AQUETONG CREEK RESTORATION PROJECT
2022 MONITORING REPORT

SOLEBURY TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA

NOVEMBER 2022

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INTRODUCTION

The purpose of this annual monitoring report, the second of five, is to document the status and development of the Aquetong Creek Restoration Project located within Aquetong Spring Park in Solebury Township, Bucks County, Pennsylvania ("Site"; **Figures 1 and 2**).

The Aquetong Creek Restoration Project is situated within the former impoundment of Aquetong Lake, which was a 15-acre impoundment formed in 1870 by the construction of an earthen dam on Aquetong Creek. Solebury Township removed the dam that formed the Aquetong Lake impoundment in April 2015 via a controlled partial breach that drained the lake and re-exposed the lake bottom. The goal of the dam breach was to reduce thermal impacts on Aquetong Creek to support a high-quality, cold-water fishery. With the dam removed and the lake drained, a meandering channel formed through the exposed lakebed, connecting the upper and lower headwater sections of Aquetong Creek. The primary source of inflow to the headwater portion of Aquetong Creek is Ingham Spring, an artesian spring formed at the contact of two geologic formations, with a sustained flow rate of 2,000 gallons per minute (F.X. Browne, Inc. 2004). Aquetong Creek also receives flow from an unnamed tributary to Aquetong Creek that enters the Site from the north under Route 202. The tributary receives inflow from a detention basin located to the northeast of the Site, as well as a large pond to the north of the Site. There is supplemental inflow to Aquetong Creek in the form of via stormwater runoff discharged from the adjacent developed areas located to the north and south of the Site.

Following the breaching of the former dam, a degree of stewardship was necessary in order to guide the early developmental stages of the former impoundment in order to enhance the establishment of desirable species and to foster the development of a productive surface water feature which will continue to maintain its population of brook trout. This project was implemented following Solebury Township's (herein referred to as "the Township") purchase of the Site. From the onset, Solebury Township and its environmental partners recognized the unique environmental benefits of the cold-water spring and the possibilities associated with the reestablishment of Aquetong Creek through the breaching of the Aquetong Lake dam. Following the dam breach, the Township and its project partner, Bucks County Trout Unlimited, successfully transplanted 1,000 native Pocono brook trout to the re-established Aquetong Creek channel. Scientific monitoring of the new stream, commissioned by the Township, confirmed after a year that the transplanted trout population was reproducing.

In 2018, the Township completed its Strategic Master Plan for Aquetong Spring Park which expanded the objectives for the restoration of the former impoundment as part of the park design. The restoration efforts included the management of diseased forest, impoundment restoration (including stormwater management), and park improvements for recreation, education, and cultural components. Immediately downgradient of the former dam remnants was a forest comprised of mostly diseased green ash (*Fraxinus pennsylvanica*) and black walnut (*Juglans nigra*) trees. The Township removed these hazard trees in 2019 and re-established the area with other native species, as well as establishing an invasive species management program. In addition, the Township reused the removed trees within the park (with Pennsylvania Department of Environmental Protection (PADEP) approval) in conjunction with the stream restoration project constructed in 2020 as habitat and park features.

The PADEP-approved Restoration Waiver 16 (Authorization ID No. 1278424, dated October 23, 2019) (See Appendix IV) also authorized the monitoring of the stream and wetland restoration areas and wetland creation areas in accordance with the Mitigation Plan narrative provided as S4 of the Aquetong Creek Restoration Project Environmental Assessment Addendum, dated June 2019, last updated September 2019. The restoration of the wetlands commenced in 2020 and included the enhancement of 1.09-acres of existing palustrine emergent (PEM) wetlands through floodplain re-connectivity, invasive species removal, subsequent installation of native herbaceous and woody plant material, and the creation of 0.25-acres of forested wetlands. The wetland enhancement and creation elements were designed to provide functions and values that are superior to the

File: P:\0388\Projects\0388011\GIS\MXD\Aerial.mxd, 11/18/2021, Drawn by bsmith, Copyright Princeton Hydro, LLC.

NOTES:
1. Project boundary obtained from Princeton Hydro planset titled "Aquetong Creek Restoration" dated 10/18/2019.
2. Aerial imagery obtained through ArcGIS Online Bing Maps (C) 2021 Microsoft Corporation and its data suppliers.

0 200 400 Feet

Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

AERIAL OVERVIEW MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

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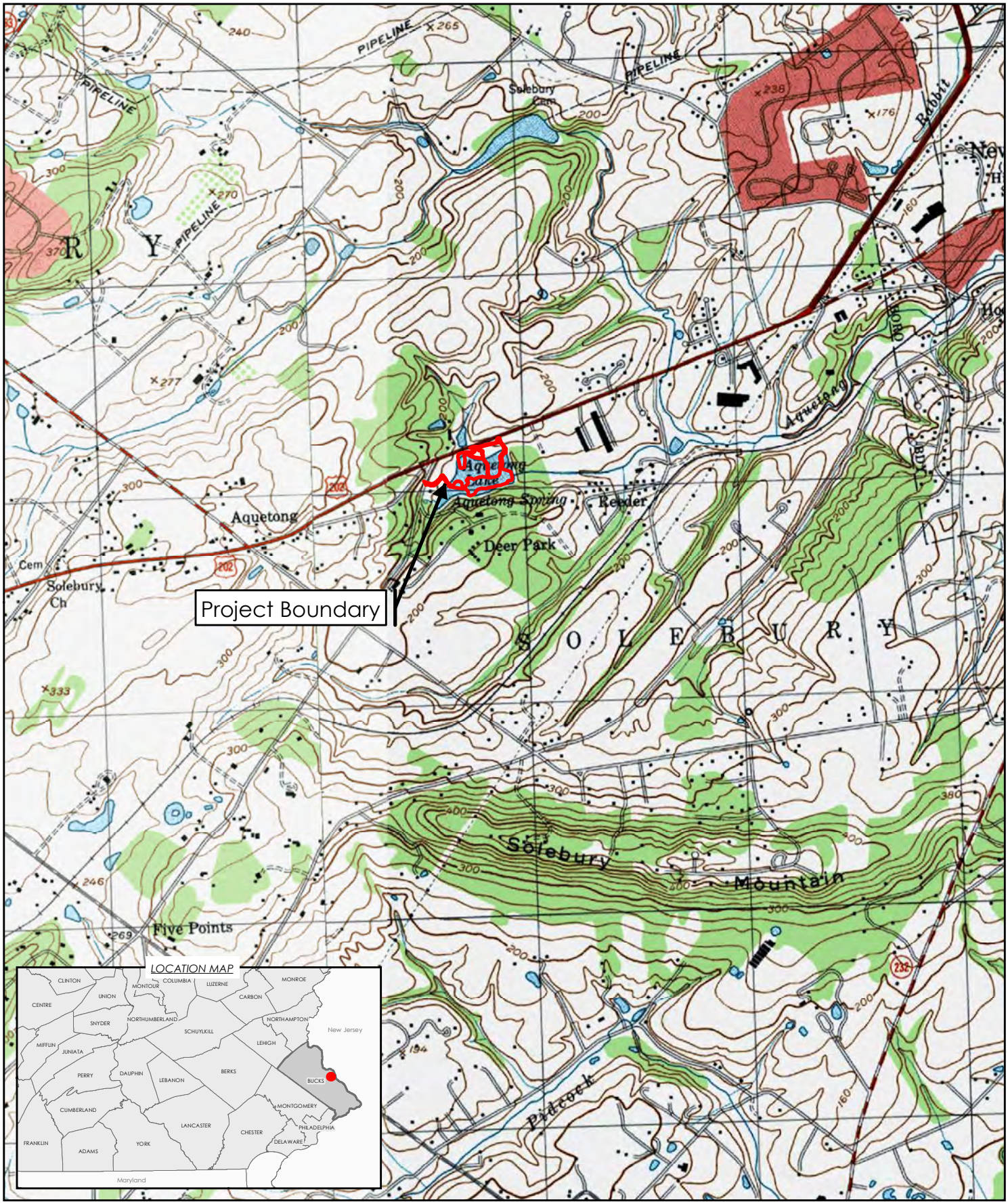

File: P:\0388\Projects\0388011\GIS\MXD\USGS.mxd, 11/18/2021, Drawn by bsmith, Copyright Princeton Hydro, LLC.

