no effects to Red-shouldered Hawks within the Natural Resources Study Area.

Eastern Box Turtle (Terrapene carolina)

Several eastern box turtles were found in emergent and forested wetlands (Wetlands A, C, D, E, and G) associated with Stream Segments 1, 3, and 4 during bog turtle and wetland surveys in the Natural Resources Study Area. Eastern box turtles use a variety of habitat as described in Section 11.9.5.16, “Federal/State Threatened and Endangered Species and State Species of Special Concern – Baseline Conditions,” and ample, suitable habitat exists within the study area. Additionally, while declining in other areas of the State, the eastern box turtle is considered fairly common in the Hudson River Valley (Gibbs et al. 2007). Therefore, decommissioning may affect, but is unlikely to adversely affect, eastern box turtles within the Natural Resources Study Area.

Spotted Turtle (Clemmys guttata)

Within the study area, potential habitat for spotted turtles is present in the vicinity of Wetlands A, D, E, G, and I. No spotted turtles were found in the study area during the species-specific study in spring 2015, the bog turtle Phase I, II, and III surveys, or other studies conducted in the study area. Decommissioning would reduce stream flow in Stream Segment 3 and result in reduced hydrology in adjacent Wetlands A, B, Southern C, D, and E. The potential loss of wetland habitat from decommissioning is not anticipated to affect spotted turtle habitat, as suitable habitat is anticipated to remain in the Natural Resources Study Area. Therefore, decommissioning may affect, but is unlikely to adversely affect, spotted turtles within the Natural Resources Study Area.

Wood Turtle (Glyptemys insculpta)

The wood turtle is a semi-aquatic species that prefers flowing waters of streams, creeks, and small rivers with undercut banks with holes and crevices and adjacent and nearby wetlands, lowlands, and uplands. In the Hudson River region, wood turtles also occupy tidal freshwater areas such as those found along Stream Segment 4. Wood turtles are scattered throughout most of the State; however, the population is healthiest in the Hudson River Valley (Gibbs et al. 2007). Reduced flows in streams impacted by decommissioning may decrease the amount of potential wood turtle habitat available within the Natural Resources Study Area. This could result in effects to individual wood turtles, if present. Any individuals affected are able to move to other suitable habitat within the Natural Resource Study Area that would not be impacted by decommissioning. However, no wood turtles were found during the species-specific 2015 study, the bog turtle Phase I, II, and III surveys, wetland delineation, or other field studies. Because the wood turtle population is stable within the region, impacts from decommissioning to some individuals would not result in significant adverse impacts to regional populations of wood turtles or their habitat. Therefore, decommissioning may affect, but is unlikely to adversely affect, wood turtles within the Natural Resources Study Area.

Jefferson Salamander (Ambystoma jeffersonianum)

As described in Section 11.9.5.16, "Federal/State Threatened and Endangered Species and State Species of Special Concern – Baseline Conditions," Jefferson salamanders require pools that only exist for a short period following precipitation or snowmelt (ephemeral) or semi-permanent vegetated wetlands for breeding. Within the Natural Resources Study Area, there are three water features that meet these criteria in the vicinity of Stream Segment 1 and Wetland I. This includes one small ephemeral pool/depression near Wetland I, the cemetery pond, and two other small beaver-created depressions that were observed and hold water. The seasonal duration of water in the small shallow depression is unknown, but likely not suitable for Jefferson salamander breeding. The cemetery pond has a resident fish population and thus would not be suitable for Jefferson salamander breeding. The two beaver-created pools are likely seasonal and fish-free. No fish were collected during electrofishing surveys within the two stream segments nearest the pools, nor were any fish observed in these pools during the May 2015 Odonate survey. The pools may provide potential breeding habitat that could be used by Jefferson salamanders and other amphibians. These are considered marginal breeding habitats due to their location along Stream Segment 1 and because the duration of seasonal water is unknown. The ponded surface expression within Wetland B also provides potential habitat, but no evidence of any salamander breeding activity (egg masses or larvae) was observed.

Because decommissioning is unlikely to result in substantially lower water levels in this portion of the study area (Segment 1 and wetland I), the ability of these pools to support Jefferson salamander breeding would remain unchanged. Additionally, breeding populations of Jefferson salamander are common and widespread throughout south and central New York (Gibbs et al. 2007). Therefore, while there is the potential for impacts to Jefferson salamander breeding habitat as a result of a lowered water table or reduced flow to the ephemeral depressions, decommissioning may affect, but is unlikely to adversely affect, Jefferson salamanders within the Natural Resources Study Area.

Federal/State Threatened, Endangered, Candidate Species, and State Species of Special Concern Conclusions

Based on the impact analysis, no take is anticipated. Decommissioning would have no significant adverse effect on any State or federally listed species that have been documented to use the Natural Resources Study Area. Decommissioning would not reduce the habitat suitability for those species that were identified as having the potential to use the study area. In e-mail correspondence dated September 16, 2015, NMFS indicated that they have no objections to DEP's determination that decommissioning would have no effect on EFH or Endangered Species Act-listed species under NMFS jurisdiction.

For the federal/State Threatened, Endangered, Candidate Species, and State Species of Special Concern documented or having the potential to use the Natural Resources Study Area, the estimated loss of approximately 1.2 acres (approximately 8 percent of the total) of wetlands would not eliminate the area's ability to provide suitable habitat. For common species, the ecological communities would remain, and the food webs needed to support them would remain intact. Any successional changes from decommissioning would be incremental, and muted by prior and ongoing land uses in the Natural Resources Study Area watershed. The detailed desktop reviews, agency file search results, field study protocols, and field surveys have produced a thorough analysis of potential species presence and habitat use, and serve as an accurate estimator of any changes that would occur from decommissioning.

Therefore, decommissioning would not result in significant adverse impacts to federal/State Threatened, Endangered, Candidate Species, and State Species of Special Concern within the Natural Resources Study Area.

11.9.5.33 Geology and Soils – Probable Impacts With Decommissioning

As previously described, the temporary shutdown and decommissioning would result in the cessation of leaks. This would affect the water level in the surrounding aquifers. During the temporary shutdown, water would be pumped from the RWBT lowering the water level in the unconsolidated and bedrock aquifers. Over the long term after decommissioning, the water level in the unconsolidated and bedrock aquifers would stabilize at a level that would be lower than baseline but similar to the water level in the unconsolidated aquifer before construction of the RWBT.

The settlement that could result due to the temporary shutdown and decommissioning was estimated based on the methodology in Section 11.9.5.9, "Geology and Soils – Impact Analysis Methodology." Potential settlement mechanisms are discussed further below.

Settlement Mechanisms

Based on the geology and soils, infrastructure, and surface expressions in the Roseton Study Area (see **Figure 11.9-3** and Section 11.9.3, "Roseton Study Area: Location and Description,") there are four settlement mechanisms that could occur during unwatering and decommissioning. These mechanisms, and their potential to occur and cause changes to geology and soils are listed below.

- Effective stress increase resulting from lowering the groundwater levels;
- Migration of fine soil particles in small localized areas around existing surface expressions;
- Sloughing of destabilized areas at the ponded surface water expression; and
- Collapse of subsurface voids or of the decommissioned section of the RWBT.

The area that could be subject to potential stress induced settlement encompasses locations where these three other potential mechanisms could occur. Therefore, stress induced settlement was used to assess the extent of potential changes to geology and soils.

While other mechanisms potentially exist, they were not considered in the analysis because of the baseline subsurface conditions, the lack of specific inducing activities, or the remote likelihood of occurrence within the Roseton Study Area. The types of geologic change eliminated from further consideration include settlement due to earthquakes, shrink-swell soil behavior, extraction of oil or natural gas, oxidation of organic soils, and collapse of subsurface mines.

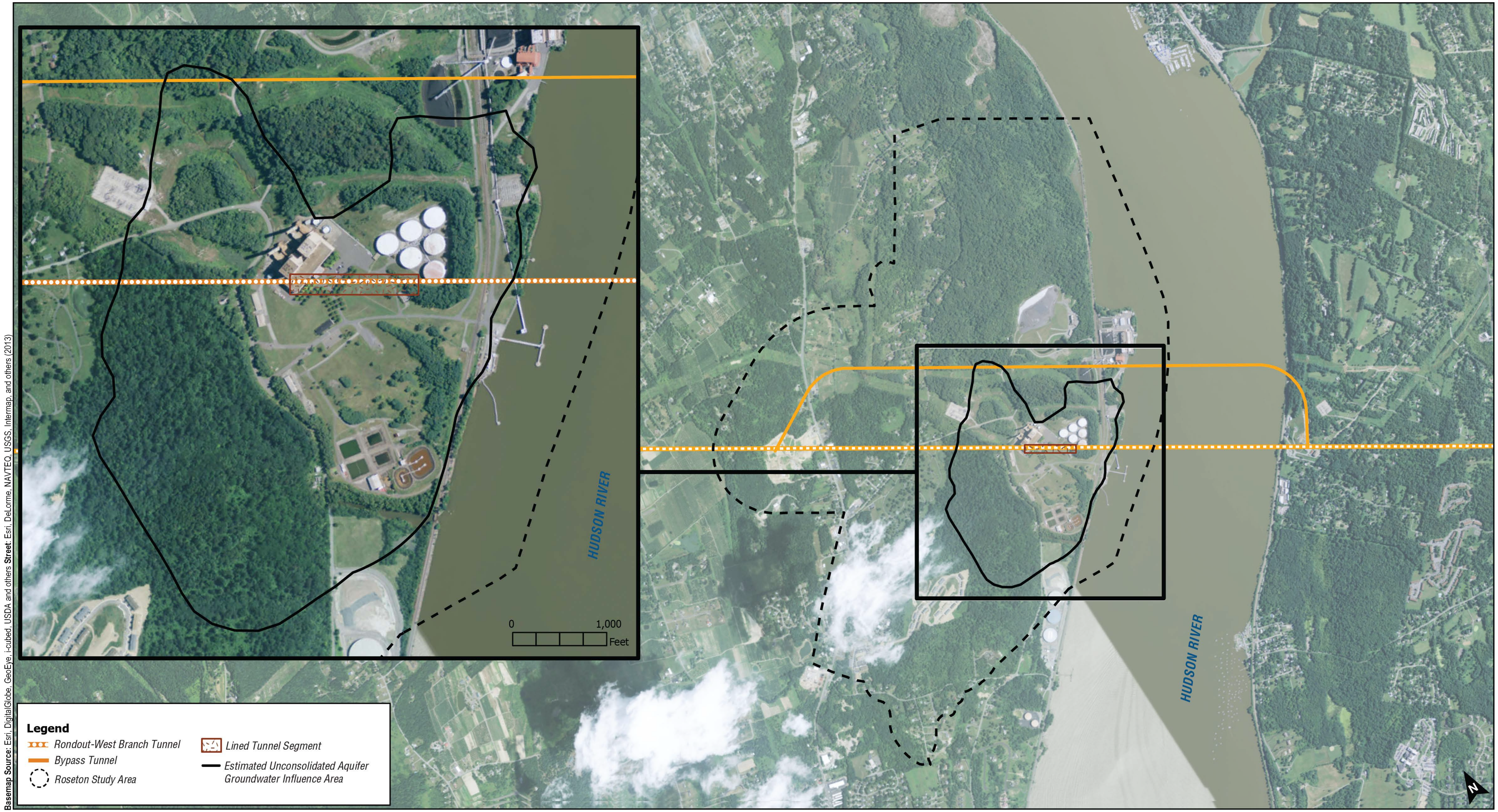
Estimated Unconsolidated Aquifer Groundwater Influence Area

The potential for impacts to geology and soils could begin when groundwater levels decline at fthe start of the temporary shutdown, when the RWBT would be depressurized and unwatered. Impacts could also occur over the long term as the groundwater levels stabilize to preconstruction RWBT levels. As described in Section 11.9.5.2, "Groundwater – Impact Analysis Methodology," the area that could be influenced by a decline in groundwater level is called the Estimated Unconsolidated Aquifer Groundwater Influence Area (see **Figure** 11.9-102). Therefore, the potential for impacts to geology and soils could occur within this area.

Results of the Geotechnical Investigation

A geotechnical investigation was completed to characterize the geology and soils summarized in Section 11.9.5.17, "Geology and Soils – Baseline Conditions." Their characteristics, as they relate to potential for settlement from lower groundwater levels, are described as follows:

- **Fill:** The fill was likely placed by a range of methods, including dumping and hydraulic filling. As these materials were likely placed in an uncontrolled fashion, their compressibility may be moderate to high. Fill was encountered in all Standard Penetration Test borings. Due to the uncontrolled placement, fill material could contribute to settlement.
- **Organic Rich Soils:** Organic rich soils tend to have high compressibility and would undergo settlement over a long period of time once an increase in stress due to groundwater lowering has occurred even after groundwater levels return to the level before the construction of RWBT. Organic rich soils were encountered in the northeastern and southwestern portion of the Estimated Groundwater Influence Area. Due to the compressibility, organic rich soils could contribute to settlement.
- **Estuarine Deposit:** Estuarine deposits consist of a thick upper layer of compressible clay with occasional interbedded silt and sand layers. Areas underlain by clay soils would have a greater potential for settlement than areas underlain predominantly by sand and silt soils. Clay soils also settle very slowly as a result of their low permeability as compared to sand and silt soils. Due to the compressibility, clay soils could potentially contribute to settlement.



Note: This preliminary assessment was conducted on existing available information, experience with similar geologic conditions, and anticipated changes in groundwater levels. The results of the preliminary assessment were used as the basis of the Geotechnical Investigation.

0 2,000 Feet

NYC Environmental Protection

Figure 11.9-102: Estimated Unconsolidated Aquifer Groundwater Influence Area

- **Glacial Till: G**lacial till was typically encountered overlying the bedrock across the site at varying depths. Glacial till tends to have low compressibility. Due to the low compressibility, glacial till would likely not contribute to settlement.
- **Bedrock:** The bedrock has a solid matrix and is typically not subject to settlement. Bedrock is considered incompressible. Stress increases associated with the lowering of the groundwater table during unwatering and equalization is not expected to contribute to settlement.

In general, the thickness of the unconsolidated soils tends to increase from the west to the east towards the Hudson River. Unconsolidated soils also generally increase in thickness towards the RWBT from both the north and south boundaries, along the eastern portion of the Estimated Unconsolidated Aquifer Groundwater Influence Area.

Areas that Could be Subject to Settlement

As described further in Section 11.9.5.9, "Geology and Soils – Impact Analysis Methodology," the results of the geotechnical investigation were used with the piezometric data from the wells installed in the geotechnical borings, and the groundwater model results to estimate the potential for stress induced settlement within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see **Figure 11.9-102**). The decline in groundwater levels within the unconsolidated aquifer would have a greater influence on soil stress changes in the compressible deposits. The potential impacts to geology and soils within the Estimated Unconsolidated Aquifer Groundwater Influence Area are discussed below.

Geology and Soils

Based on the results presented above, geology and soils within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see **Figure 11.9-103**) could be subject to potential settlement during the temporary shutdown and over the long term after decommissioning. This settlement could occur in the cohesive soils in the unconsolidated aquifer in response to the increase in stress resulting from lowered groundwater levels.

Reducing the groundwater level in an unconsolidated aquifer could result in areas that could be subject to potential ground settlement as the pore pressure in the cohesive fine-grained soils (referred to as Clay Confining Unit and Clay Lense on **Figure 11.9-104**) is reduced and the stress is transferred to the granular soils (referred to as Unconsolidated Aquifer on **Figure 11.9-104**). This increase in stress (created by the change in water level) could occur during the temporary shutdown and over the long term after decommissioning.

Because of their soil characteristics, changes in these compressible deposits from lower groundwater levels would occur slowly. Therefore, given the limited duration of the 8-month temporary shutdown, potential settlement during this phase would be nominal.

Based on the changes in groundwater levels during the temporary shutdown, potential settlement could occur in the cohesive unconsolidated aquifer at locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area. The unconsolidated aquifer contains cohesive clay with occasional interbedded layers of sand and silt.

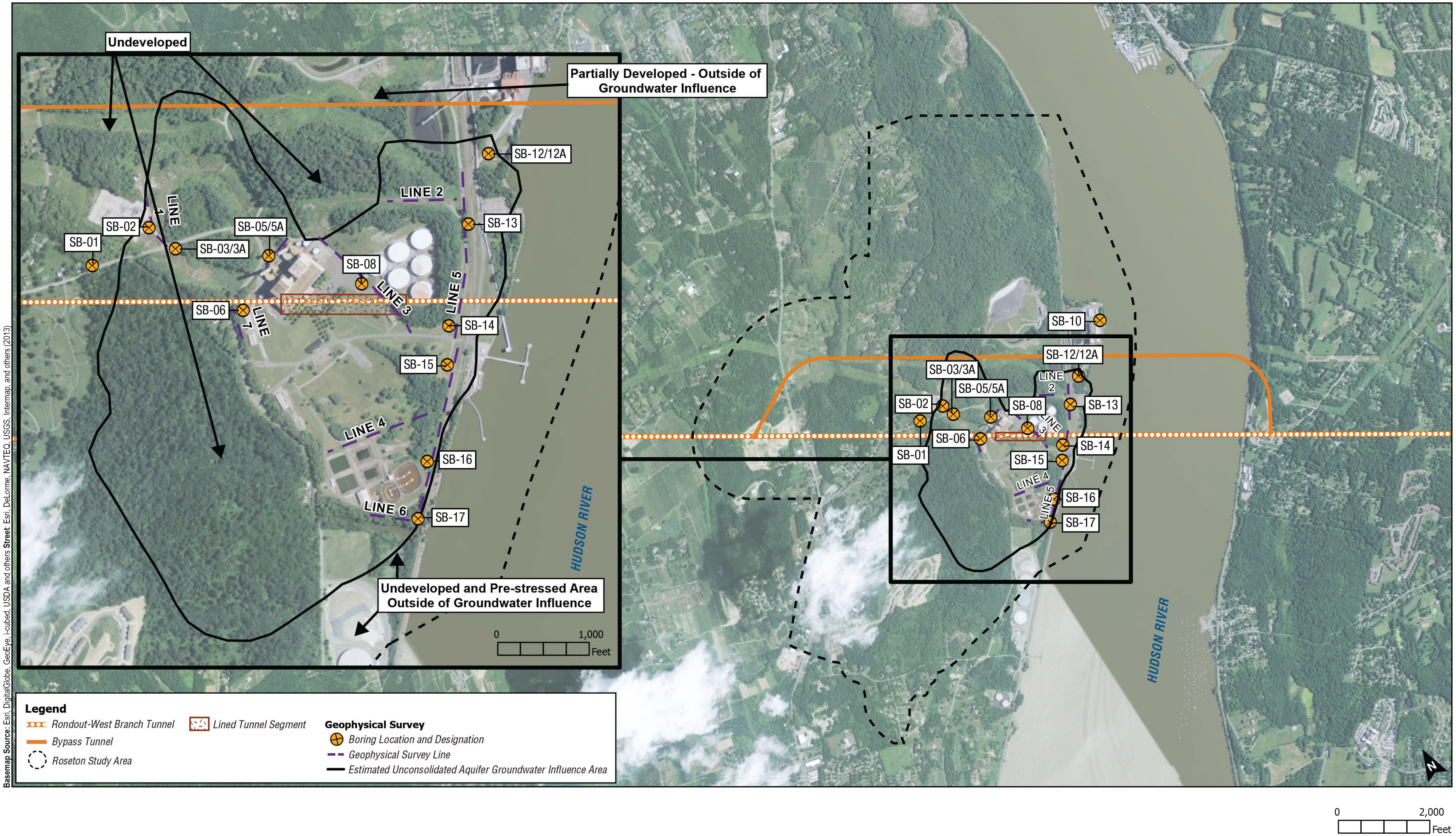


Figure 11.9-103: Estimated Unconsolidated Aquifer Groundwater Influence Area and Geotechnical Investigation Boundary

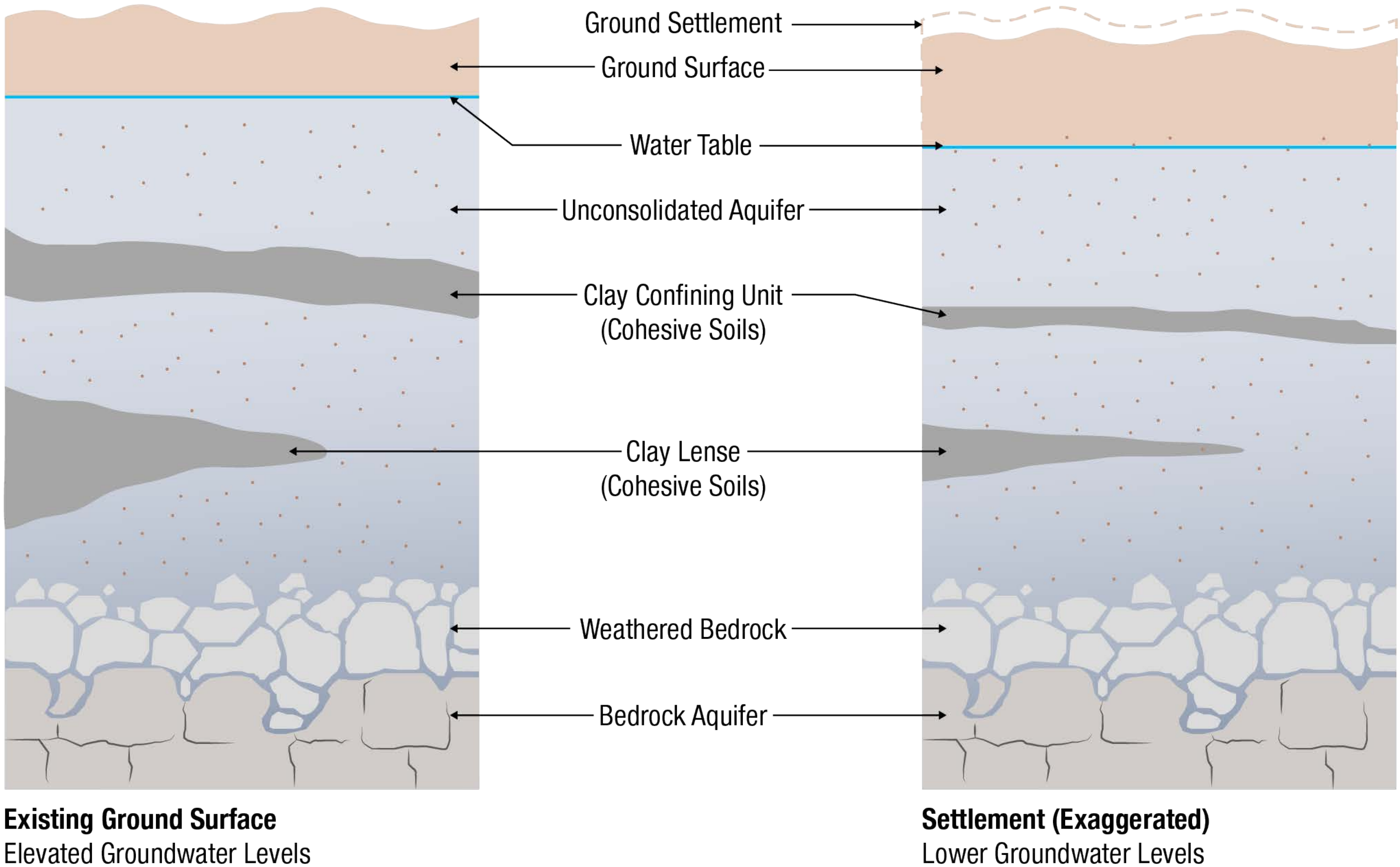


Figure 11.9-104: Illustration of Settlement Due to a Decline in Water Levels

Within the fine-grained cohesive clay and silt soils in the unconsolidated aquifer, settlement could occur as the soil stress increases and the water is slowly squeezed from the pore space (see **Figure 11.9-104**).

Based on the changes in groundwater levels, settlement could occur in the cohesive soils over the long term after decommissioning at locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area. Settlement in cohesive soils in the unconsolidated aquifer would occur slowly over decades.

The potential settlement in areas with structures and infrastructure resulting from the estimated impacts within the Estimated Unconsolidated Aquifer Groundwater Influence Area is discussed below.

Structures and Infrastructure

Structures and subsurface infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area were identified in areas that could be subject to settlement during the temporary shutdown and over the long term after decommissioning. There are 44 structures and subsurface infrastructure elements identified within the Estimated Unconsolidated Aquifer Groundwater Influence Area. The 44 structures and infrastructure elements within the Estimated Unconsolidated Aquifer Groundwater Influence Area were characterized as follows:

- **Potential for No or Nominal Settlement**. Structures that are *not likely to experience* settlement because of the following:
  - Their foundation or other characteristics negate the impact of the settlement (e.g., founded directly on rock or founded on piles extending to rock).
  - They are subjected to no amount of, or minimal uniform settlement or differential settlement that would not adversely impact the structure or infrastructure.
  - No groundwater drawdown is anticipated in the area based on proximity to the Hudson River or location beyond the Estimated Groundwater Influence Area.
- **Potential for Settlement**. Structures or facilities that *may be subject to settlement* because of the following:
  - The structure would be subjected to differential settlement over the dimensions of the structure (e.g., rigid structure subjected to bending or tilting).
  - The structure would be subjected to differential settlement because of differing foundation types for the same or a connected structure (e.g., building founded on piles and soil; or building founded on piles, but utility connections are on soil subjected to settlement).
  - The structure is a linear structure that would be subjected to differential settlement that may impact its function or dependability (e.g., railroad tracks, roadways, utilities, or pipelines).

Twenty-six of the identified structures and infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area were identified as having the potential for no settlement or nominal settlement, indicating that they would not likely be impacted by the estimated settlement. Eighteen potentially impacted structures were identified as located in areas that could be subject to settlement. This settlement could occur during the temporary shutdown and over the long term after groundwater levels reach a new equilibrium.

Geology, Soils, Structures, and Infrastructure Impact Analysis Conclusions

Based on the analysis described above, overall conclusions from the geology, soils, structures, and infrastructure analysis of potential impacts from cessation of leaks during the temporary shutdown and over the long term after decommissioning are as follows:

- **Settlement could occur within the Estimated Unconsolidated Aquifer Groundwater Influence Area during the temporary shutdown and over the long term after decommissioning.** Areas that could be subject to settlement were identified. These areas could be subject to settlement due to the stress increase to the geology and soils that would be caused by the lowering of groundwater levels during the temporary shutdown and over the long term after decommissioning. These areas were identified based on the potential decline in groundwater level, and the time rate of settlement based on the thickness of compressible layers, and compressibility characteristics. There could be areas with the potential for settlement during the temporary shutdown, and areas with the potential for settlement over the long term after decommissioning within the Estimated Unconsolidated Aquifer Groundwater Influence Area. Settlement over the long term after decommissioning would occur slowly (e.g., up to decades).

- **Settlement could impact identified structures and infrastructure located in the Estimated Unconsolidated Aquifer Groundwater Influence Area.** Twenty-six of the structures and infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area were identified as in areas that could be subject to no or nominal settlement. This indicates that they would be minimally to not likely impacted. Eighteen structures were identified as in areas that could be subject to settlement during the temporary shutdown and over the long term after decommissioning.

All structures and infrastructure with the potential for settlement (i.e., active power plants, oil storage tanks, roadways, a church, active railroads, and large and small utilities) could be stabilized, if necessary, using readily available engineering techniques to limit the potential for settlement to result in an effect to these structures. DEP is currently working with owners of properties within the Estimated Unconsolidated Aquifer Groundwater Influence Area, and is committed to developing Action Plans that include engineering techniques to protect the affected structures or infrastructure based on their type, function and estimated magnitude of change.

These Action Plans include such measures as:

- Additional investigations;

- Development of engineering techniques and structure-specific thresholds to evaluate whether additional engineering techniques are required during the temporary shutdown and over the long term after decommissioning; and
- Monitoring prior to, during, and after the temporary shutdown and after decommissioning.

These measures are further described in Section 11.10, “Commitments,” and would protect structures and infrastructure.

Therefore, while there may be some areas that could be subject to settlement within the Estimated Unconsolidated Aquifer Groundwater Influence Area, decommissioning would not result in significant adverse impacts to groundwater resources within the Roseton Study Area.

11.9.6 LAND USE, ZONING, AND PUBLIC POLICY

This section presents the analysis of the potential for decommissioning to result in direct effects to and non-compatible conditions with existing land use and zoning, or to conflict with public policies within the Roseton Study Area.

The permanent cessation of leaks would result in reduced groundwater, shallow groundwater, and surface water levels, and could result in consolidation settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area within the larger Roseton Study Area. However, decommissioning would not affect land uses within the study area or require a zoning change, nor would it physically displace existing land uses or alter existing land uses or zoning within the Roseton Study Area. Therefore, decommissioning would not result in significant adverse impacts to land use and zoning within the Roseton Study Area.

11.9.6.1 Impact Analysis Methodology

The public policy impact analysis consisted of: (1) establishing and describing the baseline conditions within the Roseton Study Area by identifying relevant public policies (described further below), including adopted State, county, neighborhood, and community plans; (2) establishing future conditions without decommissioning by identifying anticipated updates to public policies planned and programmed for implementation within the study area by the analysis year; (3) establishing future conditions with decommissioning based on the permanent cessation of leaks within the study area; and (4) analyzing the potential for impacts from decommissioning by evaluating whether the proposed project would potentially be non-compatible with applicable public policies.

The following plans contain policies and/or goals relevant to impact analysis of decommissioning: New York State Department of State (NYSDOS) Coastal Management Program (CMP), Orange County Comprehensive Plan, Orange County Supplemental Water Master Plan, and Code of the Town of Newburgh. Below is a summary of the applicable plans for which compatibility with decommissioning were analyzed in the respective Public Policy sections.

New York State Department of State Coastal Zone Program (1981)

After enactment of the federal Coastal Zone Management Act, NYSDOS developed a CMP and enacted implementing legislation in 1981 (Waterfront Revitalization and Coastal Resources Act). The purpose of this program was to achieve a balance between economic development and preservation, thus promoting waterfront revitalization and water-dependent uses (i.e., ferries and other activities unique to waterfronts), and protecting open spaces, scenic areas, public access to the shoreline, fish, wildlife, and farmland. The program also aims to minimize adverse effects to ecological systems, erosion, and flood hazards.

The CMP was approved by the U.S. Department of Commerce in September 1982, and the program is administered by the NYSDOS. The program consists of 44 Statewide coastal policies for the protection and improvement of the waterfront. These policies establish a framework for managing waterfront resources in the public interest. The potential effects of decommissioning within the Roseton Study Area were evaluated relative to compatibility with the following policies:

- Will the proposed project result in large physical change to a site within the coastal area which will require the preparation of an environmental impact statement? (Policies 25, 38)

    - ***Policy 25:*** *Protect, restore, or enhance natural and man-made resources which are not identified as being of statewide significance, but which contribute to the overall scenic quality of the coastal area.*

    - ***Policy 38:*** *The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply.*

Orange County Comprehensive Plan (Amended 2004 and 2010)

The Orange County Comprehensive Plan is a guide to set the overall direction for growth and development of the County. Recommendations found in the Orange County Comprehensive Plan are intended to address "core issues of concern" cited by Orange County, such as declining affordability, retaining and attracting youth, ensuring a lead role for central places (e.g., cities, villages and hamlets), better managing development patterns, and the future of agriculture. In addition, Orange County has developed two supplementary plans to support goals within the Orange County Comprehensive Plan, the Supplemental Open Space Plan, and the Supplementary Water Master Plan.

To support goals of the Comprehensive Plan, the Orange County Supplementary Water Master Plan was adopted in 2010, presenting water supply planning initiatives to address Orange County's overall water supply needs over a 10-year period.

No goals or recommended actions within the Comprehensive Plan or Supplemental Open Space Plan pertain to the Roseton Study Area. However, the Supplementary Water Master Plan contains provisions for the protection of natural resources and water supply management. The potential effects of decommissioning in the Roseton Study Area were evaluated relative to compatibility with the following:

- Source Water and Watershed Protection
- Capital Projects (for water infrastructure) and Potential Interconnections (between municipalities)
- Formulation of a Financial and Institutional Framework to Facilitate the Implementation of the Various Initiatives

Code of the Town of Newburgh

The potential for impacts from decommissioning within the Roseton Study Area was evaluated relative to compatibility with the following chapters of the Code of the Town of Newburgh:

Chapter 100, Environmental Quality Review

The Town of Newburgh requires compliance with New York State Environmental Quality Review Act (SEQRA).