NOTES:
1. Project boundary obtained from Princeton Hydro planset titled "Aquetong Creek Restoration" dated 10/18/2019.
2. USGS topographic digital raster graphic obtained from Terrain Navigator Pro, Lambertville and Buckingham, PA quadrangle.

0 1,000 2,000 Feet

Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

USGS LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
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pre-existing degraded PEM wetlands. The creation of wetlands was necessitated via the permanent conversion of approximately 0.07-acres of the degraded PEM wetlands to open waters; thus, 0.25-acres of wetlands designed to be forested were created in accordance with Chapter 105.20a(a)1 to compensate for the permanent areal loss of wetland. Additionally, the creation of 0.25-acres forested wetland is in accordance with Chapter 105.20a(a)2 as the forested wetland was designed to provide additional functions and values when compared to the previous degraded PEM wetland. The resulting ratio was 3:1, greater than the required 1:1 wetland replacement criterion outlined in Chapter 105.20a(a)(1). The created wetlands are located adjacent to the permanently converted PEM wetlands in accordance with the Siting Criteria outlined in Chapter 105.20a(a)(3). Overall, the project resulted in a 0.18-acre net gain of forested wetlands on-Site.

This monitoring report presents data collected during the 2022 growing season, the Site's second full growing season after planting, to illustrate compliance, and document the status and development of the project since monitoring was initiated in 2021. The data collected serves to steward the wetland's development moving forward. The information provided in this monitoring report includes the following: (i) a description of the general success of the Site at the time of inspection, (ii) an inventory of plant species present, (iii) a qualitative description of wildlife utilization, (iv) a determination of the percent areal coverage of vegetation, (v) color photographs, (vi) a Site plan indicating location and orientation of the photographs, (vii) and a description of adaptive management measures that were and/or need to be implemented to address potential problems or deficiencies identified during the inspection.

The goals for the wetland restoration project are to achieve 100% vegetative coverage of the restoration areas, with at least 85% coverage by native, desirable hydrophytic species; to achieve at least 85% woody plant survivorship; minimize the areal coverage of undesirable, non-native species to the maximum extent practicable; and to stabilize the stream channel.

SECTION 1: PRE-CONSTRUCTION SITE ENVIRONMENT

Following the breaching of the dam and draining of Aquetong Lake, a meandering channel formed through the exposed lakebed sediment, connecting the spring to the reach of Aquetong Creek below the former dam. Sufficient sediment had accumulated in the former lake such that the meandering channel that re-formed following dam removal initiated the process of channel incision or "downcutting" (i.e., active erosion of sediment from a stream that results in lowering the elevation of a channel bed and reduces channel slope). The Site experienced downcutting, creek channel instability, and erosion of the former lake bottom. Certain sections of Aquetong Creek's channel were unstable and underlain by additional erodible sediment. Further, the exposure of lake sediments following the dam breach facilitated the establishment of invasive species within portions of the former lakebed, negatively impacting the ecological functions and values of recently exposed floodplain wetlands and associated upland areas.

SECTION 2: DESIGN AND CONSTRUCTION

The restoration area is comprised of wetland creation and wetland enhancement areas. The wetland creation area consists of 0.25 acres (10,804 square feet) of palustrine forested (PFO) freshwater wetlands that mitigated the permanent loss and conversion of the adjacent degraded PEM wetland to open water. The creation area was designed to develop into a forested floodplain wetland located adjacent to the stabilized stream channel. The wetland creation area is located adjacent to Aquetong Creek and its tributary (Appendix III, Photo 5). The wetland enhancement area is comprised of 1.09 acres (47,301 square feet) of PEM wetlands. The purpose of the wetland enhancement element is to enhance the biological and physical functions of the existing PEM wetlands on-Site, such as providing fish and wildlife habitat, enhancing the water quality of Aquetong Creek, spreading and slowing floodwaters, and controlling erosion along the streambanks. The wetland enhancement areas are located on portions of the western banks of the unnamed tributary to Aquetong Creek, and along both the northern and southern banks of Aquetong Creek (Appendix III, Photos 10 and 13).

The mitigation activities resulted in the creation of PFO wetland and enhancement of PEM wetland that currently possess and will continue to support a variety of native herbaceous and woody species. The wetland restoration area was designed to connect the stream more effectively to its floodplain in order to store floodwaters from Aquetong Creek and its tributary, which are the primary hydrologic sources for the wetlands on-Site. In addition to the project's wetland creation and enhancement elements the project focused on the establishment of a stable stream channel capable of passing various flow rates without being subject to erosion. Specifically, the restoration of the wetlands and stream channel serve to foster the Site's capability of supporting a high-quality, cold-water aquatic community. Additionally, the project improves Aquetong Creek's water quality through the enhanced stability of the stream channel.

A planting plan was devised for the 1.35-acre wetland restoration effort, and is based on the local plant assemblage, hydrology, and other Site conditions. Native seed mix was applied and 6,600 two-inch herbaceous plugs were installed throughout the wetland restoration area. The type, hydrologic indicator status, and quantity of herbaceous plant material that was installed in the wetland restoration area is provided in **Tables 1 and 2** below.

Table 1. Wetland Restoration Area Seed Mix

Botanical Name	Common Name	Indicator Status	Rate (lb/acre)[1]	Quantity (%)
Bidens frondosa	Devil's beggartick	FACW	1.00	5.00
Calamagrostis canadensis	Bluejoint grass	FACW	1.50	5.00
Cinna arundinaceae	Wood reedgrass	FACW	2.25	8.00
Echinochloa muricata	Rough barnyard grass	OBL	3.00	10.00
Elymus virginicus	Virginia wildrye	FACW	5.25	18.00
Carex vulpinoidea	Fox sedge	OBL	4.00	14.00
Lolium multiflorum	Annual rye	NL	4.50	15.00
Panicum dichotoflorum	Smooth panic grass	FACW	3.00	10.00
Dichanthelium clandestinum	Deertongue	FAC	4.25	15.00
Persicaria pensylvanica	Pennsylvania smartweed	FACW	0.75	3.00
Verbena hastata	Blue vervain	FACW	0.25	1.00
Senna hebecarpa	Wild senna	FACW	0.25	1.00

[1] Seed was spread over entire area (1.35 acres) at a rate of 30 pounds per acre.

Table 2. Wetland Restoration Area Herbaceous Plugs

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity[1]
Asclepias incarnata	Swamp milkweed	OBL	2" Plug	300
Carex comosa	Longhair sedge	OBL	2" Plug	450
Carex crinita	Fringed sedge	OBL	2" Plug	500
Carex lurida	Shallow sedge	OBL	2" Plug	500
Carex scoparia	Broom sedge	FACW	2" Plug	600
Elymus virginicus	Virginia wildrye	FACW	2" Plug	600
Eupatorium perfoliatum	Boneset	FACW	2" Plug	250
Helenium autumnale	Common sneezeweed	FACW	2" Plug	400
Iris versicolor	Blueflag iris	OBL	2" Plug	350
Juncus effusus	Soft rush	OBL	2" Plug	600
Leersia oryzoides	Rice cutgrass	OBL	2" Plug	400
Schoenoplectus tabernaemontani	Soft-stem bulrush	OBL	2" Plug	500
Scirpus cyperinus	Woolgrass	FACW	2" Plug	550
Smphyotrichum novae-angliae	New England aster	FACW	2" Plug	300
Verbena hastata	Blue vervain	FACW	2" Plug	300

[1] The quantity of herbaceous plants is based on a planting density of 3 feet on center.