Wetlands

Wetlands are discussed in the following sections of the Town of Newburgh Town Code:

- Town Code Chapter 83 - Clearing and Grading - Wetland is defined as “Areas of aquatic or semi-aquatic vegetation or any areas which have been mapped as such by the County Soil and Water Conservation District or the NYSDEC under the Freshwater Wetlands Act. Editor's Note: See Environmental Conservation Law §24-0101 et seq.” Watercourse is defined as “Any natural or artificial stream, river, creek, channel, canal, conduit, culvert, drainage way, gully, ravine or wash in which water flows in a definite direction or course, either continuously or intermittently, and which has a definite channel, bed and banks.” A permit must be obtained prior to conducting “[s]ite preparation within wetlands or within a one-hundred-foot buffer strip of a wetland.” Site preparation activities include excavation, clearing, grading, filling, and timber harvesting. The following activity is exempt from permit requirements: “Clearing or grading which affects less than 10,000 square feet of ground surface, except where said clearing or grading occurs within wetlands, within a one-hundred-foot buffer strip of a wetland or within the one-hundred-year floodplain of any watercourse or within a critical environmental area.”

- Chapter 185 - Zoning - Wetland, Protected is defined as “An area subject to continued marginal inundation or saturation of soil such that it contains specific indicator vegetation types as defined on a map prepared by the NYSDEC in March 1987, and as subsequently amended by the NYSDEC, and all land within 100 feet of such wetland boundary; or all lands subject to federal wetland regulation or jurisdiction; and either federal or State land which has not been granted a permit for development by either the federal or State agency(ies) having jurisdiction.” Unless a permit is obtained from the applicable regulatory agencies, protected wetlands are subject to regulations, including those listed below.

- No structure or filling of land shall be permitted within a protected wetland that will result in a reduction of the runoff storage capacity of the wetland or the elimination of any indicator vegetation association from the protected wetland.

- Any use conducted within or adjacent to a protected wetland shall make long-term provisions for the control of erosion and the transport of silt and debris to the protected wetland so that said wetland will not be subjected to unnecessary accretion of sediments.

- Chapter 157 Stormwater Management - Wetland is defined as "Any area meeting the requirements of the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (latest edition), and/or any area identified by the NYSDEC as being a State-protected wetland." Watercourse is defined as "A permanent or intermittent stream or other body of water, either natural or man-made, which gathers or carries surface water." Stormwater Management Plans must include "[a] description of all watercourses, waterbodies and wetlands on or adjacent to the site or into which the stormwater flows." Furthermore, without the appropriate permits or a letter from the applicable regulatory agencies, "[s]tormwater management facilities shall not be constructed within or discharge directly to wetland areas, wetland buffer areas or existing waterbodies."

11.9.6.2 Impact Analysis

<u>New York State Department of State Coastal Zone Program</u>

This section examines the consistency of decommissioning with the applicable NYSDOS CMP policies. The analysis is the primary foundation for the evaluation of consistency with the applicable CMP policies. Each policy evaluated with consistency below was identified based on the completion of the NYSDOS Federal Consistency Assessment Form.

- "*Will the proposed project result in large physical change to a site within the coastal area which will require the preparation of an environmental impact statement?" (Policies 25, 38)"*

  Policy 25*: Protect, restore or enhance natural and man-made resources which are not identified as being of statewide significance, but which contribute to the overall scenic quality of the coastal area.*

As noted in Section 11.9.5, "Natural Resources," decommissioning would result in changes to natural resources in the Roseton area, including: groundwater, surface water, wetlands, aquatic and benthic habitats; and geology and soils. However, decommissioning could provide a beneficial effect to Roseton Brook, as the reduction in the amount of coldwater inputs would allow the resource to restore to the typical water quality regime for streams in the Roseton region of the Hudson River. Therefore, decommissioning would be consistent with this policy.

> ***Policy 38:*** *The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply.*

As discussed in Section 11.9.2, "Description of Rondout-West Branch Tunnel Decommissioning," decommissioning would result in the cessation of leaks within the Roseton Study Area. In particular, decommissioning was evaluated to determine if cessation of leaks would alter specific land uses of parcels at certain locations within the Roseton Study Area due to: the potential for groundwater level decline within the Estimated Bedrock Aquifer Groundwater Influence Area (see Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning"); and areas that could be subject to settlement (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning") within the Estimated Unconsolidated Aquifer Groundwater Influence Area. Lowering of the groundwater level could potentially affect properties with private water supply wells. However, DEP is committed to developing and working with owners to implement preventative Action Plans for affected parcels to allow for a water supply source, and implement protective measures for structures in areas that could be subject to settlement, as described further in Section 11.10, "Commitments." Therefore, decommissioning would be consistent with this policy.

Orange County Comprehensive Plan (Amended 2004 and 2010)

No goals or recommendations within the Orange County Comprehensive Plan pertain to decommissioning. However, the Supplementary Water Master Plan contains provisions for the protection of natural resources and water supply management. The consistency of decommissioning with the applicable recommended actions of the Supplementary Water Master Plan is analyzed below.

Orange County Supplementary Water Master Plan (2010)

- *Source Water and Watershed Protection*

  The Supplemental Water Master Plan has identified the need for greater protection of Orange County's surface water. To do so, the Plan encourages completion of watershed management plans as a tool to strategically protect and restore surface waterbodies and groundwater resources.

Decommissioning would not preclude Orange County from implementing a watershed management plan or alter plans to protect and restore surface waterbodies and groundwater resources. Lowering of the groundwater level could potentially affect properties with private water supply wells. However, groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area would eventually stabilize following decommissioning. If required, DEP would provide alternate water supply sources to water users on parcels affected by changing groundwater levels, allowing those users to maintain their existing access to potable water (see Section 11.9.13, "Water and Sewer Infrastructure"). Therefore, decommissioning would be consistent with this policy.

Code of the Town of Newburgh

The portions of the Town of Newburgh Code that would apply to decommissioning are the town codes related to compliance with SEQRA and Wetland Regulations.

Chapter 100, Environmental Quality Review

Decommissioning is undergoing an environmental review in compliance with SEQRA, as summarized in this FDEIS. As such, decommissioning is compliant with the Town of Newburgh Code related to Environmental Quality Review.

Wetlands

As described further in Section 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning," the cessation of leaks as a result of decommissioning would lead to the anticipated loss of 1.2 acres of wetland as a result of changes to shallow groundwater levels. Decommissioning does not require grading or clearing in wetlands and therefore decommissioning would comply with the Town of Newburgh Code.

In summary, decommissioning would comply with all applicable plans and codes, and would not alter or conflict with the local and county polices.

Therefore, decommissioning would not result in significant adverse impacts to public policy within the Roseton Study Area.

11.9.7 SOCIOECONOMIC CONDITIONS

This section assesses the potential for decommissioning to result in direct or indirect effects to factors that influence the socioeconomic conditions or character of the area, including land use, population, housing, and economic activity within the Roseton Study Area.

The repair to the RWBT would result in the permanent cessation of leaks that could reduce groundwater levels at some locations within the Estimated Bedrock Aquifer Groundwater Influence Area. However, DEP is committed to developing Action Plans to provide alternate water supplies for affected wells to avoid impacts. Therefore, these changes would be minimal and would not result in indirect or direct displacement of the residential populations or existing businesses or institutions, nor would they have adverse effects on specific industries in the Roseton Study Area. As also discussed in Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels that could result in areas subject to consolidation settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area. DEP is committed to developing and is working with owners to implement preventative Action Plans for affected features within this boundary to avoid impacts, as described in Section 11.10, "Commitments."

Therefore, decommissioning would not result in significant adverse impacts to socioeconomic conditions within the Roseton Study Area.

11.9.8 COMMUNITY FACILITIES AND SERVICES

This section analyzes the potential for decommissioning to result in changes to community facilities and services in the Roseton Study Area. Specifically, the analysis focused on whether a decline in groundwater levels would physically displace or alter community facilities and services from a reduced water supply in the Estimated Bedrock Aquifer Groundwater Influence Area, or areas that could be subject to settlement within the Estimated Unconsolidated Aquifer Groundwater Influence Area.

A desktop evaluation and a windshield survey were performed to verify the local community facilities and service providers within the Roseton Study Area. One community facility, Our Lady of Mercy Church, was observed within the study area. The potential for impacts to community facilities and services within the Roseton Study Area was evaluated using the methodology described below.

11.9.8.1 Impact Analysis Methodology

The impact analysis consisted of: (1) establishing and describing the baseline conditions within the study area by identifying the local community facilities and services; (2) establishing future conditions without decommissioning by identifying anticipated changes to community facilities and services planned and programmed for implementation within the study area that are anticipated to be completed by the analysis year; (3) establishing future conditions with decommissioning based on the cessation of leaks within the study area; and (4) analyzing the potential for impacts from decommissioning to those community facilities and services due to the physical displacement or alteration of land occupied by a community facility or service, increased demands on community facilities and services, or disruption of operations of the community facility or services.

11.9.8.2 Impact Analysis

Baseline Conditions

As described above, one community facility exists within the Roseton Study Area: Our Lady of Mercy Church, located on River Road, in the center of the Roseton Study Area (see **Figure 11.9-105**).

Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no major developments or programs are planned within the Roseton Study Area within the timeframe of the impact analysis. Therefore, in the future without decommissioning, it is assumed that community facilities and services would be similar to baseline conditions.

Future With Decommissioning

Decommissioning would not physically displace or alter water supply sources provided to Our Lady of Mercy Church. As noted in Section 11.9.13 "Water and Sewer Infrastructure," decommissioning would result in the permanent cessation of leaks within the Roseton Study Area.

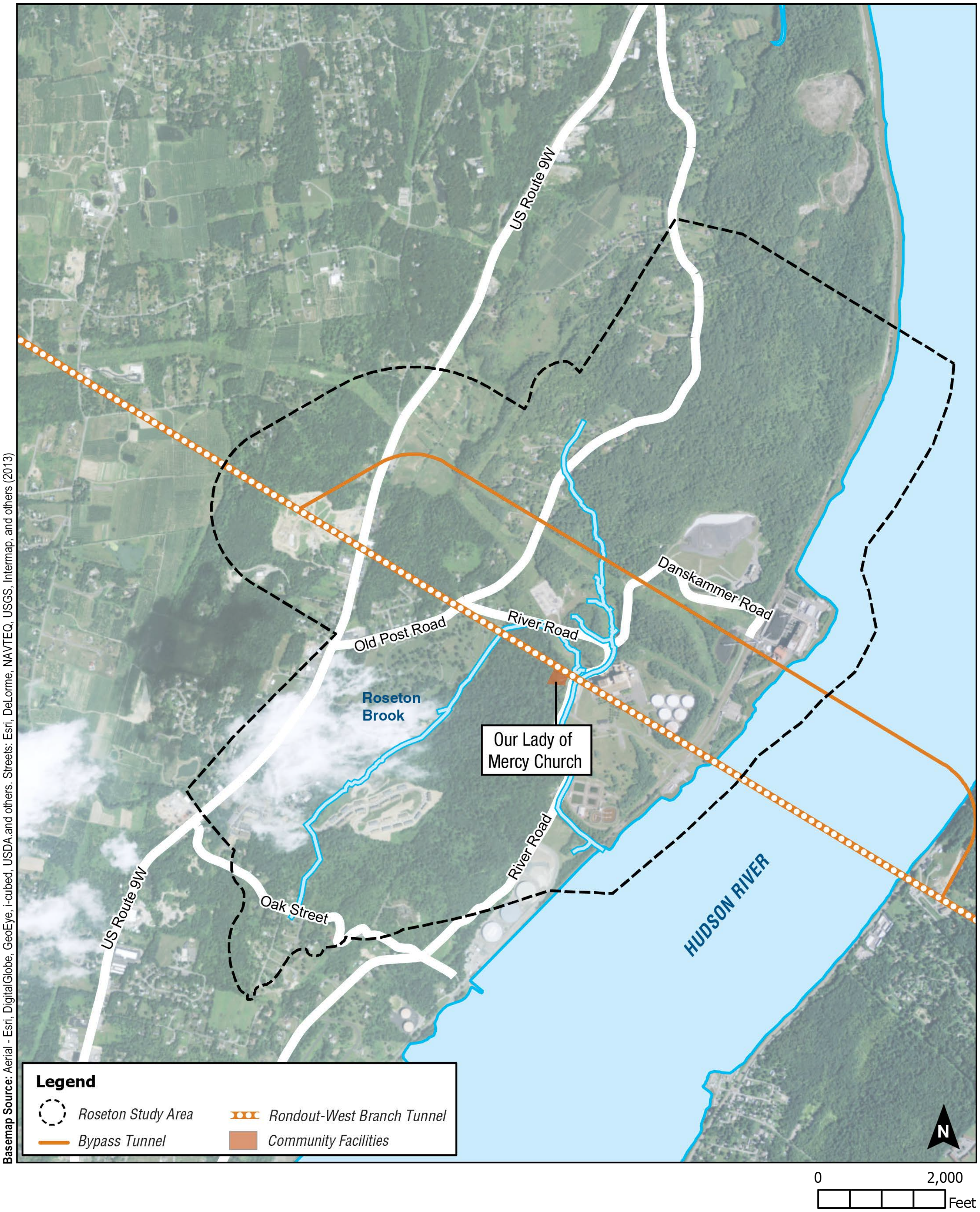


Figure 11.9-105: Community Facilities – Roseton Study Area

Lower groundwater levels could potentially affect properties with private water supply wells during the temporary shutdown and over the long term after decommissioning. However, Our Lady of Mercy Church is not expected to be affected since they have access to a public water supply system. In addition, decommissioning would not cause a change in population that would create significant new demand or introduce new users of the community facilities and services.

As discussed in Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning," decommissioning would result in areas that could be subject to settlement at some locations with the Estimated Unconsolidated Aquifer Groundwater Influence Area including Our Lady of Mercy Church. DEP is committed to developing and is working with owners to implement preventative Action Plans for affected features within this boundary, as described in Section 11.10, "Commitments."

Therefore, decommissioning would not result in significant adverse impacts to community facilities and services within the Roseton Study Area.

11.9.9 OPEN SPACE AND RECREATION

This section analyzes the potential for decommissioning to result in changes to open space and recreation in the Roseton Study Area. Specifically, the analysis focused on characterizing existing and potential future open space uses at the county and local levels in the Roseton Study Area that may be affected by decommissioning. This was performed using an ArcGIS analysis, followed by a field survey that provided further information about these uses.

Open spaces were identified within the Roseton Study Area and are listed in **Table 11.9-41**.

Table 11.9-41: Open Spaces within the Roseton Study Area

Name	Address	Approximate Acreage	Approximate Acreage within Study Area
Mill Creek Golf Club	5530 State U.S. 9W North, Newburgh, New York 12550	60	56
Firemen's Field	5459 State U.S. 9W, Newburgh, New York 12550	20	3
Cedar Hill Cemetery	5468 State U.S. 9W North, Newburgh, New York 12550	138	138
Hudson River	NA	NA	178
Note: NA = Not Available			

While three of the open spaces identified above are under private ownership, they are available to the public, on a regular basis, for either active or passive recreation. The one additional open space is the Hudson River.

11.9.9.1 Impact Analysis Methodology

The impact analysis consisted of: (1) establishing and describing the baseline conditions within the study area by mapping existing uses of open space and recreational resources, including those identified in local open space plans; (2) establishing future conditions without decommissioning by identifying plans to expand or create new open spaces or recreational resources within the study area that are anticipated to be completed by the analysis year; (3) establishing future conditions with decommissioning based on the permanent cessation of leaks within the study area; and (4) analyzing the potential for impacts from decommissioning on open space and recreational resources by evaluating if the proposed project would potentially restrict public access to or displace open spaces and recreational resources.

11.9.9.2 Impact Analysis

Baseline Conditions

The existing open spaces within the Roseton Study Area are shown in **Table 11.9-41** and on **Figure 11.9-106**.

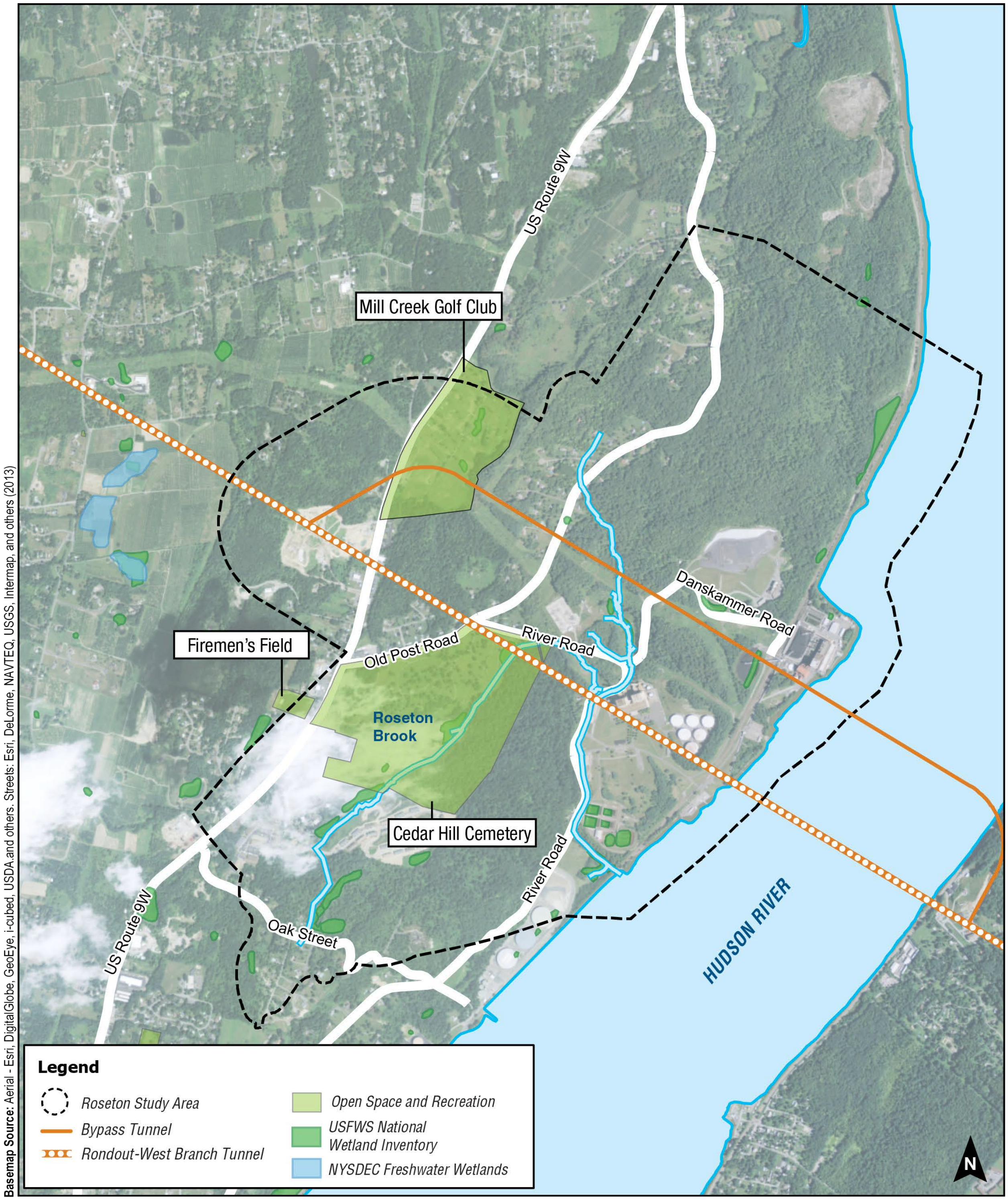
Mapped open spaces within the Roseton Study Area consist of the Hudson River and three privately owned parcels: the Mill Creek Golf Club, Firemen's Field, and Cedar Hill Cemetery (see **Table 11.9-41**). Mill Creek Golf Club, located within the northwestern section of the Roseton Study Area on U.S. Route 9W, has an area of approximately 60 acres (with approximately 56 acres within the Roseton Study Area), and is a privately owned nine-hole golf course. In the southwestern portion of the Roseton Study Area on U.S. Route 9W is Firemen's Field, an approximately 20-acre park owned and operated by the Middle Hope Fire District. Approximately 3 acres of the park are located within the Roseton Study Area. Recreational amenities at Firemen's Field include a baseball field, picnic facilities, and restrooms. Of the amenities located at Firemen's Field, only the picnic area is located within the Roseton Study Area. Cedar Hill Cemetery is approximately 138 acres and is located on the south side of Old Post Road between U.S. Route 9W and River Road in the southwestern portion of the Roseton Study Area. There is a bench located near a pond on the Cedar Hill Cemetery property for passive recreation. Approximately 178 acres of the 315-mile Hudson River is located along the eastern edge of the approximately 1,817-acre Roseton Study Area. The river is used for recreational fishing and boating.

Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that there are no plans to expand or create new open space or recreational resources within the Roseton Study Area within the timeframe of the impact analysis. Natural processes, such as changes in habitat due to natural vegetative succession, is anticipated to continue. Therefore, in the future without decommissioning, it is assumed that open space and recreation in the Roseton Study Area would be the same as baseline conditions.

Future With Decommissioning

The future with decommissioning consists of the permanent cessation of leaks within the Roseton Study Area which could affect groundwater, surface water, and shallow groundwater and wetlands levels in the Roseton Study Area (see Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," through 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning").



Note: USFWS = U.S. Fish and Wildlife Service
NYSDEC = N.Y.S. Department of Environmental Conservation

Figure 11.9-106: Open Space and Recreation – Roseton Study Area

The Mill Creek Golf Club, Fireman's Field, and Hudson River open space resources are not located within the Roseton Study Area where the permanent cessation of leaks could affect groundwater, surface water, and shallow groundwater and wetland levels. The Cedar Hill Cemetery open space resource is located within the Roseton Study Area. However, the change in water levels as a result of decommissioning within the Estimated Bedrock Aquifer Groundwater Influence Area would not encroach upon, cause a loss of open space, impact the use or physical character of, or disrupt views from Cedar Hill Cemetery. Given the limited use of non-potable water by the cemetery, changes in water levels are not anticipated to impact the use and operation of Cedar Hill Cemetery (see Section 11.9.13, "Water and Sewer Infrastructure"). As also described further in Section 11.9.13, "Water and Sewer Infrastructure," if required, DEP would provide alternate water supply sources or monitoring for water supply wells if they are affected by changing groundwater levels, allowing users to maintain their existing access to potable and non-potable water. As discussed in Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning," decommissioning would result in areas that could be subject to settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area. DEP is committed to developing and working with owners to implement preventative Action Plans for affected features within this boundary, as described in Section 11.10, "Commitments."

Therefore, decommissioning would not result in significant adverse impacts on open space and recreation within the Roseton Study Area.

11.9.10 HISTORIC AND CULTURAL RESOURCES

This section analyzes the potential for decommissioning to result in changes to historic and cultural resources in the Roseton Study Area. Specifically, the analysis focused on whether a decline in groundwater levels that could result in a reduced water supply within the Estimated Bedrock Aquifer Groundwater Influence Area, or areas that could be subject to settlement at certain locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area, would alter the integrity of historic and cultural resources in the Roseton Study Area.

The historic and cultural resources assessments were conducted in accordance with the New York State Historic Preservation Act (SHPA) of 1980, as set forth in Section 14.09 of the New York State Parks, Recreation and Historic Preservation Law. The assessments have also been prepared in accordance with Section 106 of the National Historic Preservation Act of 1966 (NHPA). These laws require that state and federal agencies, respectively, consider the effects of their actions on any properties listed on or determined eligible for listing on the National and State Registers of Historic Places (N/SR).

A review of the New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP) Cultural Resource Information System indicated that a portion of the Roseton Study Area has the potential to contain archeological resources. However, there would be no planned excavation or other intrusive ground disturbance associated with decommissioning. Therefore, no changes to potential archeological resources would occur and an impact analysis is not warranted.

In May 2015, the New York State Historic Preservation Office (SHPO) at the NYSOPRHP was consulted. Historic sites listed or eligible for listing on the N/SR were identified by NYSOPRHP within the Roseton Study Area. An architectural reconnaissance survey was performed to identify properties that are potentially eligible for listing on the N/SR within the area where decommissioning could result in reduced groundwater levels or areas that could be subject to consolidation settlement (see Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," and Section Geology and Soils – Probable Impacts With Decommissioning"). Based on the analysis, six structures eligible for listing on the N/SR were identified. Two of these structures were determined to not be eligible for listing by NYSOPRHP in July 9, 2015 correspondence.

The potential for impacts to historic resources within the Roseton Study Area was evaluated using the methodology described below.

11.9.10.1 Impact Analysis Methodology

The impact analysis consisted of: (1) describing existing historic resources; (2) establishing future conditions without decommissioning by identifying whether any changes to existing historic or potential historic resources are likely to occur by the analysis year; (3) establishing future conditions with decommissioning based on the permanent cessation of leaks within the study area; and (4) analyzing the potential for impacts from decommissioning on historic resources by evaluating if decommissioning would potentially disturb or alter the integrity of historic and cultural resources.

11.9.10.2 Impact Analysis

Baseline Conditions

There are no currently designated historic resources within the Roseton Study Area (i.e., none are listed on the N/SR) (see **Figure 11.9-107**). However, based on a review of the NYSOPRHP Cultural Resource Information System and the architectural reconnaissance survey performed, six structures were identified as potentially eligible for listing: two structures on private properties and Our Lady of Mercy Church, each identified by NYSOPRHP, and three additional structures observed during an architectural reconnaissance survey on residential properties (see **Table 11.9-42**).

In response to the architectural reconnaissance survey on July 9, 2015, SHPO confirmed the eligibility of the structures listed in **Table 11.9-42**, and determined that two of the structures are not eligible for listing, specifically the residential properties at 913 and 915 River Road.

Future Without Decommissioning

In the future without decommissioning, it is assumed that historic and cultural resources within the Roseton Study Area would be the same as baseline conditions.

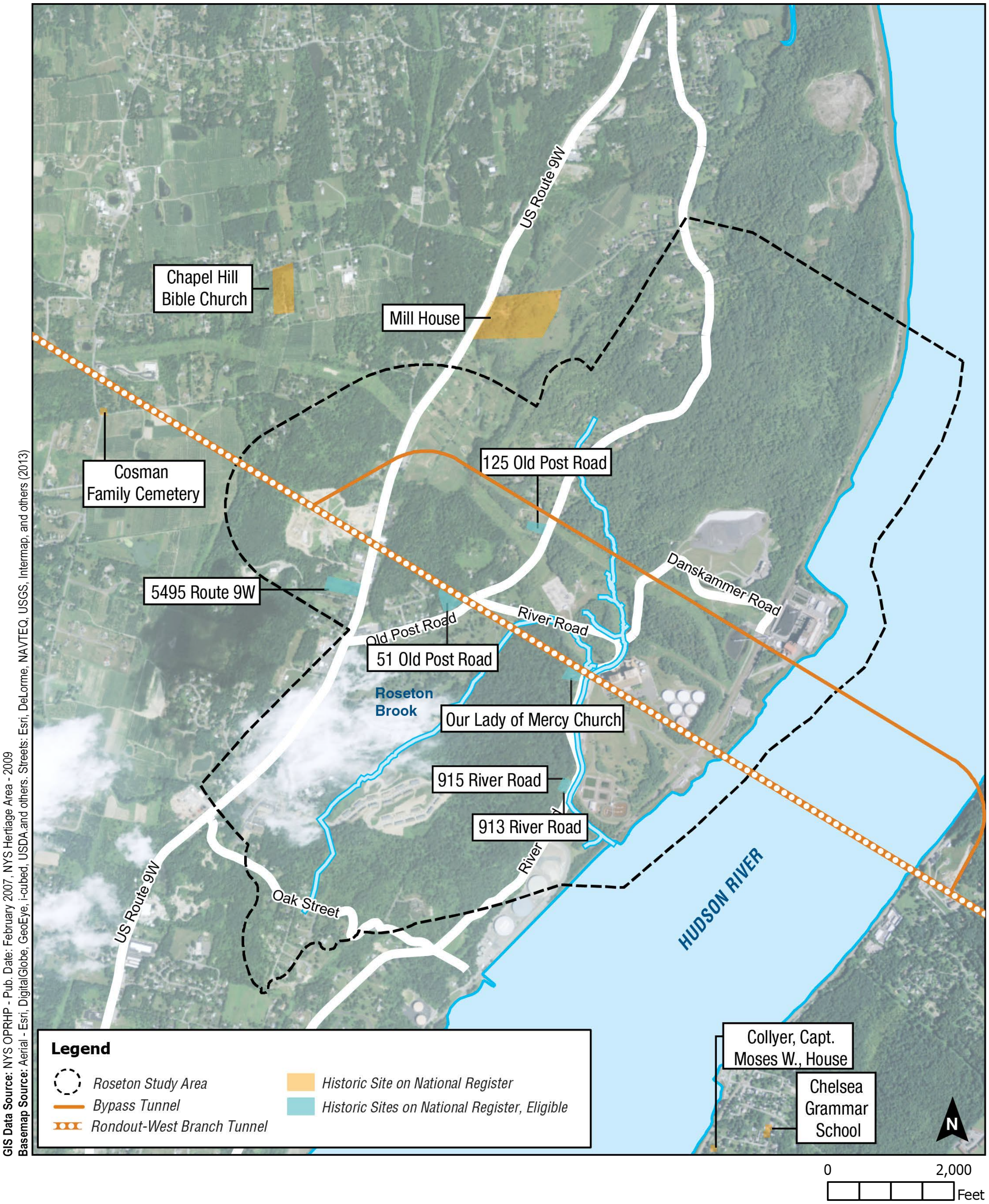


Figure 11.9-107: Historic and Cultural Resources – Roseton Study Area

Table 11.9-42: Historic Resources Eligible for Listing on the National/State Register of Historic Places

Name/Type	Address	Status
Residential Property[1]	5495 U.S. Route 9W	Eligible
Residential Property[1]	51 Old Post Road	Eligible
Residential Property[2]	125 Old Post Road	Eligible
Our Lady of Mercy Church[1]	977 River Road	Eligible
Residential Property[2]	913 River Road	Not Eligible[3]
Residential Property[2]	915 River Road	Not Eligible[3]

Notes:
[1] Properties identified in NYSOPRHP's Cultural Resource Information System.
[2] Properties identified in architectural reconnaissance survey.
[3] Determined not eligible by NYSOPRHP in July 9, 2015 correspondence.

Future With Decommissioning

As noted in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would consist of the permanent cessation of leaks within the Estimated Bedrock Aquifer Groundwater Influence Area. Lowering of the groundwater level would result in areas that could be subject to settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area within the Roseton Study Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). Three of the structures eligible for listing are located within the Roseton Study Area: residential structure at 51 Old Post Road, residential structure at 125 Old Post Road, and Our Lady of Mercy Church at 977 River Road. As discussed in 11.9.8, ''Community Facilities and Services," Our Lady of Mercy Church is located within the Estimated Unconsolidated Aquifer Groundwater Influence Area.

The proposed activities within the Roseton Study Area would not result in new structures or additions to existing structures, excavation, or ground disturbance. As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area and would result in areas that could be subject to settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). DEP is committed to developing and working with owners to implement preventative Action Plans for affected features within this boundary, as described in Section 11.10, "Commitments."

Therefore, although Our Lady of Mercy Church is eligible for listing under the N/SR, decommissioning would not result in significant adverse impacts to historic and cultural resources within the Roseton Study Area due to DEP's commitment to prepare and work with Our Lady of Mercy Church to implement a preventative Action Plan.

11.9.11 VISUAL RESOURCES

This section analyzes the potential for decommissioning to result in changes to views to or from visual resources or within view corridors with aesthetic value that could be altered from a decline in surface water levels in the Roseton Study Area.

NYSDEC provides a list of 17 categories of State aesthetic and visual resources that should be included in an evaluation of potential for impacts to visual resources, as identified in **Table 11.9-43**. Local resources are also considered in this analysis, such as parks, historic structures, and landmarks, and the Hudson River as an American Heritage River. American Heritage Rivers are designated by federal Executive Order 13061 to protect natural resources and the environment, support economic revitalization, and preserve historic and cultural resources.