Additionally, a total of 710 woody plants (385 trees and 325 shrubs) were installed in the wetland creation and enhancement areas in 2020. The tree species included red maple (*Acer rubrum,* FAC), river birch (*Betula nigra*, FACW), American sycamore (*Platanus occidentalis*, FACW), swamp white oak (*Quercus bicolor,* FACW), pin oak (*Quercus palustris*, FACW), and black willow (*Salix nigra*, OBL). The shrub species included smooth alder (*Alnus serrulata,* OBL*)*, red chokecherry (*Aronia arbutifolia*, FACW), common buttonbush (*Cephalanthus occidentalis*, OBL), silky dogwood (*Cornus amomum*, FACW), winterberry holly (*Ilex verticillata,* FACW), swamp rose (*Rosa palustris,* OBL), and pussy willow (*Salix discolor,* FACW). Woody material was installed in suitable habitat areas and were selected based on (1) being indigenous to the region, (2) provide either good cover or food for wildlife, and (3) have generally good to high survivorship. The type, wetland hydrologic indicator status, and quantity of woody plant material that was installed within the restoration areas are provided in **Tables 3 and 4**.

Table 3. Wetland Restoration Area Tree Installation

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity[1]
Acer rubrum	Red maple	FAC	24" - 36" Container	20
Betula nigra	River birch	FACW	24" - 36" Container	40
Platanus occidentalis	American sycamore	FACW	24" - 36" Container	60
Quercus bicolor	Swamp white oak	FACW	24" - 36" Container	95
Quercus palustris	Pin oak	FACW	24" - 36" Container	95
Salix nigra	Black willow	OBL	24" - 36" Container	75

[1] The quantity of trees is based on a planting desnity of 10 feet on center.

Table 4. Wetland Restoration Area Shrub Installation

Botanical Name	Common Name	Indicator Status	Planting Type	Quantity[1]
Alnus serrulata	Smooth alder	OBL	24" - 36" Container	35
Aronia arbutifolia	Red chokecherry	FACW	24" - 36" Container	65
Cephalanthus occidentalis	Common buttonbush	OBL	24" - 36" Container	15
Cornus amomum	Silky dogwood	FACW	24" - 36" Container	65
Ilex verticillata	Winterberry holly	FACW	24" - 36" Container	50
Rosa palustris	Swamp rose	OBL	24" - 36" Container	30
Salix discolor	Pussy willow	FACW	24" - 36" Container	65

[1] The quantity of shrubs is based on a planting desnity of 10 feet on center.

SECTION 3: MONITORING METHODOLOGY

Vegetative cover of the wetland creation and enhancement areas was determined through the use of eight (8) permanent 1 x 1-meter quadrats. The area within each quadrat that lacked vegetation (hereinafter referred to as the "unvegetated area") was visually estimated in accordance with the *Ocular Estimation of Cover Technique* (USFWS, 1981). The total area of cover was considered to be the area that remained after excluding the areas determined to be unvegetated. Percent vegetative cover determined by this method is derived by subtracting the unvegetated area from the total area of each quadrat. The formula below was utilized to determine the percent vegetative cover by this method.

Percent Vegetative Cover = {(total area - unvegetated area)/total area} x 100

All references to vegetative cover in this document are based on this formula. Subsequently, the vegetative cover provided by each species was visually estimated. Species that were present, but provided less than 1 percent cover, were indicated to be "P" (present). The species-by-species sampling data for each quadrat is provided in Tables 5 and 6. The estimates of total vegetative cover provided by this method are essentially relative values comparing the area within each quadrat that is covered by vegetation relative to un-vegetated areas within the quadrat. However, since plant cover can overlap, the total vegetative cover present in any given quadrat often exceeds the percent vegetative cover derived by the above referenced formula. The formula used above provides a simple mechanism to portray the area within each quadrat that is covered by vegetation relative to meeting established regulatory objectives. The use of total vegetative cover, however, more effectively conveys

the ecological development of the area since it takes into account the cover provided by each species. Total vegetative cover thus provides a mechanism to see the changes in cover that occur as the wetland matures and becomes more structurally complex.

SECTION 4: MONITORING INSPECTION

The monitoring inspection, the second of five, was conducted on September 15, 2022. The inspection included the evaluation of eight (8) fixed monitoring plots which included four (4) plots situated in representative locations of both the wetland creation and wetland enhancement areas. Vegetative cover and woody survivorship of the wetland restoration areas was estimated and evaluated in accordance with the methodology detailed in *Section 3.0*. At the time of the inspection, the wetland restoration area exhibits 100% vegetative cover and 145.4% total cover. The monitoring plot data for the wetland creation and wetland enhancement areas are discussed in *Subsections 4.1 and 4.2,* respectively, below. In accordance with the *Aquetong Creek Restoration Project Environmental Assessment Addendum* (Princeton Hydro, 2019), a qualitative description of wildlife utilization of the wetland restoration areas is also provided in *Subsection 4.6*.

SUBSECTION 4.1 WETLAND CREATION AREA PLOTS

Four (4) quadrats were established in representative locations throughout the wetland creation area. At the time of the fall 2022 inspection, the wetland creation area possessed 100% vegetative cover and 136.3% total cover (**Table 5**), which is well above the 85% vegetative cover threshold stipulated by PADEP. The plots possessed high total vegetative cover of desirable native hydrophytes, and high vegetative species richness (n=20). The two (2) most prevalent species within the wetland creation area were American sycamore and Pennsylvania smartweed (*Persicaria pensylvanicum*, FACW), which comprised 20% and 18.8% cover, respectively. The increase in total percent cover between 2021 and 2022 is representative of a Site that is continuing on a positive developmental trajectory while also developing increased structural heterogeneity, as evidenced by the total cover exceeding 100% (Appendix III, Photos 1, 2, and 13).

No barren areas were observed. The continued establishment of a diverse assemblage of native species throughout the wetland creation portions of the restoration project supports the position that the wetland creation areas possess suitable substrate and hydrology resulting in a structurally diverse plant assemblage. Further, the positive developmental trajectory is anticipated to continue moving forward, satisfying the established goals for the Site to be deemed a success.

The wetland creation area was largely devoid of undesirable, non-native species, however, common reed (*Phragmites australis*, FACW), reed canarygrass (*Phalaris arundinacea*, FACW) Japanese stiltgrass (*Microstegium vimineum*, FAC), and Japanese bristlegrass (*Setaria faberi*, UPL), with respective percent cover of, 10%, 3.8%, and 3.8% were observed. Japanese bristlegrass and common reed were also present in 2021, with reed canarygrass and Japanese stiltgrass also colonizing portions of the wetland creation area in 2022. To address their presence, these species were targeted with an herbicide on October 7th, 2022 (see Section 4.4).