Table 11.9-43: Decommissioning Visual Resources Analysis Summary

Aesthetic/Visual Resource	Description	Analysis Required
National/State Register of Historic Places	Listed or eligible for listing on the National or State Register of Historic Places (sites, districts, buildings, structures, and objects that are deemed worthy of preservation).	Yes
State Parks	Defined by New York State Parks, Recreation and Historic Preservation Law §3.09 to encourage, promote, and provide recreational opportunities.	No
Heritage Areas	Designated by New York State as special places to honor history, celebrate the present, and plan the future of our communities.	No
State Forest Preserve/State Forests	State Forest Preserves are designated by the New York State Legislature with Constitution Article XIV, and protected as “forever wild.” State Forests are lands acquired and managed by NYSDEC as Reforestation Areas, Multiple-Use Areas, Unique Areas, and State Nature and Historic Preserves, as authorized by the 1929 State Reforestation Act.	No
National/State Wildlife Refuge, State Wildlife Management Areas	National Wildlife Refuges are designated public lands and waters given special protection by the National Wildlife Refuge System Administration Act 16 U.S. Code (USC) 668dd-668ee and amended by Public Law 105-57 to conserve fish, wildlife, and plants. State Game Refuges are designated by NYSDEC’s Environmental Conservation Law §11-2105 as lands for the protection of fish wildlife, and State Wildlife Management Areas are owned by New York State under the control and management of NYSDEC’s Division of Fish, Wildlife, and Marine Resources for the protection and promotion of fish and wildlife resources.	No

Table 11.9-43: Decommissioning Visual Resources Analysis Summary

Aesthetic/Visual Resource	Description	Analysis Required
National Natural Landmark	Designated by the Secretary of the Interior and defined by 36 CFR Part 62 as conservation sites that contain outstanding biological and geological resources, including both public and private lands, and are selected for their condition, illustrative value, rarity, diversity, and value to science and education.	No
National Park System, Recreation Areas, Seashores, Forests	Established by an Act of Congress and defined by 16 USC §1c to identify Parks, Preserves, Battlefields, Memorials, Recreation Areas, Seashores, Monuments, Rivers, Parkways, and Cemeteries as significant resources.	No
National/State Wild, Scenic, or Recreational Rivers	Established by an Act of Congress and defined by Public Law 90-542 under the Wild and Scenic Rivers Act and New York State Wild, Scenic, and Recreational Rivers System Act, defined under NYSDEC's ECL §15-27 for outstanding natural, cultural, and recreational values in a free-flowing condition.	No
Scenic Site, Area, Lake, Reservoir, or Highway	Designated and defined by NYSDEC's ECL Article 49, Protection of Natural and Man-Made Beauty or highways designated by the U.S. Department of Transportation Federal Highway Administration or the New York State Department of Transportation as scenic roads and byways.	No
Scenic Areas of Statewide Significance	Designated by the NYSDOS to identify the scenic qualities of coastal landscapes that possess inherent scenic qualities, including the presence of water, dramatic shorelines, expansive views, historic landings, working landscapes, and great estates.	No
National/State Trails	Federal trails, as defined by 16 USC Chapter 27 and designated by the Secretary of the Interior or the Secretary of Agriculture and State trails, as part of New York State Parks, Historic Sites, and Forests to provide a variety of outdoor recreation uses.	No
Adirondack Park Scenic Vistas	Identified in the Adirondack Park State Land Master Plan as scenic pull-offs within the Adirondack Park, as established by an Act of the NYS Legislature and defined by Adirondack Park Agency and NYSDEC.	No
State Nature and Historic Preserve Areas	Designated by the NYS Legislature and defined by Section 4 of Article XIV of the New York State Constitution for the protection of natural resources, development of agricultural lands, and to conserve and protect its natural resources and scenic beauty and encourage the development and improvement of its agricultural lands for the production of food and other agricultural products.	No

Table 11.9-43: Decommissioning Visual Resources Analysis Summary

Aesthetic/Visual Resource	Description	Analysis Required
Palisades Interstate Park	The Palisades Interstate Park Commission operates the Park in New Jersey and the State Parks and Historic Sites that comprise New York State's Palisades Region. Palisades Interstate Park Commission's mission is to support, protect, and educate the public and raise awareness of the natural and cultural resources of the parks and historic sites of the Palisades Interstate Park system.	No
Bond Act Properties	Bond Act properties are properties purchased under the "exceptional scenic beauty" or "open space" category of the Environmental Bond Act of 1986, established by the NYS Legislature.	No
American Heritage River	The American Heritage Rivers Protection Program, created by an Executive Order 13061, and designated by the EPA to advance three objectives: natural resource and environmental protection, economic revitalization, and historic and cultural preservation.	Yes
Local	Defined and/or designated by regional planning entities, such as counties, and local communities, such as municipalities.	Yes

A review of the inventory of aesthetic and visual resources in the Roseton Study Area revealed six resources from three aesthetic/visual categories that require analysis, as shown in **Table 11.9-44**. The potential for impacts to visual resources within the study area was evaluated using the methodology described below.

Table 11.9-44: Decommissioning Visual Resources

Visual Resource	Resource Type
Residential Property - 5495 U.S. Route 9W	Eligible for N/SR
Residential Property - 51 Old Post Road	Eligible for N/SR
Residential Property - 125 Old Post Road	Eligible for N/SR
Our Lady of Mercy Church - 977 River Road	Eligible for N/SR
Cedar Hill Cemetery	Local Open Space
Hudson River	American Heritage River

11.9.11.1 Impact Analysis Methodology

The impact analysis consisted of: (1) establishing and describing the baseline conditions within the study area by determining existing aesthetic and visual resources, including a characterization of existing public view corridors within the study areas; (2) establishing future conditions without decommissioning by identifying proposed projects that would alter views within the study area that are anticipated to be completed by the analysis year; (3) establishing future conditions with decommissioning based on the proposed activities within the study area; and (4) analyzing the potential for impacts from decommissioning to visual resources through a qualitative determination of the effect to these view corridors from decommissioning and the magnitude of change to eliminate or substantially limit views that are deemed to have aesthetic value from within the Roseton Study Area.

11.9.11.2 Impact Analysis

Decommissioning would result in the permanent cessation of leaks within the Roseton Study Area and would affect groundwater and surface water levels in the Natural Resources Study Area within the larger Roseton Study Area (see Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning").

Baseline Conditions

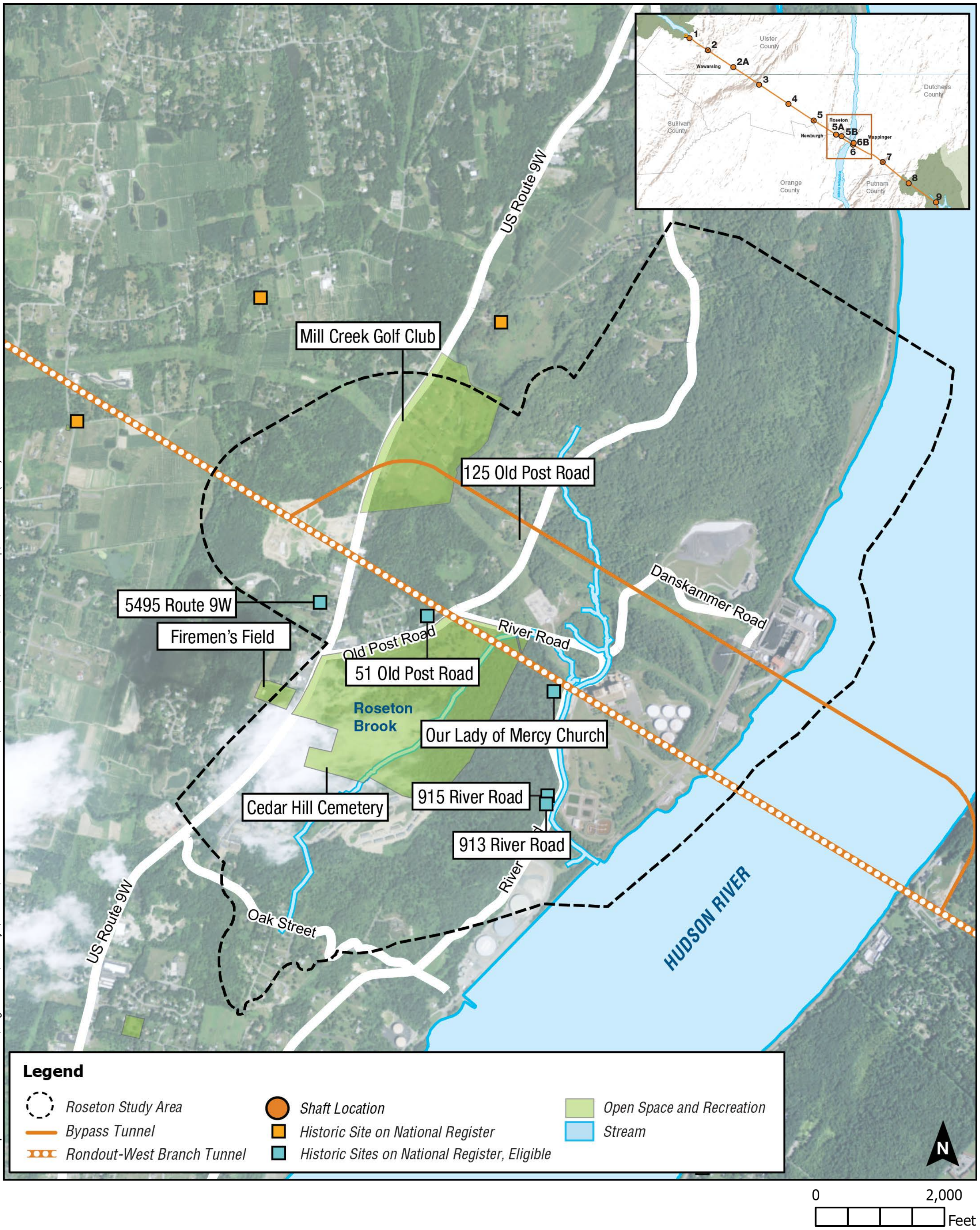
The existing visual resources within the Roseton Study Area that have the potential to influence views to or from a visual resource include four structures eligible for listing on the N/SR, a local open space, and an American Heritage River (see **Figure 11.9-108** and **Figure 11.9-109**).

Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new projects or structures that would alter views from or of visual or aesthetic resources are anticipated within the Roseton Study Area within the timeframe of the impact analysis. The future without decommissioning would consist of very few, if any, changes to stream segments or wetlands. At most, there could be limited successional changes to vegetation within the streams and wetlands of the Natural Resources Study Area within the larger Roseton Study Area (see Section 11.9.5.28, "Wetlands – Probable Impacts With Decommissioning"). As discussed in Section 11.9.5.25, "Geology and Soils – Future Without Decommissioning," it is assumed that geology and soil resources within the Roseton Study Area could change, but would be monitored by DEP and would be similar to baseline conditions. Therefore, it is assumed that future visual and aesthetic resource conditions without decommissioning would be the same as baseline conditions, including views to and from the visual resources.

Future With Decommissioning

The changes within the Roseton Study Area would not result in new structures or additions to existing structures. As previously described, decommissioning would result in the cessation of leaks within the area and would affect groundwater and surface water levels in the Natural Resources Study Area within the larger Roseton Study Area. As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Unconsolidated Aquifer Groundwater Influence Area. This could result in some areas that could be subject to settlement at some locations within the Estimated Unconsolidated Groundwater Influence Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). DEP is committed to developing and working with owners to implement preventative Action Plans for affected features within this boundary, as described in Section 11.10, "Commitments."



GIS Data Source: NWI - http://www.fws.gov/wetlands/ NYSDEC - http://www.dec.ny.gov/lands/305.html
Basemap Source: Aerial - Esri, DigitalGlobe, GeoEye, i-cubed, USDA and others. Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)

Figure 11.9-108: Visual Resources – Roseton Study Area

Photograph 24: Our Lady of Mercy Church

Photograph 25: Existing View from the driveway of Our Lady of Mercy Church, looking north along River Road toward Stream Segment 2

Figure 11.9-109: Photographs – Our Lady of Mercy Church

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Therefore, it is assumed that geology and soil resources within the Roseton Study Area could change, but would be monitored and mitigated by DEP and would not result in changes to or from the visual resources.

The anticipated changes to and from visual resources based on the permanent cessation of leaks are described below (see **Table 11.9-45**).

Table 11.9-45: Potential Changes to Visual Resources with Decommissioning

Visual Resource	Associated Visible Stream Segment	Anticipated Visual Resource Changes (see Section 11.9.5.27)
Residential Property - 5495 U.S. Route 9W	Stream Segments 1 and 2	Marginal to moderate surface water impacts anticipated, therefore no further visual impact analysis conducted
Residential Property - 51 Old Post Road	Stream Segments 1 and 2	Marginal to moderate surface water impacts anticipated, therefore no further visual impact analysis conducted
Residential Property - 125 Old Post Road	Stream Segment 3A	Marginal to moderate surface water impacts anticipated, therefore no further visual impact analysis conducted
Our Lady of Mercy Church - 977 River Road	Stream Segments 3 and 4	Surface water impacts anticipated. See discussion below for anticipated visual changes
Cedar Hill Cemetery	Stream Segments 1 and 2	Marginal to moderate surface water impacts anticipated, therefore no further visual analysis conducted
Hudson River	Stream Segment 4	Surface water impacts anticipated: see discussion below for anticipated visual changes

Flow rates in Stream Segments 3, 3B and 4 would be most affected by decommissioning. As shown above in **Table 11.9-45**, these stream segments are visible only from two of the identified visual resources, Our Lady of Mercy Church and the Hudson River. Over time, the volume of water and the substrate for Stream Segments 3, 3B, and 4 would likely change (see Section 11.9.5.27, "Surface Water – Probable Impacts With Decommissioning"), reverting to the natural conditions prior to the leak. Visually, the stream segments would remain, with the vegetation density that would remain similar to baseline conditions because the amount and density of vegetation are not expected to change, even though there may be a gradual succession of species based on the reduction of water as a result of the cessation of leaks. As such, the future visual and aesthetic resource conditions, including views of and from Our Lady of Mercy Church (see **Table 11.9-45**) and the Hudson River, are not expected to be substantively altered since the views of the stream segments would be similar to baseline conditions as a result of decommissioning.

Therefore, decommissioning would not result in significant adverse impacts to visual resources within the Roseton Study Area.

11.9.12 HAZARDOUS MATERIALS

As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area, and could result in areas that could be subject to consolidation settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). However, these changes would occur at locations that have been influenced by the leaks since the RWBT began leaking and would not introduce a new source of contamination or excavation of previously undisturbed soils. In addition, DEP is committed to developing and working with owners to implement preventative Action Plans for sensitive infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area, as described in Section 11.10, "Commitments." The change in groundwater levels would not result in the storage or use of hazardous materials use or chemicals in the study area.

Therefore, decommissioning would not result in significant adverse impacts from the presence or disturbance of hazardous materials within the Roseton Study Area.

11.9.13 WATER AND SEWER INFRASTRUCTURE

This section analyzes the potential for decommissioning to result in changes to water and sewer infrastructure from a decline in water levels within the Estimated Bedrock Aquifer Groundwater Influence Area. The methodology for developing the Estimated Bedrock Aquifer Groundwater Influence Area is described further in Section 11.9.5.2, Groundwater – Impact Analysis Methodology."

The lower groundwater levels would also have the potential to result in areas that could be subject to potential settlement that could affect water and sewer infrastructure. The methodology to assess the impacts due to potential settlement is found in Section 11.9.5.9, "Geology and Soils – Impact Analysis Methodology." This analysis also considers the possible settlement effects on the built environment (buildings, roadways, and utilities, which would include the subsurface water and sewer infrastructure) within the Estimated Unconsolidated Aquifer Groundwater Influence Area.