Table 5. Wetland Creation Area Percent Vegetative Cover

Species	Wetland Creation Plot				Mean % Cover
	W3	W5	W6	W7	
Barren Soil	0	0	0	0	0.0
Platanus occidentalis	0	0	0	80	20.0
Persicaria pensylvanica	10	10	55	0	18.8
Phragmites australis	0	0	0	50	12.5
Eupatorium perfoliatum	40	0	0	0	10.0
Impatiens capensis	10	0	0	30	10.0
Phalaris arundinacea	0	40	0	0	10.0
Betula nigra	0	0	35	0	8.8
Echinochloa muricata	5	15	0	0	5.0
Quercus bicolor	20	0	0	0	5.0
Senna marilandica	0	20	0	0	5.0
Cornus amomum	0	15	0	0	3.8
Helenium autumnale	15	0	0	0	3.8
Helianthus strumosus	15	0	0	0	3.8
Leersia oryzoides	15	0	0	0	3.8
Microstegium vimineum	0	0	0	15	3.8
Setaria faberi	15	0	0	0	3.8
Bidens cernua	10	0	0	0	2.5
Erechtites hieraciifolius	0	0	10	0	2.5
Verbena hastata	10	0	0	0	2.5
Panicum virgatum	5	0	0	0	1.3
Percent Cover	**100**	**100**	**100**	**100**	**100.0**
Total Cover	**170**	**100**	**100**	**175**	**136.3**

SUBSECTION 4.2 WETLAND ENHANCEMENT AREA PLOTS

Four (4) quadrats were also established in representative locations throughout the wetland enhancement area. At the time of inspection, the wetland enhancement area possessed 100% vegetative cover and 154.5% total cover (**Table 6**), satisfying the requisite 85% vegetative cover threshold. Total cover increased by 43.5% between

2021 and 2022. No barren ground was observed and all plots were well-established with a diverse native herbaceous plant community. The increasing total vegetative cover is indicative of a site that is (1) on a positive developmental trajectory, and (2) the continued establishment of a diverse assemblage of native species throughout the wetland enhancement portions of the restoration project supports the position that the wetland enhancement areas possess suitable substrate and hydrology resulting in a structurally diverse plant assemblage. All four plots in the wetland enhancement area possessed greater than 100% total herbaceous cover. The species richness was high (n = 22), and additional recruitment occurred when compared to 2021 (n=17). The most prevalent species included black willow (32.5%), river birch (10%), Canadian clearweed (*Pilea pumila,* FACW) (6.25%), shallow sedge (*Carex lurida*, OBL) (6.25%), and Pennsylvania smartweed (5%).

Overall, the results of the second monitoring inspection indicate that the wetland enhancement area is on a positive developmental trajectory, given the high vegetative cover, species richness, and a plant community comprised of native and target hydrophytes. Further, the positive developmental trajectory is anticipated to continue moving forward, satisfying the established goals for the Site to be deemed a success.

Table 6. Wetland Enhancement Area Percent Vegetative Cover

Species	Wetland Enhancement Plot				Mean % Cover
	W1	W2	W4	W8	
Barren Soil	0	0	0	0	0
Salix nigra	0	5	70	55	32.5
Leersia oryzoides	20	0	50	0	17.5
Microstegium vimineum	0	0	0	70	17.5
Impatiens capensis	0	60	0	0	15.0
Betula nigra	0	0	0	40	10.0
Persicaria punctata	0	20	15	5	10.0
Carex lurida	20	0	5	0	6.3
Phragmites australis	15	0	5	5	6.3
Pilea pumila	25	0	0	0	6.3
Persicaria pensylvanica	0	20	0	0	5.0
Verbena hastata	0	20	0	0	5.0
Carex lupulina	0	0	15	0	3.8
Typha latifolia	0	0	15	0	3.8
Arthraxon hispidus	0	10	0	0	2.5
Epilobium coloratum	0	0	10	0	2.5
Scirpus atrovirens	10	0	0	0	2.5
Scirpus cyperinus	10	0	0	0	2.5
Cephalanthus occidentalis	0	0	5	0	1.3
Juncus effusus	5	0	0	0	1.3
Lythrum salicaria	5	0	0	0	1.3
Solidago altissima	0	5	0	0	1.3
Solanum dulcamara	0	0	3	0	0.8
Percent Cover	**100**	**100**	**100**	**100**	**100.0**
Total Cover	**110**	**140**	**193**	**175**	**154.5**

SUBSECTION 4.3 WOODY PLANT SURVIVORSHIP

As shown in **Table 7**, the woody plant survivorship of the entire wetland restoration area was 85.1%, which meets the 85% survivorship threshold stipulated by the permit.

Table 7. Wetland Restoration Area Woody Plant Survivorship

Scientific Name	Common Name	Number Installed	Quantity Observed	Survivorship (%)
Acer rubrum	Red maple	20	31	>100.0
Betula nigra	River birch	40	82	>100.0
Platanus occidentalis	American sycamore	60	82	>100.0
Quercus bicolor	Swamp white oak	95	70	73.7
Quercus palustris	Pin oak	95	60	63.2
Salix nigra	Black willow	75	169	>100.0
Alnus serrulata	Smooth alder	35	15	42.9
Aronia arbutifolia	Red chokecherry	65	17	26.2
Cephalanthus occidentalis	Common buttonbush	15	8	53.3
Cornus amomum	Silky dogwood	65	40	61.5
Ilex verticillata	Winterberry holly	50	6	12.0
Rosa palustris	Swamp rose	30	8	26.7
Salix discolor	Pussy willow	65	16	24.6
Total		**710**	**604**	**85.1**

The species with the highest survivorship (>100%) were red maple, river birch, American sycamore, and black willow, while the species with the lowest survivorship was winterberry holly (12%). Survivorship declined from 97.6% in 2021 to 85.1% in 2022. This decline is likely attributable to (1) the long-term drought the mid-Atlantic region was subjected to during the majority of the growing season, and (2) evidence of deer browse was observed. The drought conditions of 2022 contributed to the dryer hydrologic regime which provided the opportunity for American burnweed (*Erechtites hieraciifolius*) to establish within the wetland enhancement area in the eastern portion of the Site. This native annual species grew in a tall (>7'), dense patch and was observed to shade out smaller installed woody species that require full-sun conditions, such as swamp rose. Despite this, black willow, red maple, American sycamore, and river birch continued to colonize the Site with each species possessing greater stem numbers than was initially installed. For example, seventy-five (75) black willow saplings were installed, but one hundred and sixty-nine (169) viable black willow saplings were observed in 2022.

While mortality was noticeable for some of the installed woody species between 2021 and 2022, this is not unexpected as a species ability to establish and proliferate on any given site is driven by a myriad of environmental conditions. These observations are typically magnified during the first few years of establishment where any individual species ability to adapt to a Site become evident early in this process. The fact that the Site possesses greater than 85% survivorship of installed woody species supports the position that both the substrate and hydrology are sufficient to support woody species acclimated to a wet hydrologic regime. If additional woody species plantings are warranted moving forward, selected species would only include those that have shown an aptitude for this Site's underlying environmental variables.

SUBSECTION 4.4 UNDESIRABLE PLANT SPECIES

As outlined within the wetland creation and wetland enhancement discussions above, undesirable non-native species were observed within the wetland creation and restoration plots. Specifically, the following undesirable plant species were observed within the plots: common reed, Japanese stiltgrass, purple loosestrife (*Lythrum salicaria,* FACW), Japanese bristlegrass, small carpetgrass (*Arthraxon hispidus*, FAC), and reed canarygrass.

Overall invasive species cover increased within the wetland monitoring plots by 12.8% between 2021 and 2022 (**Tables 5 and 6**). While a limited number of invasive species were present, they were not ubiquitous, with certain plots having higher instances of undesirable species cover. For instance, wetland creation area plot W-7 had high vegetative cover of common reed (50%) and Japanese stiltgrass (15%) under a desirable American sycamore canopy. Wetland creation area plot W-5 had high vegetative cover of reed canarygrass (40%), and wetland enhancement area plot W-8 had high cover of Japanese stiltgrass (70%). However, the other five wetland monitoring plots were not dominated by any invasive species, and if they were present, they occurred in very low quantities. Additionally, reductions in invasive species areal coverage within these plots and associated wetland areas are anticipated to occur naturally as vegetation on Site continues to mature, reducing the amount of direct sunlight reaching the understory and herbaceous plant layers.

In addition to the undesirable non-native species listed above, the following undesirable non-native species were observed in small numbers scattered around the Site: watercress (*Nasturtium officinale*, OBL), yellow iris (*Iris pseudacorus*, OBL), Canada thistle (*Cirsium arvense*, FACU), multiflora rose (*Rosa multiflora*, FACU), autumn olive (*Elaeagnus umbellata*, NL), and charlock mustard (*Sinapis arvensis,* NL).

To address the presence of undesirable non-native species, Princeton Hydro targeted these species with a herbicide application occurring on October 7th, 2022. It is anticipated that these efforts will (1) prevent the continued establishment of undesirable non-native species, and (2) facilitate continued development of desirable native species. Additionally, as the installed woody material continues to mature it is anticipated that the presence of undesirable non-native species will concomitantly reduce in areal coverage as they require a full sun regime to proliferate. The continued need for implementation of adaptive management efforts related

to the presence of undesirable non-native species will continue to be monitored moving forward with additional herbicide applications targeting these species on an as warranted basis.

SUBSECTION 4.5 SOILS AND HYDROLOGY

As outlined by the U.S. Department of Agriculture (1988), "*a hydric soil is a soil in which the surface horizons are saturated, flooded or ponded long enough during the growing season to develop anaerobic conditions.*" Hydric soils have a water table at less than 1 foot from the surface for a significant period, typically a week or more, during the growing season (U.S. Army Corps of Engineers, 1987).

The project has been designed to support wetland creation and enhancement areas, and to enhance the floodplain and hydrologic re-connectivity associated with Aquetong Creek and its tributary (See Appendix III, Photos 5 and 7). The planting plans were informed by on-Site hydrology, specifically, most plants targeted for and installed within the wetland restoration areas are classified as facultative (FAC), facultative wetland (FACW), or obligate (OBL). Currently, the herbaceous species present within the seed mix are well-established especially in the periodically inundated zones of the wetland creation area which suggests that the hydrology is adequate to support hydrophytic plant species (See Appendix III, Photos 3 and 13). The existing wetland areas are supporting obligate hydrophytes, including jewelweed, woolgrass (*Scirpus cyperinus*, FACW), pussy willow, black willow, swamp smartweed, shallow sedge, and rice cutgrass (See Appendix III, Photos 2, 4, 9, and 11). The initial establishment of hydrophytic vegetation within the wetland creation and wetland enhancement areas supports the position that a suitable wetland hydrologic regime is present within the Site.

SUBSECTION 4.6 WILDLIFE UTILIZATION

During the Site inspections conducted during the Spring and Fall of the 2022 growing season, a wide variety of avian, fish, amphibian, mammal, and insect species were observed utilizing the Site, specifically the wetland restoration areas. During the May 26th Site inspection a wide variety of avian species, including species that rely on wetlands, were observed, indicating usage of the wetland restoration area for breeding. Among the most notable species were willow flycatcher (*Empidonax traillii*), yellow warbler (*Setophaga petechia*), warbling vireo (*Vireo gilvus*), and red-winged blackbird (*Agelaius phoeniceus*), all of which breed nearly exclusively in wetlands and riparian areas in Pennsylvania. In addition to wetland and riparian specialists, a number of shrub and edge species were observed utilizing the habitat in the wetland creation area including: orchard oriole (*Icterus spurius*), Baltimore oriole (*Icterus galbula*), indigo bunting (*Passerina cyanea*), cedar waxwing (*Bombycilla cedrorum*), great crested flycatcher (*Myiarchus crinitus*) eastern bluebird (*Sialia sialis*), eastern kingbird (*Tyrannus tyrannus*), chipping sparrow (*Spizella passerina*), house wren (*Troglodytes aedon*), Carolina wren (*Thryothorus ludovicianus*), song sparrow (*Melospiza melodia*), and American goldfinch (*Spinus tristis*). Additionally, mallard (*Anas platyrhynchos*), belted kingfisher (*Megaceryle alcyon*), and great blue heron (*Ardea herodias*) were observed utilizing the pools and open water of Aquetong Creek for foraging. The assemblage and diversity of avian species utilizing the wetland restoration areas indicate that the Site is providing quality habitat and is important to local avifauna.

Brook trout (*Salvelinus fontinalis*), ranging in size from 4 to 15 inches, were observed throughout Aquetong Creek with schools of fingerlings concentrated in the deeper portions of the creek in the eastern portion of the Site. Largemouth bass (*Micropterus salmoides*), ranging in size from 3 to 10 inches, were observed utilizing the tributary. The larger individuals were observed occupying the outfall pool just south of Route 202. Other fish species observed throughout the Site included creek chub (*Semotilus atromaculatus*), panfish (*Lepomis sp.*), and longnose dace (*Rhinichthys cataractae*). A number of green frog (*Lithobates clamitans*) and pickerel frog (*Lithobates palustris*) were also observed throughout the wetland and creek areas of the Site. Tadpoles occupied the little to no flow areas of the deep pool sections of Aquetong Creek. Eastern pondhawk (*Erythemis*

simplicicollis) and jewelwing (*Calopteryx maculata)* was observed utilizing Aquetong Creek and the herbaceous vegetation within the wetland creation and wetland enhancement areas.

White-tailed deer (*Odocoileus virginianus*) was observed within the upland portions of the Site. Groundhog (*Marmota monax*) and eastern cottontail (*Sylvilagus floridanus*) was observed in multiple portions of both the wetland enhancement and wetland creation areas. Eastern meadow vole (*Microtus pennsylvanicus*) and red fox (*Vulpes vulpes*) was observed in the wetland enhancement area along the southern bank of Aquetong Creek.

SUBSECTION 4.7 ADDITIONAL OBSERVATIONS

In vast contrast to 2021, almost no spotted lanternflies (*Lycorma delicatula)* were observed infesting the mature trees, such as black willows, on-Site. Due to drought conditions during the growing season in 2022, the dryer hydrologic regime provided the opportunity for a different suite of species to establish. For example, American burnweed, an annual, comprised a large portion of the wetland enhancement area along the northern bank of Aquetong Creek in the eastern part of the Site. The proliferation of this native species grew in excess of seven (7) feet tall, which shaded out smaller installed woody species and herbaceous hydrophytic vegetation.

SECTION 5: DISCUSSION AND RECOMMENDATIONS

As of September 2022, the wetland creation area possessed 100% vegetative cover and 136.3% total cover and the wetland enhancement area possessed 100% total cover and 154.5% total cover, with species composition and abundance primarily driven by hydrophytic native herbaceous and woody species. Both areas supported the installed seed mix, herbaceous plugs, and woody species. The average vegetative and total cover of the wetland restoration area is 100% and 145.4%, respectively.

The observed survivorship of woody plants within the wetland restoration area was 85.1%, which meets the 85% survivorship threshold. The high survivorship is primarily driven by the continued development and recruitment red maple, river birch, American sycamore, and black willow.

Non-native, undesirable species increased by 12.8% between 2021 to 2022 (**Tables 5 and 6**). Invasive species occurring within the wetland creation and restoration area included common reed, Japanese stiltgrass, purple loosestrife, Japanese bristlegrass, small carpetgrass, and reed canarygrass, with a small number of additional invasive species documented on-Site in areas outside of the wetland monitoring plots. While invasive cover was high at a select few monitoring plots, the majority had very little to no invasive species present and were dominated by desirable native hydrophytes. The Site's location is likely a contributing factor when analyzing the presence of invasive species as one of the hydrologic inputs for the Site is via a tributary that receives stormwater runoff from both Route 202 and surrounding developments, both of which are well documented sources of input for invasive species. As discussed above, monitoring of invasive species presence will continue moving forward with additional herbicide applications occurring on an as warranted basis.

To address increasing invasive species cover on-Site, Princeton Hydro applied herbicide on October 7th, 2022, with the effort targeting these previously documented undesirable species. It is anticipated that, as the Site continues to develop, the desirable native species will continue to proliferate and spread into areas previously treated with herbicide. As warranted, additional herbicide applications will occur moving forward.