11.9.13.1 Impact Analysis Methodology

The potential for impacts to water and sewer infrastructure by a lower the water level in the unconsolidated and bedrock aquifer were assessed using the methodology below. The evaluation of the potential impacts to water supplies within the Roseton Study Area focused on the potential for changes to groundwater levels during the temporary shutdown and over the long term after decommissioning, and consisted of:

(1) Establishing baseline conditions of the groundwater and identifying the Roseton Study Area. The baseline groundwater conditions were used to construct a groundwater flow model. The groundwater flow model was used to predict the extent of water level decline in the unconsolidated and bedrock aquifers during the temporary shutdown and

over the long term after decommissioning (see Section 11.9.5.26, “Groundwater – Probable Impacts With Decommissioning”). This is called the Estimated Bedrock Aquifer Groundwater Influence Area;

(2) An inventory of parcels was completed to identify the parcels that do not have access to a public water supply within the study area;

(3) Assessing the amount of water level decline in each aquifer and identifying the parcels that do not have access to public water supply to determine the number of and location of parcels that could be affected by the proposed project; and

(4) Establishing criteria that can be applied to current or future water supply wells within the Estimated Bedrock Aquifer Groundwater Influence Area to assess if a water supply well owner is eligible for monitoring.

Baseline groundwater and water level conditions and an inventory of parcels was completed as described in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology,” and the results are described in Section 11.9.5.10, “Groundwater – Baseline Conditions.”

The potential water level decline was estimated using methods described in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology. Parcels within the Estimated Bedrock Groundwater Influence Area with existing or future water supply wells that could be affected by the proposed project were identified.

Next, criteria were developed to assess those existing or future water supply wells with the Estimated Bedrock Aquifer Groundwater Influence Area that could be affected during the temporary shutdown and decommissioning. The criteria were based on a number of well characteristics including the type of aquifer, well depth, well yield, water usage rates, well storage, and well pump setting. These water supply well characteristics were used to assess water storage in a well and the well yield.

11.9.13.2 Impact Analysis

The potential for impacts to water and sewer infrastructure during the temporary shutdown and over the long term after decommissioning is discussed below.

Baseline Conditions

Baseline Groundwater Conditions

Determination of baseline groundwater and water level conditions were completed as described in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology,” and the results are described in Section 11.9.5.10, “Groundwater – Baseline Conditions.”

The groundwater model was used to identify the estimated groundwater influence areas in the unconsolidated and bedrock aquifers. This is described in Section 11.9.5.2, “Groundwater – Impact Analysis Methodology.”

Groundwater Use

The primary source of drinking water within the Roseton Study Area is a mix between public water supply and privately owned groundwater wells. Municipal water systems in the vicinity of the Roseton Study Area include the Town of Newburgh water district and the Town of Marlborough water district. The primary supplies for the Towns of Newburgh and Marlborough are Chadwick Lake Reservoir and a connection to the RWBT. Neither the reservoir nor the RWBT connection is located within the Roseton Study Area.

The Town of Newburgh water supply infrastructure approaches the Roseton Study Area from the south, with a main transmission line running along U.S. Route 9W and service branches running along River Road eastward toward properties near the River Road intersection with Danskammer Road. An additional service line running along Danskammer Road was installed during late 2014. However, the Town of Newburgh water department personnel indicated that the main line along River Road terminates near the industrial property near 992 River Road. Water from the Town of Newburgh also services the large townhome/apartment complex south of Cedar Hill Cemetery near the southern boundary of the Roseton Study Area. In addition to providing drinking water, this public water supply also provides fire protection as evidenced by the fire hydrants in the housing complex and that currently exist along Old Post Road and portions of River Road (see **Figure 11.9-24**).

According to the Town of Marlborough water district map and information provided by water department personnel, the southern extent of the water district for Marlborough ends at the border between Ulster and Orange counties along Lattintown Road (west of U.S. Route 9W). The border is just south of the U.S. Route 9W and Old Post Road intersection along U.S. Route 9W, and also includes parcels between Poppy Lane and Quarry Road on the east side of Old Post Road. Just west of Old Post Road, between U.S. Route 9W and Old Post Road, the southern border of the water district is defined by the parcels directly adjacent to Mill Creek on the north side of the creek before angling to the northwest toward the U.S. Route 9W and Old Post Road intersection (see **Figure 11.9-24**).

As discussed in Section 11.9.5.10, “Groundwater – Baseline Conditions,” groundwater resources in the study area are used for domestic supplies for single-family residences that are not served by the public water supplies for the Towns of Newburgh and Marlborough. Typically, each home using groundwater as a water supply has a single bedrock supply well located near the home. Similar drilled bedrock supply wells are also found at various commercial businesses in the area. The bedrock in the study area is capable of producing enough groundwater to supply a home or business.

There are approximately 119 parcels that likely rely on private water supply wells within the Roseton Study Area. The highest density of private supply wells are on parcels along Old Post Road between its intersection with River Road and the southern boundary of the Town of Marlborough water district.

Two commercial properties in the vicinity of the Roseton Study Area are known to use water supply wells. According to verbal correspondence with personnel at the cemetery, there are four wells on the cemetery property. A shallow, stone-lined dug well is located near River Road at the northeastern corner of the cemetery but is not utilized as a water supply. A second unused well is located in the field west of the mausoleum at the cemetery. The water supply well at the mausoleum is used regularly to provide water for various potable purposes. Another well near the cemetery maintenance garage complex along U.S. Route 9W is used for various non-potable purposes such as irrigation. The cemetery also has a service line from the Town of Newburgh water system off of U.S. Route 9W, which is used to fill tanks and used for irrigation and other water needs related to cemetery operations (based on verbal communication with site contact, October 2014 and January 2015).

A golf course located near the Shaft 5B site along State Route 9W in the Town of Newburgh also uses water supply wells. According to verbal correspondence with golf course personnel, the property is supplied by two wells. The first well is located on the northeastern corner of the restaurant building near the entrance of the property. This well is used to supply water to a restaurant and bathroom. The second well is located next to a pond in the northern portion of the golf course. This well is used to periodically for irrigation.

The Roseton Study Area contains no underground municipal or community sewer systems, but instead relies upon privately owned septic tanks to dispose of wastewater (Town of Newburgh 2005). However, the area does contain a municipal storm sewer system that discharges into surface water (Orange County 2014). At least one industrial plant within the study area operates a wastewater system. A multi-family housing complex located along Cortland Drive also contains a small wastewater treatment facility.

A description of the number of and location of parcels that could be affected by the proposed project and the criteria used to assess if a water supply well owner is eligible for an Action Plan is described below.

Future Without Decommissioning

DEP has consulted with the Town of Newburgh and Orange County, and it is DEP's understanding that no new projects or structures that would affect water and sewer infrastructure are anticipated within the study area within the timeframe of the impact analysis. The flows and quality of the leak water are relatively consistent, and very little, if any, future changes would be expected. Therefore, in the future without decommissioning it is assumed that the features characterizing the water and sewer infrastructure in the Roseton Study Area (i.e., location and use of private water supply wells and septic systems) would be the same as baseline conditions.

Probable Impacts With Decommissioning

Internal repairs to the RWBT within the Roseton Study Area would stop water from leaking from the RWBT into groundwater in the bedrock and unconsolidated aquifers. This could reduce the recharge to the bedrock and unconsolidated aquifers that could affect groundwater resources within the Roseton Study Area. However, approximately 600 gpd of groundwater recharge can be expected to occur on each one-acre residential property during an average precipitation year. This recharge should be sufficient to meet the water demand for each home.

As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," the results of the groundwater modeling show the area where the water table in the unconsolidated aquifer and potentiometric water level in the bedrock aquifer could be lowered over the long term after decommissioning (the estimated groundwater influence areas).

The majority of parcels in the Roseton Study Area would not be affected by decommissioning the RWBT. Based on groundwater flow modeling, the Estimated Unconsolidated Aquifer Groundwater Influence Area falls within the Estimated Bedrock Aquifer Groundwater Influence Area, see **Figure 11.9-56** through **Figure 11.9-59**. Therefore, parcels were identified with possible known, potential or future water supply wells within the larger Estimated Bedrock Aquifer Groundwater Influence Area to assess potential impacts to users. Furthermore, all of the known wells are presumed to be installed in the bedrock aquifer, and it is likely that all future wells would be installed in the bedrock aquifer. Therefore, the extent of the Estimated Bedrock Aquifer Groundwater Influence Area was overlain with maps that show the parcels with possible known, potential or future water supply wells, as shown on **Figure 11.9-110**.

Figure 11.9-110 shows the Estimated Bedrock Aquifer Groundwater Influence Area. This is the area estimated from the groundwater flow model where groundwater levels could decline during the temporary shutdown and over the long term after decommissioning. Potential impacts to users within the Estimated Bedrock Aquifer Groundwater Influence Area are based on the evaluation criteria below.

The evaluation criteria for impacts due to groundwater change in the aquifer was selected based on the following:

- A bedrock well's ability to supply a home with water could be affected with a water level change of 10 feet or more depending on the well yield and depth, and the seasonal fluctuation of the potentiometric water level in the well. This value was selected based on the following rationale:

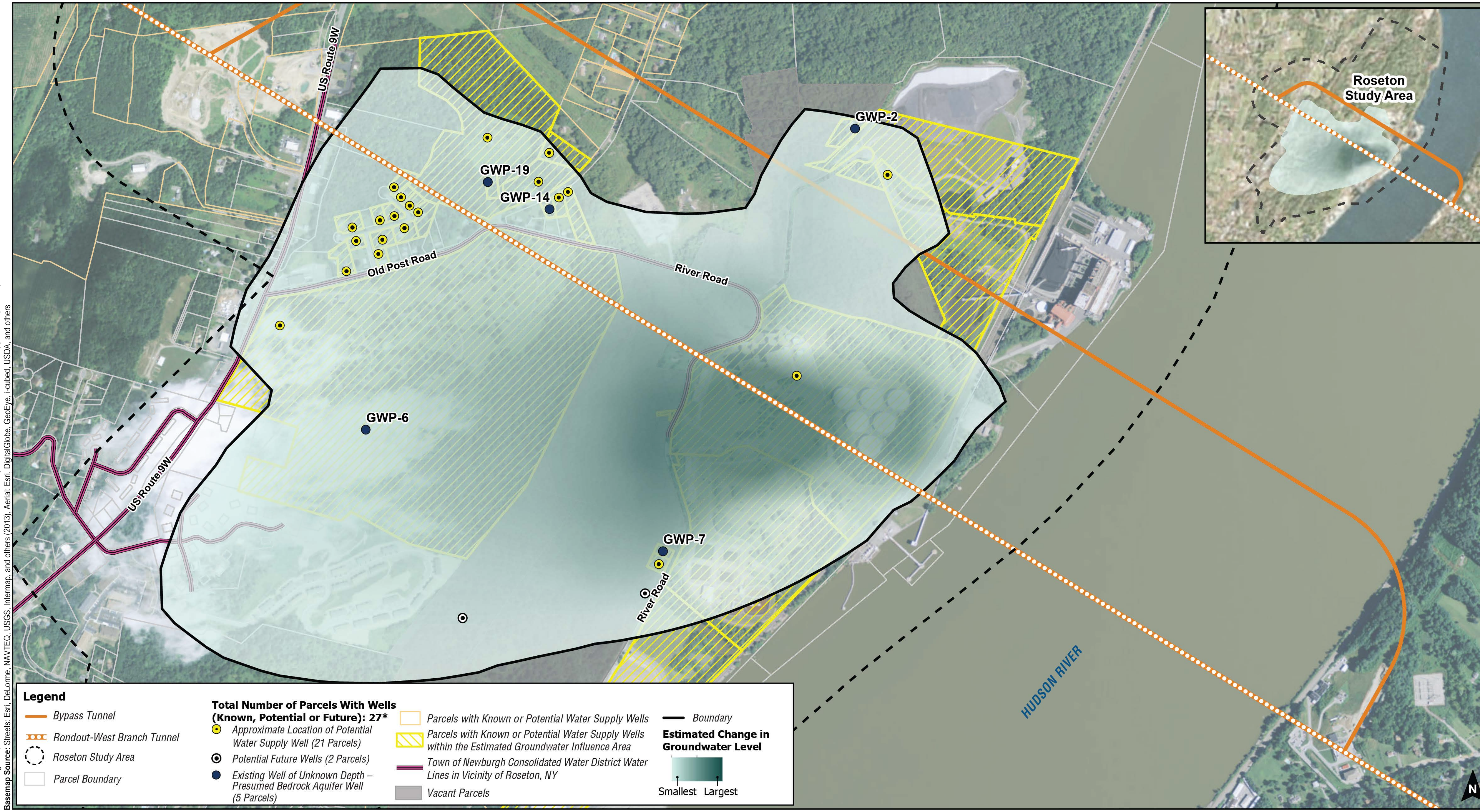
  - A 10 foot water level change (equates to 15 gallons in a typical 6-inch diameter bedrock well);

  - A maximum 5.5 foot seasonal water level fluctuation as documented by the USGS (equates to 8.1 gallons in a typical 6-inch diameter bedrock well);

  Combining these effects could result in a water storage change (up to 23 gallons) that is slightly less than a 10 percent of the NYSDOH recommendations for a well with a yield from 0.5 and 1 gpm that is supplying water to a 3 bedroom home (250 gallons of storage).

There are 27 parcels within the Estimated Bedrock Aquifer Groundwater Influence Area with known, potential or future potential private drinking water supply wells in either the unconsolidated or bedrock aquifers (see **Figure 11.9-110**). One parcel (Cedar Hill Cemetery) has two existing wells which brings the total number of known, potential or future potential private supply wells to 28.

DEP is committed to implementing a Well Action Plan for property owners with wells in these parcels that meet the combination of well characteristics described below. As part of the Action Plan, DEP would assess the potential changes in water levels and the overall ability of a well to meet the water supply needs of each home. The Well Action Plans are described further in Section 11.10, "Commitments." They include identifying well characteristics and monitoring or providing alternate water supply, as required.



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

*Note: *One parcel contains both a known supply well and a potential supply well*
GWP = Groundwater Point Well

0 800 Feet

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Figure 11.9-110: Estimated Bedrock Aquifer Groundwater Influence Area - Parcels With Known, Potential or Future Wells

Therefore, there would be no significant adverse impacts to water infrastructure within the Estimated Bedrock Aquifer Groundwater Influence Area from to changes in groundwater levels during the temporary shutdown and over the long term after decommissioning.

Wastewater Infrastructure

As discussed above, the cessation of leaks could result in potential consolidation settlement of soils at some locations within the Roseton Study Area. However, this would occur over a long period of time (e.g., up to decades). The potential impacts from decommissioning to any septic systems or wastewater infrastructure or linear structures would be negligible.

DEP is currently working with owners of properties within the Estimated Unconsolidated Aquifer Groundwater Influence Area, and is committed to developing Action Plans that include engineering techniques to protect the affected structures or infrastructure based on their type, function and estimated magnitude of change. Therefore, there would be no significant adverse impacts to wastewater infrastructure within the Estimated Unconsolidated Aquifer Groundwater Influence Area from to changes in groundwater levels during the temporary shutdown and decommissioning.

11.9.14 ENERGY

As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area. This could result in areas that would be subject to consolidation settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). DEP is committed to developing and working with owners to implement preventative Action Plans for affected features within the Roseton Study Area, as described in Section 11.10, "Commitments." The permanent cessation of leaks would not result in changes to energy. Therefore, decommissioning would not result in significant adverse impacts to energy infrastructure within the Roseton Study Area.

11.9.15 TRANSPORTATION

As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area. The permanent cessation of leaks would not result in changes to traffic, public transportation, parking, or pedestrians as there would be no vehicles involved in decommissioning. Reduced groundwater levels would result in areas that could be subject to settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area (see Section 11.9.5.33, "Geology and Soils – Probable Impacts With Decommissioning"). Sections of River Road and the railroad tracks are located within this boundary. However, DEP is committed to developing and working with owners to implement preventative Action Plans for affected features within the Estimated Unconsolidated Aquifer Groundwater Influence Area, as described in Section 11.10, "Commitments." The specific

Action Plans would identify measures that could be implemented prior to, during, and after the temporary shutdown to protect River Road and the railroad tracks from settlement effects.

Therefore, decommissioning would not result in significant adverse impacts to transportation and transportation infrastructure within the Roseton Study Area.

11.9.16 AIR QUALITY

The cessation of leaks would not result in changes to air quality, as there would be no emissions as a result of decommissioning. Therefore, decommissioning would not result in significant adverse impacts to air quality within the Roseton Study Area.

11.9.17 NOISE

The cessation of leaks would not result in changes to noise, as there would be no noise-generating sources as a result of decommissioning. Therefore, decommissioning would not result in significant adverse impacts to noise-sensitive receptors within the Roseton Study Area.