Overall, the Site is on a positive developmental trajectory, as evidenced by the diverse suite of desirable native species; structural diversity; and Site utilization by breeding avifauna that require specific habitat attributes associated with the presence of desirable native species and structural diversity. Equally important is the presence of a suitable hydrological regime that supports the development of hydrophytic plant species, both

herbaceous and woody. It is anticipated that this positive developmental trajectory will continue moving forward, ultimately resulting in the restoration areas satisfying the conditions set forth by the PADEP Restoration Waiver 16 and accompanying statutes.

SECTION 6: REFERENCES

Environmental Laboratory. 2012. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0). U.S. Army Engineer Research and Development Center, Vicksburg, MS.

F.X. Browne, Inc. 2004. Ingham Spring Dam Removal Study.

Princeton Hydro, LLC. June 2019. *Aquetong Creek Restoration Project Environmental Assessment Addendum*. Last updated September 2019.

United States Army Corps of Engineers (USACE). 2020. The National Wetland Plant List, Version 3.5. https://cwbi-app.sec.usace.army.mil/nwpl_static/v34/home/home.html#

APPENDIX I

PLANT SPECIES LIST

PLANT SPECIES LIST

The following is a list of plant species that occur at the Aquetong Spring Park Restoration Project located in Solebury Township, Bucks County, Pennsylvania. Nomenclature follows the National Wetland Plant List: 2020 wetland ratings (USACE 2020) for the Eastern Mountains and Piedmont Region. NA = Not Applicable, NI = No Indicator, NL = Not Listed.

Scientific Name	Common Name	Indicator Status
Aceraceae	**Maple Family**	
Acer negundo	Boxelder	FAC
Acer rubrum	Red maple	FAC
Acer saccharinum	Silver maple	FACW
Alismataceae	**Water-Plantain Family**	
Sagittaria latifolia	Broadleaf arrowhead	OBL
Anacardiaceae	**Sumac Family**	
Toxicodendron radicans	Eastern poison ivy	FAC
Apocynaceae	**Dogbane Family**	
Apocynum cannabinum	Indianhemp	FACU
Aquifoliaceae	**Holly Family**	
Ilex opaca	American holly	FACU
Ilex verticillata	Common winterberry	FACW
Asclepiadaceae	**Milkweed Family**	
Asclepias incarnata	Swamp milkweed	OBL
Asclepias syriaca	Common milkweed	FACU
Asteraceae/Compositae	**Aster Family**	
Ageratina altissima	White snakeroot	FACU
Ambrosia artemisiifolia	Annual ragweed	FACU
Artemisia vulgaris	Common wormwood	UPL
Bidens cernua	Nodding beggartick	OBL
Bidens frondosa	Devil's beggartick	FACW
Cirsium arvense	Canada thistle	FACU
Erechtites hieraciifolius	American burnweed	NL
Erigeron philadelphicus	Philadelphia fleabane	FACU
Eupatorium perfoliatum	Common boneset	FACW
Helenium autumnale	Common sneezeweed	FACW
Helianthus strumosus	Paleleaf woodland sunflower	FACU
Rudbeckia laciniata	Cutleaf coneflower	FACW
Solidago altissima	Tall goldenrod	FACU
Symphyotrichum lateriflorum	Calico aster	FACW

Scientific Name	Common Name	Indicator Status
Symphyotrichum novae-angliae	New England aster	FACW
Symphyotrichum puniceum	Purplestem aster	OBL
Balsaminaceae	**Touch-Me-Not Family**	
Impatiens capensis	Jewelweed	FACW
Betulaceae	**Birch Family**	
Alnus serrulata	Smooth alder	OBL
Betula nigra	River birch	FACW
Boraginaceae	**Borage Family**	
Hackelia virginiana	Beggar's-lice	FACU
Myosotis scorpioides	True forget-me-not	OBL
Brassicaceae/Cruciferae	**Mustard Family**	
Alliaria petiolata	Garlic mustard	FACU
Cardamine bulbosa	Bulbous bittercress	OBL
Cardamine hirsute	Hairy bittercress	FACU
Cardamine impatiens	Narrowleaf bittercress	FAC
Nasturtium officinale	Watercress	OBL
Sinapis arvensis	Charlock mustard	NL
Thlapsi arvense	Field pennycress	UPL
Buddlejaceae	**Butterfly-bush Family**	
Buddleka davidii	Orange-eye butterfly-bush	FACU
Caprifoliaceae	**Honeysuckle Family**	
Lonicera japonica	Japanese honeysuckle	FACU
Viburnum dentatum	Southern arrowwood	FAC
Viburnum sieboldii	Siebold's viburnum	NL
Cornaceae	**Dogwood Family**	
Cornus amomum	Silky dogwood	FACW
Cucurbitaceae	**Cucumber Family**	
Sicyos angulatus	One-seed bur cucumber	FACU
Cupressaceae	**Cypress Family**	
Juniperus virginiana	Eastern redcedar	FACU
Cyperaceae	**Sedge Family**	
Carex comosa	Longhair sedge	OBL
Carex crinita	Fringed sedge	OBL
Carex gracillima	Graceful sedge	FACU
Carex hystericina	Bottlebrush sedge	OBL

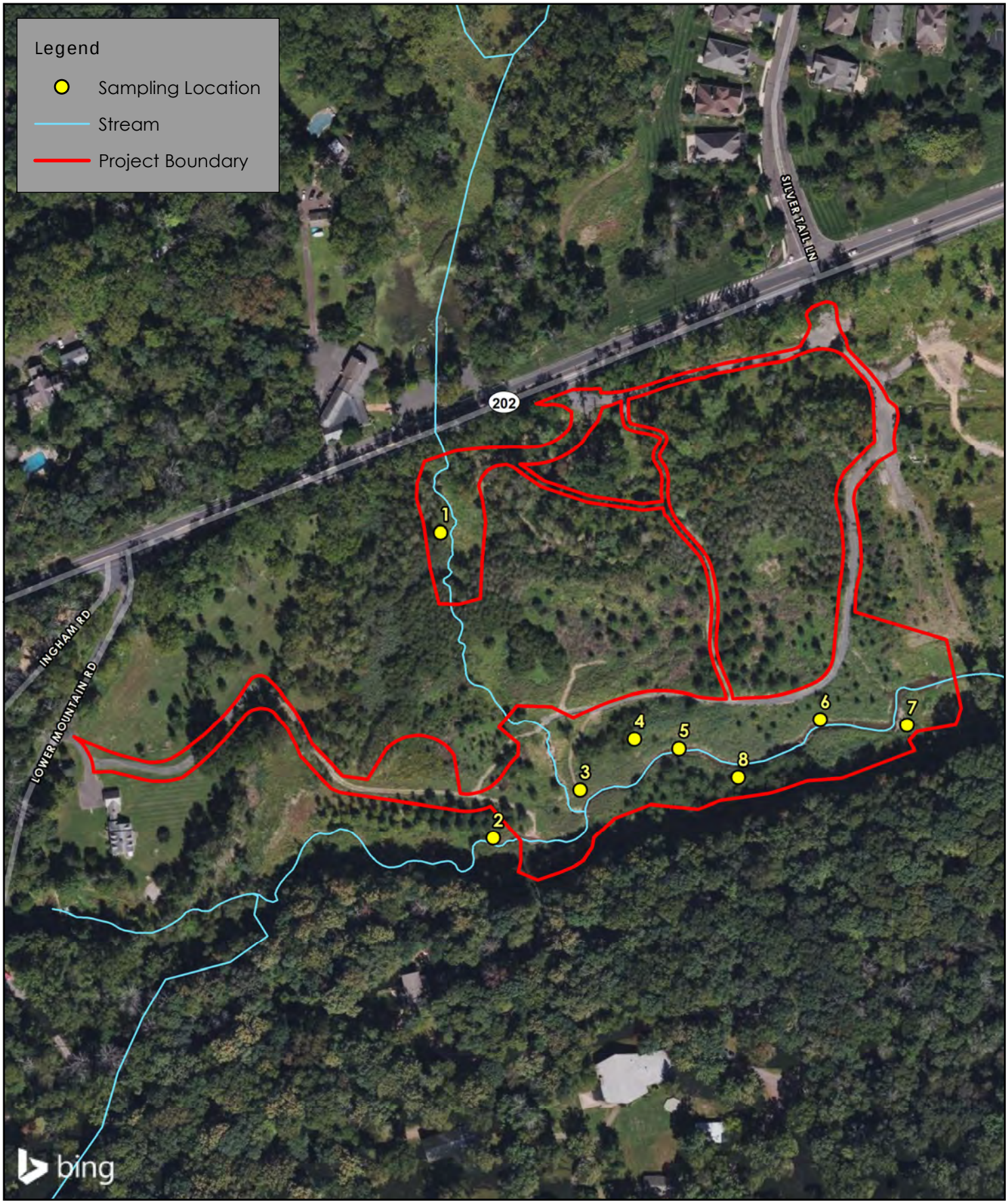
Scientific Name	Common Name	Indicator Status
Carex lupulina	Hop sedge	OBL
Carex lurida	Shallow sedge	OBL
Carex scoparia	Broom sedge	FACW
Carex vulpinoidea	Fox sedge	OBL
Schoenoplectus tabernaemontani	Softstem bulrush	OBL
Scirpus atrovirens	Green bulrush	OBL
Scirpus cyperinus	Woolgrass	FACW
Elaeagnaceae	**Oleaster Family**	
Elaeagnus angustifolia	Russian olive	FACU
Elaeagnus umbellata	Autumn olive	NL
Fabaceae/Leguminosae	**Pea Family**	
Robinia pseudoacacia	Black locust	FACU
Senna hebecarpa	American senna	FAC
Senna marilandica	Maryland senna	FAC
Trifolium repens	White clover	FACU
Fagaceae	**Beech Family**	
Quercus bicolor	Swamp white oak	FACW
Quercus palustris	Pin oak	FACW
Quercus phellos	Willow oak	FAC
Iridaceae	**Iris Family**	
Iris versicolor	Harlequin blueflag	OBL
Iris pseudacorus	Paleyellow iris	OBL
Juglandaceae	**Walnut Family**	
Juglans nigra	Black walnut	FACU
Juncaceae	**Rush Family**	
Juncus effusus	Common rush	FACW
Juncus tenuis	Path rush	FAC
Lemnaceae	**Duckweed Family**	
Lemna minor	Common duckweed	OBL
Liliaceae	**Lily Family**	
Allium vineale	Wild garlic	FACU
Lythraceae	**Loosestrife Family**	
Lythrum salicaria	Purple loosestrife	FACW