11.9.18 NEIGHBORHOOD CHARACTER

As discussed in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," decommissioning would result in reduced groundwater levels within the Estimated Bedrock Aquifer Groundwater Influence Area. This would result in areas that could be subject to settlement at some locations within the Estimated Unconsolidated Aquifer Groundwater Influence Area, but is not expected to generate significant adverse effects within the Roseton Study Area in the technical areas that are considered during analysis of neighborhood character. As described in Section 11.9.4, "Screening Assessment, Methodology, and Impact Analysis Overview," there would be no potential for the repair and rehabilitation to affect shadows and urban design. As described in Section 11.9.6, "Land Use, Zoning, and Public Policy," Section 11.9.7, "Socioeconomic Conditions," Section 11.9.9, "Open Space and Recreation," Section 11.9.10, "Historic and Cultural Resources," Section 11.9.11, "Visual Resources," Section 11.9.15, "Transportation, and Section 11.9.17, "Noise," there would be no impacts to land use, zoning, or public policy; socioeconomic conditions; open space and recreation; shadows; historic and cultural resources; urban design and visual resources; transportation; or noise in the Roseton Study Area that would be affected by cessation of leaks. Surface water in stream segments that would be affected by the lower water levels are not used for recreational purposes and access is limited since they are located on privately owned parcels. DEP is committed to developing and working with owners to implement preventative Action Plans for settlement affected features within the Estimated Unconsolidated Groundwater Influence Area, as described in Section 11.10, "Commitments." Potential impacts to wetlands would be monitored and mitigated. Therefore, decommissioning would not result in significant adverse impacts to neighborhood character within the Roseton Study Area.

11.9.19 PUBLIC HEALTH

This section presents an analysis of the potential for decommissioning to result in effects to public health within the Roseton Study Area. In particular, decommissioning could result in reduced groundwater levels and in changes to overall groundwater quantity and quality within the Estimated Bedrock Aquifer Groundwater Influence Area. This was evaluated to determine whether these changes would alter public health due to significant unmitigated adverse impacts in related technical areas, such as air quality, water quality, hazardous materials, or noise.

There would be no potential for impacts to public health due to significant unmitigated adverse impacts in other related technical areas, such as air quality, hazardous materials, and noise in the Roseton Study Area (see Section 11.9.16, "Air Quality," Section 11.9.12, "Hazardous Materials," and Section 11.9.17, "Noise"). Therefore, this analysis focuses on changes to the quantity and quality of drinking water in the Roseton Study Area to determine the potential impacts to public health as a result of decommissioning.

11.9.19.1 Impact Analysis Methodology

The impact analysis consisted of: (1) establishing and describing the baseline conditions of the drinking water quality within the Roseton Study Area; (2) establishing future conditions without decommissioning by identifying plans that would potentially change drinking water quality within the Roseton Study Area that are anticipated to be completed by the analysis year; (3) establishing future conditions with decommissioning based on the permanent cessation of leaks within the study area; and (4) analyzing the potential for water quantity and quality changes by evaluating whether decommissioning would potentially result in changes to the available groundwater supply or groundwater quality changes such that the quality no longer meets applicable drinking water standards.

11.9.19.2 Impact Analysis

Baseline Conditions

As discussed in Section 11.9.13, "Water and Sewer Infrastructure," the primary source of drinking water within the Roseton Study Area is a mix between municipal water and groundwater. Municipal water systems providing drinking water to the public in the vicinity of the Roseton Study Area include the Town of Newburgh water district and the Town of Marlborough water district. Groundwater within the Roseton Study Area is not utilized as a source for these water districts. However, groundwater in the study area is used for domestic supplies for single-family residences that are outside of the public water supply district for these two towns. There are approximately 119 parcels that likely rely on private water supply wells that are located within the Roseton Study Area largely concentrated within the residential development along Old Post Road. Two commercial properties in the vicinity of the Roseton Study Area, are known to utilize groundwater supplies via production well(s) for varying needs, including drinking water. As also noted previously, groundwater quality in Orange County is generally considered suitable for domestic use without treatment (OCWA 1995).

Future Without Decommissioning

In the future without decommissioning, the RWBT would continue to leak water into the bedrock aquifer and leak water would continue to be transmitted through the bedrock aquifer into the unconsolidated aquifer. DEP has consulted with the Towns of Newburgh and Marlborough and Orange County, and it is DEP's understanding that no changes to the water and sewer infrastructure are currently approved within the Roseton Study Area within the timeframe of the impact analysis.

Changes to water infrastructure that could affect water quality and its contribution to public health are not anticipated within the Roseton Study Area within the timeframe of the impact analysis. Therefore, in the future without decommissioning, it is assumed that the quality of water within the Roseton Study Area would be the same as baseline conditions.

Probable Impacts With Decommissioning

As discussed above, the permanent cessation of leaks within the Roseton Study Area has the potential to change existing groundwater levels within the Estimated Groundwater Influence Area of the unconsolidated and bedrock aquifer. Based on the impact analysis of the changes in groundwater levels described in Section 11.9.5.26, "Groundwater – Probable Impacts With Decommissioning," the water level in water supply wells on 27 of the 119 parcels within the Roseton Study Area could change during the temporary shutdown and over the long term after decommissioning. As groundwater levels decline, the quality of groundwater in the Roseton Study Area could also change. However, as discussed further in Section 11.10, "Commitments," DEP commits to Well Action Plans to monitoring eligible wells and to treat wells that experience changes in water quality from the decline in groundwater levels.

It is also anticipated that groundwater in the Roseton Study Area would reach a new equilibrium condition that reflects groundwater quality typical for this area of Orange County. Groundwater quality in Orange County was identified as generally suitable for domestic use without treatment (OCWA 1995).

Groundwater samples were collected from four wells (GWP-5, GWP-6, GWP-7, and GWP-12) before, during, and after the October 2014 depressurization. Results indicated that, although there was some variation in water quality parameters throughout the duration of the depressurization, nearly all test parameters consistently remained at or below NYSDOH public drinking water standards that are recommended for residential wells (NYSDOH 2006) prior to, throughout, and after the depressurization was complete.

In certain geologic settings in Orange County, groundwater may be mineralized and exhibit elevated concentrations of iron, manganese, or sodium (Frimpter 1972). By comparison, the source of water currently leaking from the RWBT is a surface water reservoir that exhibits very low concentrations of minerals. As a result, the leak water dilutes these dissolved compounds (e.g., minerals) naturally occurring in the aquifers. Any noticeable water quality changes from removal of the diluting effect of leaks would likely be limited to aesthetic changes, including a change in taste, odor, and appearance. All applicable drinking water standards for public health would continue to be met.

In summary, the effect of decommissioning on groundwater quality would be minor to negligible. Groundwater quality is expected to revert to a condition that is similar to adjacent areas in Orange County that are unaffected by the leaks and meet applicable drinking water standards.

Therefore, there would be no significant adverse impacts to public health from changes to water quality during the temporary shutdown and over the long term after decommissioning.

Based on the analysis above, decommissioning would not result in significant adverse impacts to groundwater or any of the technical areas related to public health: air quality, water supply, hazardous materials, or noise.

11.10 COMMITMENTS

As part of the proposed project, DEP identified and incorporated specific commitments and protective measures within the Rondout-West Branch Tunnel Inspection and Repair (inspection and repair) component of Upstate Water Supply Resiliency. Commitments and protective measures were incorporated to avoid and/or minimize the potential for significant adverse impacts to the maximum extent practicable. Commitments and protective measures that have been identified are summarized below.

11.10.1 NATURAL RESOURCES

- For federal/State Threatened, Endangered Species, and Candidate Species, State Species of Special Concern, protective measures include perimeter fencing and species relocation.

11.10.2 NOISE

- Construction associated with the inspection and repair would require operation of fans and generators. Generators would not exceed a maximum noise emission of 75 dBA L_{eq} at 50 feet from the generators, and may need to be equipped with protective and sound attenuating enclosures to meet this level. Fans would not exceed a maximum noise emission of 51 dBA L_{eq} at 50 feet from the fans.

11.10.3 WATER AND SEWER INFRASTRUCTURE

- DEP would implement a Well Action Plan for potentially affected private drinking water supply wells within the applicable study areas, as described further below.

11.10.3.1 Well Action Plan

To commence the Well Action Plan, a survey would be prepared and sent to landowners to obtain information on available well construction details, water use, and occupants, for the following parcels:

- Within the Wawarsing Leak Repair Study Area, there are 145 total parcels with known, potential or future private drinking water supply wells identified in the Estimated Bedrock Aquifer Groundwater Influence Area (see **Figure 11.10-1**). One hundred and two (102) of these parcels currently have structures with potential wells. Forty three (43) of these parcels are vacant parcels that may be developed in the future and could require a private drinking water supply well; and

- Within the Roseton Study Area, there are 27 parcels with known, potential or future potential private drinking water supply wells identified in the Estimated Bedrock Aquifer Groundwater Influence Area (see **Figure 11.10-2**). Twenty five (25) of these parcels currently have structures with potential wells (one parcel has both a known supply well and a potential drinking water supply well). Two (2) of these parcels are vacant parcels that may be developed in the future and could require a private drinking water supply well. There are 28 known, potential, or future wells, as one parcel (Cedar Hill Cemetery) has two existing wells.

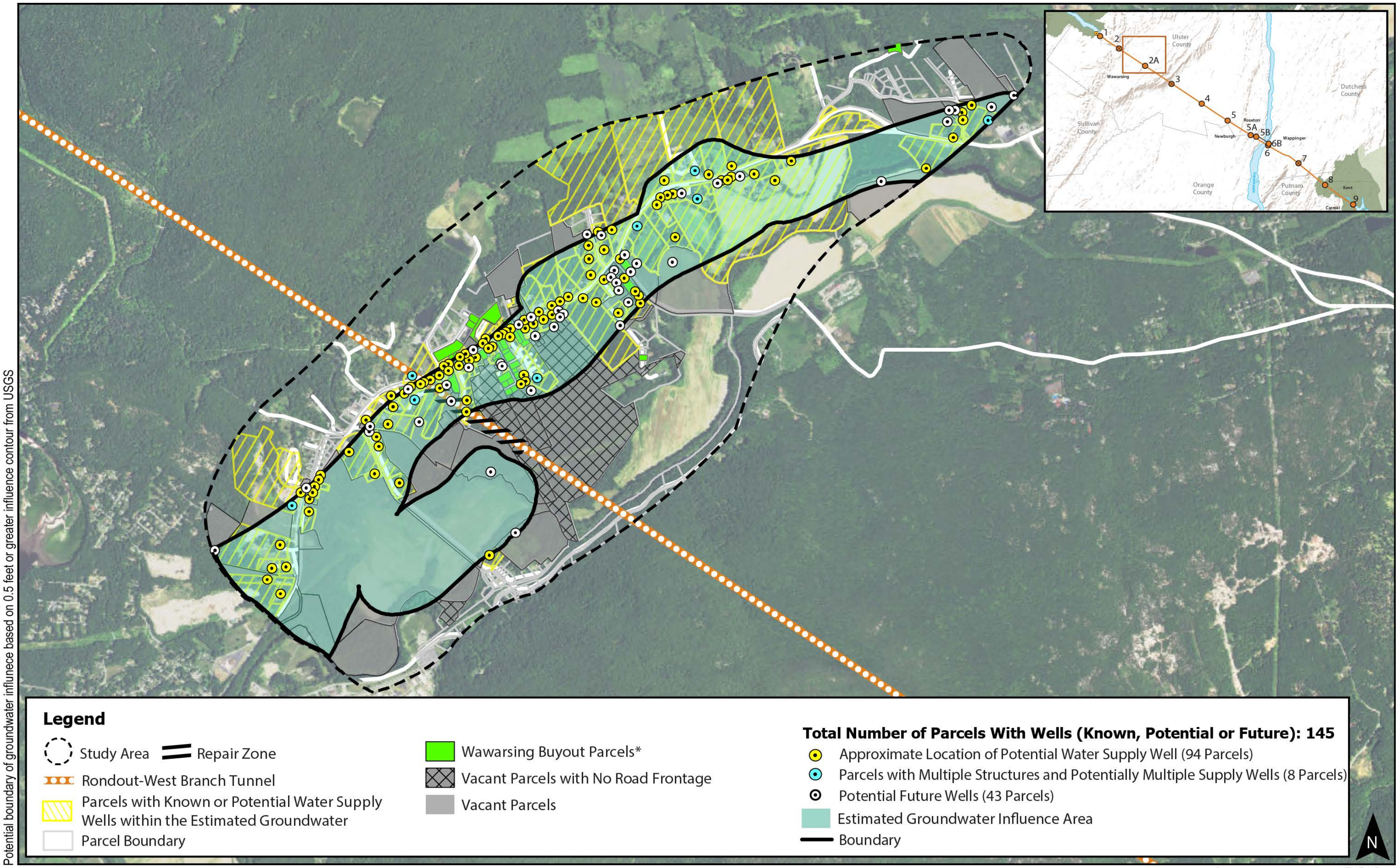
If the landowner provides the applicable well characteristics (e.g., depth and yield), they would be compared to the well monitoring criteria described further below. If a landowner does not have or cannot provide sufficient information for comparison to the well monitoring criteria, DEP would, with their approval, determine the water supply well characteristics (e.g., depth and yield) approximately one year before the RWBT temporary shutdown.

11.10.3.2 Well Action Plan Criteria

The criteria below were created to identify wells or parcels with future wells that have the potential for water level changes due to the inspection and repair and decommissioning. They were created based on a combination of well characteristics. These include the type of aquifer, well depth, well yield, water usage rates, well storage, and well pump setting, and whether a lower groundwater level could affect the well's ability to meet the water supply needs of its users.

The criteria are based on NYSDOH Individual Water Well recommendations. A well that yields 5 gpm or more is capable of meeting the peak-day demand and the average day demand for a home. For wells that yield less than 5 gpm, it is necessary to store a sufficient volume of water in the well and in the pressure tank for the home to meet peak demands. The NYSDOH recommends a minimum storage volume that ranges from 100 gallons for a two-bedroom home to 300 gallons for a five-bedroom home based on the yield of the well. To put this into perspective, a standard 6-inch drilled bedrock well contains 1.5 gallons per foot, or 150 gallons for every 100 feet of water in the well. These factors were used to create the well monitoring eligibility criteria as described below.

Before the start of the temporary shutdown, the wells would be evaluated to determine if they meet the criteria below. Each well would be evaluated to determine the well yield (in gallons per minute [gpm] over a 4-hour period), depth to water, depth to pump intake, and depth to bottom of well.