Scientific Name	Common Name	Indicator Status
Magnoliaceae	**Magnolia family**	
Liriodendron tulipifera	Tuliptree	FACU
Oleaceae	**Olive Family**	
Fraxinus pennsylvanica	Green ash	FACW
Onagraceae	**Evening Primrose family**	
Chamerion angustifolium	Fireweed	FAC
Epilobium coloratum	Purpleleaf willowherb	FACW
Phytolaccaceae	**Pokeweed Family**	
Phytolacca americana	American pokeweed	FACU
Poaceae / Gramineae	**Grass Family**	
Arthraxon hispidus	Small carpetgrass	FAC
Bromus inermis	Smooth brome	UPL
Calamagrostis canadensis	Bluejoint grass	FACW
Cinna arundinacea	Woodreed	FACW
Dichanthelium clandestinum	Deertongue	FACW
Echinochloa muricata	Rough barnyard grass	OBL
Elymus virginicus	Virginia wildrye	FACW
Leersia oryzoides	Rice cutgrass	OBL
Lolium multiflorum	Italian ryegrass	NL
Microstegium vimineum	Nepalese browntop	FAC
Panicum dichotoflorum	Fall panicgrass	FACW
Panicum virgatum	Switchgrass	FAC
Poa pratensis	Kentucky bluegrass	FACU
Phalaris arundinacea	Reed canarygrass	FACW
Phragmites australis	Common reed	FACW
Schedonorus arundinaceus	Tall fescue	FACU
Setaria faberi	Japanese bristlegrass	UPL
Tridens flavus	Purpletop tridens	FACU
Polygonaceae	**Buckwheat Family**	
Persicaria hydropiperoides	Swamp smartweed	OBL
Persicaria pensylvanicum	Pennsylvania smartweed	FACW
Persicaria punctata	Dotted smartweed	OBL
Polygonum persicaria	Spotted lady's-thumb	FACW
Rumex obtusifolius	Bitter dock	FACU
Potamogetonaceae	**Pondweed Family**	
Potamogeton crispus	Curly pondweed	OBL
Platanaceae	**Plane-Tree Family**	
Platanus occidentalis	American sycamore	FACW

Scientific Name	Common Name	Indicator Status
Rosaceae	**Rose Family**	
Amelanchier canadensis	Canadian serviceberry	FAC
Aronia arbutifolia	Red chokecherry	FACW
Rosa multiflora	Multiflora rose	FACU
Rosa palustris	Swamp rose	OBL
Rubus phoenicolasius	Wine raspberry	FACU
Rubiaceae	**Madder Family**	
Cephalanthus occidentalis	Common buttonbush	OBL
Salicaceae	**Willow Family**	
Populus deltoides	Eastern cottonwood	FAC
Salix discolor	Pussy willow	FACW
Salix nigra	Black willow	OBL
Scrophulariaceae	**Figwort Family**	
Paulownia tomentosa	Princesstree	UPL
Penstemon digitalis	Foxglove beardtongue	FAC
Verbascum thapsus	Common mullein	FACU
Veronica anagallis-aquatica	Water speedwell	OBL
Simaroubaceae	**Quassia Family**	
Ailanthus altissima	Tree of heaven	FACU
Solanaceae	**Potato Family**	
Solanum dulcamara	Climbing nightshade	FAC
Typhaceae	**Cat-tail Family**	
Typha latifolia	Broadleaf cattail	OBL
Urticaceae	**Nettle Family**	
Boehmeria cylindrica	Smallspike false nettle	FACW
Pilea pumila	Canadian clearweed	FACW
Hydrocharitaceae	**Tape-grass Family**	
Vallisneria americana	American eelgrass	OBL
Verbenaceae	**Verbena Family**	
Verbena hastata	Swamp verbena	FACW
Verbena urticifolia	White vervain	FAC
Vitaceae	**Grape Family**	
Parthenocissus quinquefolia	Virginia creeper	FACU

APPENDIX II

SAMPLING PLOT LOCATIONS



File: P:\0388\Projects\0388011\GIS\MXD\Sampling_Locations.mxd, 11/18/2021, Drawn by bsmith, Copyright Princeton Hydro, LLC.

NOTES:
1. Sampling locations are approximate.
2. Project boundary obtained from Princeton Hydro planset titled "Aquetong Creek Restoration" dated 10/18/2019.
3. Aerial imagery obtained through ArcGIS Online Bing Maps (C) 2021 Microsoft Corporation and its data suppliers.

0 100 200 Feet

Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

SAMPLING LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING
www.PrincetonHydro.com

APPENDIX III

PHOTOGRAPHS

PHOTO LOCATION MAP

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 1

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
West

Comments:
General view of the diverse herbaceous layer on both banks of the tributary on-Site, including tall goldenrod (*Solidago altissima*) and black willow (*Salix nigra*).

Photograph ID: 2

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
East

Comments:
View of the well-established herbaceous community along the banks of Aquetong Creek featuring jewelweed (*Impatiens capensis*).

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 3

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northeast

Comments:
View of the wetland creation area along the northern bank of Aquetong Creek featuring tulip tree (*Liriodendron tulipifera*) and river birch (*Betula nigra*).

Photograph ID: 4

Date: Sept. 27, 2021

Location:
See photo location map.

Direction:
South

Comments:
View of the wetland enhancement area featuring the healthy (>5 ft.) installed woody species such as tulip poplar (left) and black willow (right).