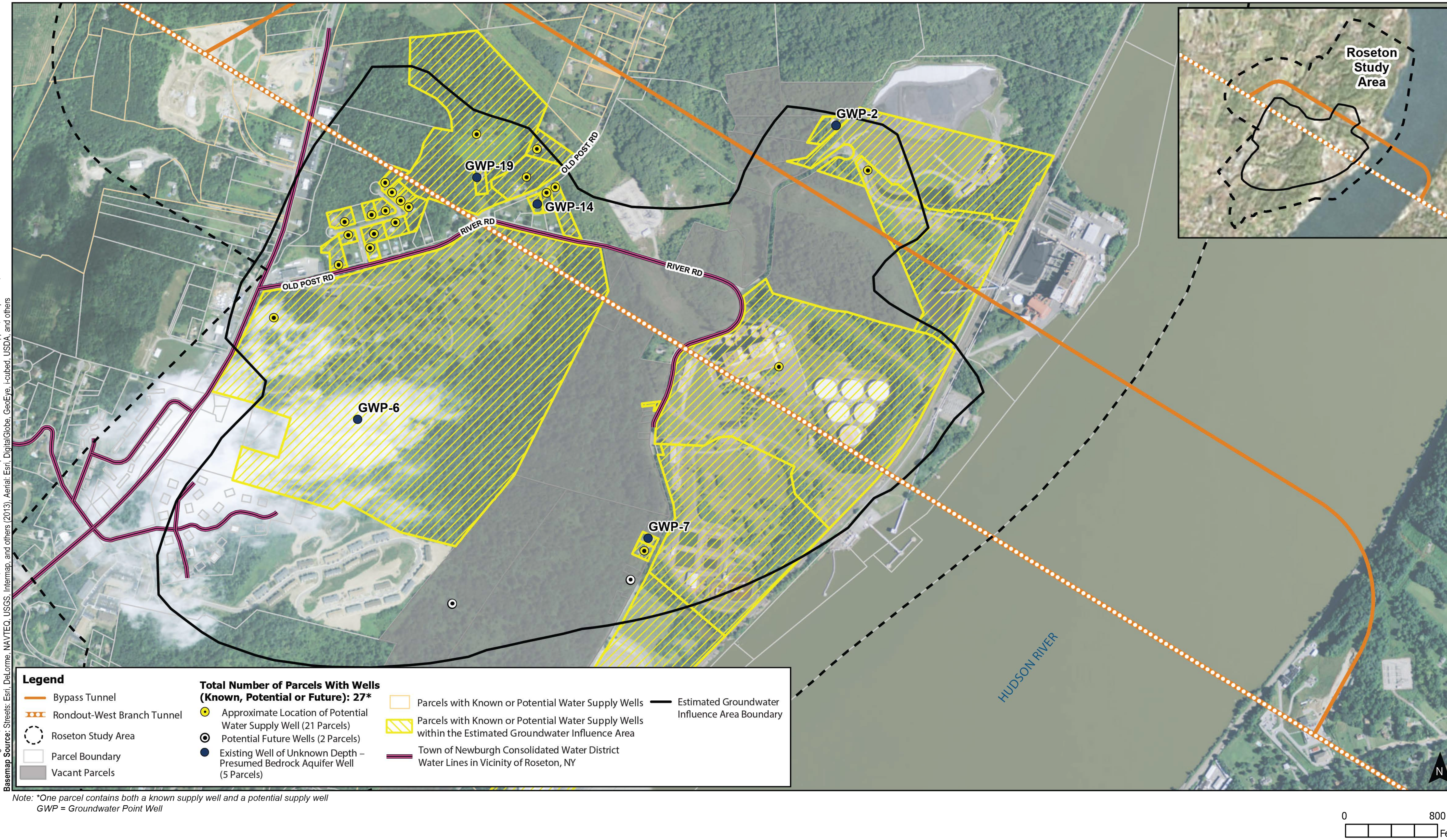
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013)
Potential boundary of groundwater influence based on 0.5 feet or greater influence contour from USGS

*Note: *Parcels included in the Wawarsing Buyout Assistance Program*

0 2,640 Feet

Figure 11.10-1: Well Action Plan – Wawarsing Leak Repair Study Area

NYC Environmental Protection



Sources: Figure 9, Roseton Groundwater Flow Model Construction, Calibration and Simulations for Aqueduct Connection Environmental Support, Geopentech, October 2015.
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013). Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

*Note: *One parcel contains both a known supply well and a potential supply well*
GWP = Groundwater Point Well

Figure 11.10-2 : Well Action Plan – Roseton Study Area Estimated Groundwater Influence Areas

These data would be used to evaluate the well performance characteristics of each well and would be compared to the criteria below. Wells with yield greater than 5 gpm:

- NOT MONITORED - would not be monitored.

- Well with yield greater than 3 but less than 5 gpm:
  - NOT MONITORED - would not be monitored if the well stores greater than 300 gallons;
  - MONITORED - would be monitored if the well stores less than 300 gallons;
  - ALTERNATIVE SUPPLY - would be provided an alternative water supply if the well stores less than 100 gallons.

- Well with yield greater than 1 but less than 3 gpm:
  - NOT MONITORED - would not be monitored if the well stores greater than 350 gallons;
  - MONITORED - would be monitored if the well stores less than 350 gallons;
  - ALTERNATIVE SUPPLY - would be provided an alternative water supply if the well stores less than 200 gallons.

- Well with yield less than 1 gpm:
  - ALTERNATIVE SUPPLY - would be provided an alternative water supply.

These criteria were established by adding 50 gallons to the NYSDOH storage recommendations (Individual Water Supply Wells – Fact Sheet No. 2) for a five-bedroom home for each well yield range (e.g., 1 to 3 gpm and 3 to 5 gpm). Fifty gallons of storage was added to the NYSDOH recommended water storage to account for the water storage that could be lost (e.g., 25 feet of water in a 6-inch diameter well equates to 37.5 gallons) during the temporary shutdown and over the long term from repair of the leaks.

A well that yields 5 gpm or greater would be excluded from the Action Plan. If a water supply well meets the criteria for monitoring and the landowner allows, DEP would conduct well monitoring for groundwater level and groundwater quality 12 months before, during, and up to 12 months after the temporary shutdown. Monitoring would include installing a water level transducer in each well to measure and record the water level fluctuation in each well. Monitoring would also include collecting water samples quarterly and analyzing the water samples for metals and inorganic parameters.

A well in the monitoring program would receive an alternative supply based on the following criteria:

- If the water level in the monitored well is within 20 feet of the pump intake at its typical lowest operating point.

- If a metal or inorganic water quality parameter result exceeds the NYSDOH Part 5 Standards as confirmed by a second sample collected as soon as practical once sampling results indicate a possible exceedance. In the event the baseline water quality monitoring prior to the temporary shutdown demonstrates an existing water quality exceedance, an increase in the concentration of that parameter would also result in alternative supply (see Section 11.10.4, "Public Health").

If a water supply well meets the alternative supply criteria, and where the landowner allows, DEP would provide an augmented or alternative water supply. The augmented or alternative supply may include the following options:

- Install an above ground pneumatic storage tank to increase water storage capacity;
- Lower the pump intake in the well to increase water storage capacity in the well;
- Drill the well deeper and lower the pump intake in the well to increase water storage capacity in the well if it is a bedrock well and the well is judged to be suitable to be deepened; or
- Drill a new deeper well and lower the pump intake in the well to increase storage capacity in the well if it is an unconsolidated well.

If the water quality results show that quality exceeds the NYSDOH Part 5 drinking water standards, DEP would provide treatment to treat or remove contaminants to below the NYSDOH Part 5 drinking water standards (see Section 11.10.4, "Public Health").

The Town of Wawarsing has initiated the planning studies for the formation of a municipal water supply district that would provide a public water supply for the local residents. For those properties that connect to the water district, this would result in the abandonment of the existing water supply wells, and the need for a Monitoring Action Plan would no longer be necessary. For any additional parcels that may become connected to either a local or municipal water supply district within the study area, well monitoring would no longer be necessary.

11.10.4 PUBLIC HEALTH

As further described above under Section 11.10.3.2, "Well Action Plan Criteria," if the water quality results from the Well Action Plan show that quality exceeds the NYSDOH Part 5 drinking water standards, DEP would provide either an alternate supply or treatment to treat or remove contaminants to below the NYSDOH Part 5 drinking water standards.

11.10.5 GEOLOGY AND SOILS

Decommissioning would result in a change of ground water levels, which could result in areas that could be subject to settlement within the Roseton Study Area. DEP is developing and working with owners to implement preventative Action Plans for structures within this area, as described further below.

11.10.5.1 Action Plans for Structures

DEP is developing, and working with owners to implement, preventative Action Plans for areas within the area that could be subject to settlement during and after the RWBT temporary shutdown (see shaded parcels in **Figure 11.10-3**). Where structures and infrastructure are located in areas that have the potential to be subject to ground settlement, the specific Action Plans would identify measures that could be implemented prior to, during, and after the temporary shutdown to protect the potentially affected structures or infrastructure based on their type, function, and estimated magnitude of change. These measures could include: additional investigations; development of engineering techniques; and further assessment against structure-specific thresholds to evaluate whether additional engineering techniques are required.

Prior to the temporary shutdown, additional investigations that could be conducted include the following:

- Pre-condition surveys of existing structures and infrastructure within the targeted area of potential settlement to establish structure/infrastructure-specific baseline conditions; and

- Additional structure/infrastructure-specific geotechnical investigations (field explorations and laboratory testing) for specific structure/infrastructure.

Results from these investigations would be used to assess the estimated values for stress, strain, and distortion the structure or infrastructure could experience as a result of the changing physical condition of the ground as settlement occurs. These estimated values would be compared with structural or empirical criteria to further identify the potential response of the structure or identified infrastructure to the estimated ground settlement.

If results from these additional investigations identify potential settlement that could affect the integrity of a structure or infrastructure, DEP would work with owners to provide protective engineering techniques that would be implemented prior to the temporary shutdown. All of the structures and infrastructure in the Estimated Unconsolidated Aquifer Groundwater Influence Area could be stabilized, if necessary, using readily available engineering techniques. For example, structures or infrastructure that could be subject to differential settlement (e.g., rigid structure subjected to bending or tilting) can be stabilized using grouting techniques such as jet, compaction, or compensation grouting. Additional commonly used engineering techniques for stabilization include providing additional structural supports, providing flexible connections for utilities, and rerouting critical infrastructure.

Some structures or infrastructure could be subject to differential settlement because of differing foundation types used within the same or connected structures (e.g., building founded on piles and soil, or a building founded on piles with utility connections founded on soil). For these, stabilizing techniques that could be applied consist of compaction grouting to prevent ground movements or modification of connections to accommodate potential differential settlement.

Linear structures and infrastructure that could be subject to differential settlement (e.g., railroad tracks, utilities, or pipelines) could be stabilized to stabilize and reinforce the soil.

Figure 11.10-3: Action Plan Parcels in Roseton

Prior to the temporary shutdown, a settlement monitoring program would also be developed and implemented during the temporary shutdown as part of the Action Plans. The monitoring program would be specific to the type and function of each potentially impacted structure or infrastructure. It would include monitoring to measure settlement and movements or changes to structures or infrastructure that could be subject to settlement for comparison to estimated changes. The monitoring could include the following measures:

- Surface/subsurface instrumentation such as high-precision settlement survey markers, piezometers, extensometers, and inclinometers; and
- Structural/infrastructure monitoring with instruments such as tiltmeters, crack gauges, and vibration monitors.

In addition to these engineering techniques, the Action Plans could include implementation of similar techniques for specific structures or infrastructure if threshold values of changes associated with estimated settlement or structure/infrastructure distress are exceeded during monitoring (e.g., vibration level, crack size, or new observed distresses). As applicable, the Action Plans would include threshold action values that would be agreed upon with the owners based on the anticipated potential settlement or structure/infrastructure stress levels. For example, for structures or infrastructure that could be subject to differential settlement, compaction grouting or modification of connections would be initiated if the anticipated settlement reaches the agreed-upon threshold action values.

11.11 MITIGATION

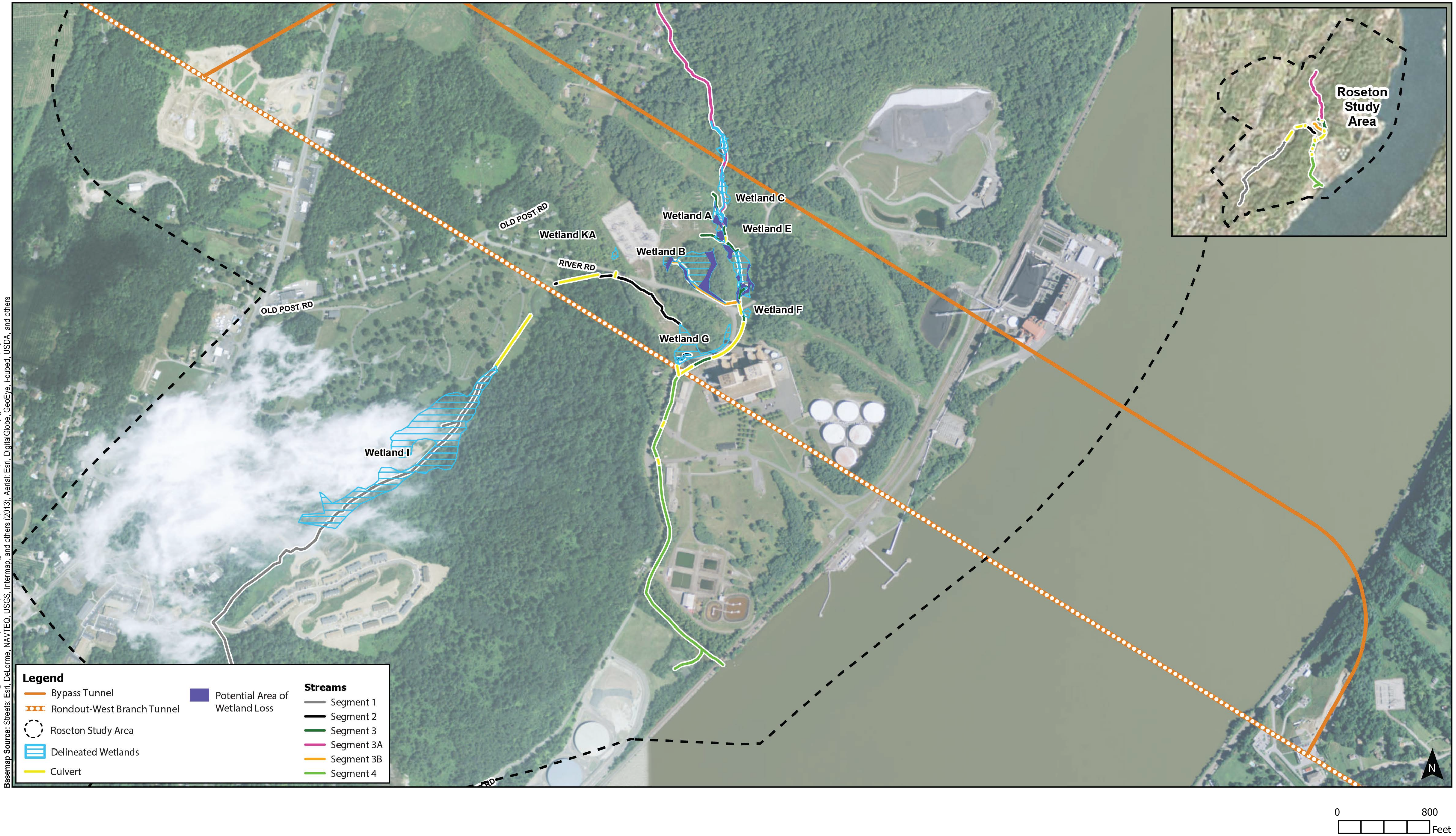
There remains the potential for significant adverse impacts to non-regulated (USACE and NYSDEC) wetlands in the Roseton Study Area associated with the inspection and repair. For these potential impacts, mitigation measures would be developed as discussed below.

11.11.1 WETLANDS

A total of approximately 1.2 acres of existing delineated non-regulated wetlands within the Roseton Study Area are estimated to be lost as a result of the cessation of leaks from decommissioning on surface water and shallow groundwater levels that are the source of water to these wetlands, including Wetlands A, B, D, and E (see **Figure 11.11-1**).

DEP commits to developing a wetland monitoring program that would be implemented prior to, during, and after the RWBT temporary shutdown to assess the impacts to Wetlands A, B, C, D, and E, and riparian areas adjacent to Stream Segments 3, 3B, and 4. The monitoring program would consist of continuous hydrologic monitoring for up to 5 years following decommissioning, and biennial vegetation monitoring, wetland delineation, wetland functional assessment, and photographic documentation of fixed monitoring plots during the first, third, and fifth years following decommissioning. The objective of the monitoring program would be to document changes to wetland communities and their size and function, and to compare changes to local reference wetlands to determine if significant adverse impacts have occurred as a result of decommissioning. The monitoring of reference wetlands would allow for comparison to determine if any change at the potentially impacted wetland is a result of decommissioning or other source (e.g., climatological). Should permanent impacts to wetland size and/or function be measured, DEP would perform compensatory mitigation.

Compensatory mitigation for permanent impacts to wetlands would include wetland creation, restoration, and/or enhancement, with a minimum one to one mitigation ratio (i.e., 1 acre of wetland creation, restoration, or enhancement for every acre of wetland permanently lost as a result of the project). Once the compensatory mitigation site is established, DEP would monitor the site for a minimum of 3 years to confirm that the site meets the objective to compensate for the permanent loss of wetlands in the Roseton Study Area.



GIS Data Sources: Stream Sege ments - AKRF, NWI - http://www.fws.gov/wetlands/, NYSDEC - http://www.dec.ny.gov/lands/305.html, Hydric Soils - NRCS
Basemap Source: Streets: Esri, DeLorme, NAVTEQ, USGS, Intermap, and others (2013), Aerial: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, and others

Figure 11.11-1: Estimated Impacts to Non-regulated Wetlands - Roseton Study Area