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 5

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northeast

Comments:
View of the well-established herbaceous and woody vegetation within the wetland enhancement area along Aquetong Creek.

Photograph ID: 6

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
East

Comments:
View of the well-established hydrophytic vegetation within the wetland enhancement area along Aquetong Creek featuring pussy willow (*Salix discolor*).

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 7

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
West

Comments:
View of the diverse plant community within the wetland creation and enhancement areas along the banks of Aquetong Creek.

Photograph ID: 8

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
North

Comments:
Typical view of the wetland creation area within the eastern portion of the Site, featuring swamp white oak (*Quercus bicolor*) amidst a well-established hydrophytic herbaceous community.

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 9

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northwest

Comments:
View of the well-established black willow live stakes and American sycamore (background) within the wetland enhancement area in the eastern portion of the Site.

Photograph ID: 10

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northwest

Comments:
View of healthy woody material within the wetland enhancement area, including black willow, river birch (*Betula nigra*), and swamp white oak.

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 11

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northeast

Comments:
Closeup view of woolgrass (*Scirpus cyperinus*), a desirable hydrophyte, within the wetland enhancement area.

Photograph ID: 12

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
North

Comments:
Closeup view of a pin oak within a robust herbaceous community in the wetland enhancement area.

Photographic Log

Client: Solebury Township
Site Name: Aquetong Spring Park Restoration Project

Project Number: 0388.011
Site Location: Solebury Township, PA

Photograph ID: 13

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
Northeast

Comments:
General view of the diverse and well-established herbaceous layer within the wetland creation area along Aquetong Creek.

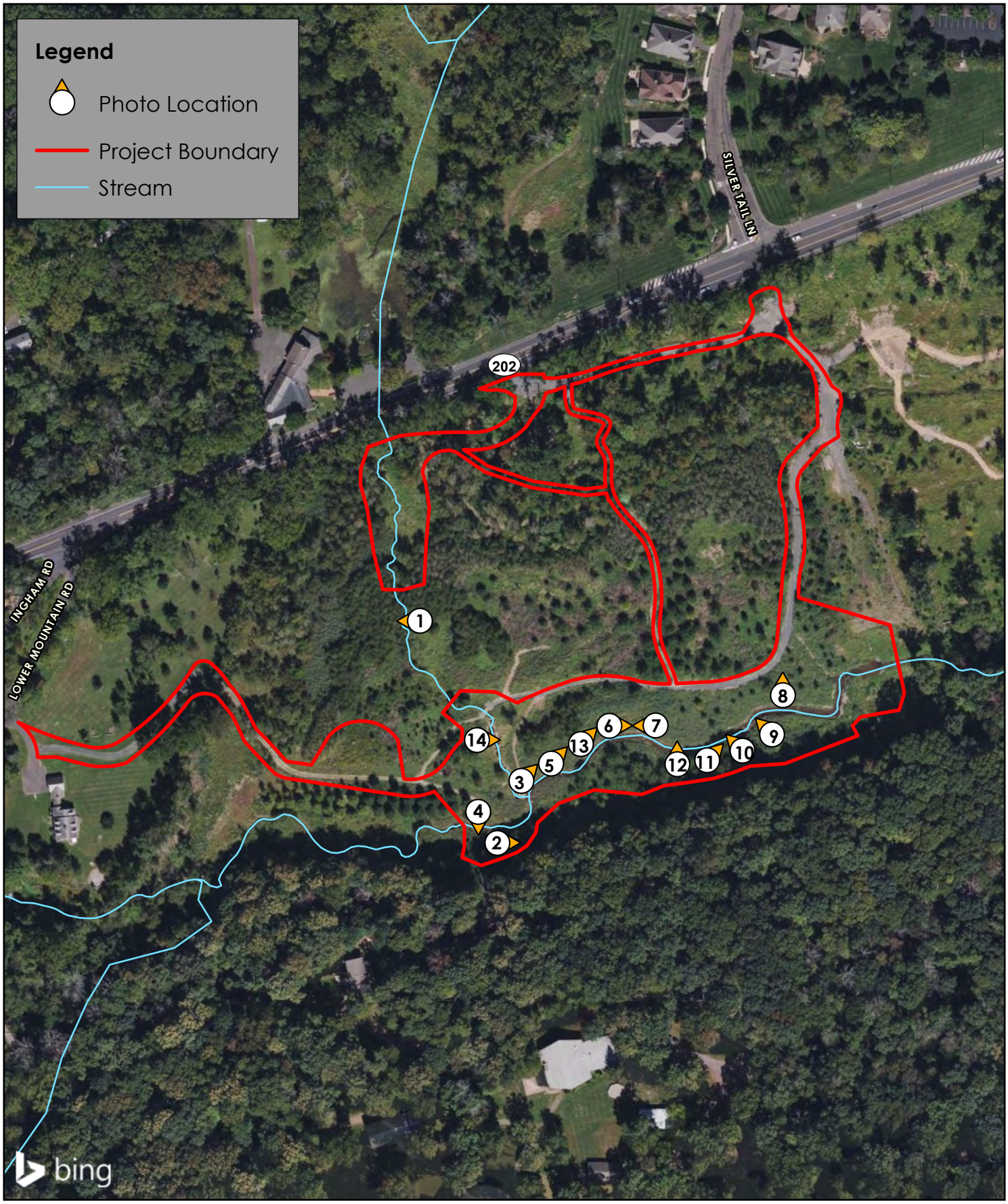
Photograph ID: 14

Date: Sept. 15, 2022

Location:
See photo location map.

Direction:
East

Comments:
Closeup view of a healthy silky dogwood (*Cornus amomum)* planting, jewelweed, and broadleaf cattail (*Typha latifolia*) along the bank of the tributary to Aquetong Creek.



NOTES:
1. Photo locations are approximate.
2. Project boundary obtained from Princeton Hydro planset titled "Aquetong Creek Restoration" dated 10/18/2019.
3. Aerial imagery obtained through ArcGIS Online Bing Maps (C) 2022 Microsoft Corporation and its data suppliers.

0 100 200 Feet

Map Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

PHOTO LOCATION MAP

AQUETONG CREEK RESTORATION PROJECT
WETLAND MITIGATION MONITORING
AQUETONG SPRING PARK
SOLEBURY TOWNSHIP
BUCKS COUNTY, PENNSYLVANIA

PRINCETON HYDRO
SCIENCE DESIGN ENGINEERING
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APPENDIX IV

PADEP CHAPTER 105 RESTORATION WAIVER 16 APPROVAL LETTER

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

October 23, 2019

Mr. Dennis Carney
Solebury Township
3092 Sugan Road
P.O. Box 139
Solebury, PA 18963

Re: Aquetong Creek Restoration Project
DEP File Nos. EA09-013 and WL0919301
APS No. 996246, AUTH ID No. 1278424
Solebury Township
Bucks County

Dear Mr. Carney:

The Department of Environmental Protection (DEP) has reviewed and approved the Environmental Assessment and Restoration Plan, including the 401 Water Quality Certification to restore and maintain approximately 1,200 linear feet of stream channel and to enhance the floodplain grading and riparian corridor along Aquetong Creek (Perennial, HQ-CWF). The southern limit of the site is located at the former terminus of the Aquetong Lake impoundment (Lambertville, NJ, USGS Quadrangle, Latitude: 40.354181N"; Longitude: -74.988711W").

This letter may be considered sufficient authorization for the proposed stream restoration plan with the following special conditions:

A. Stream and wetland restoration areas and wetland creation areas shall be monitored, and reports submitted to DEP, in accordance with the Mitigation Plan narrative included in the Environmental Assessment provided to DEP.

B. All Conservation Measures recommended in the Pennsylvania Department of Conservation and Natural Resource's review letter dated May 1, 2019, shall be incorporated into the project.

C. Temporary stream crossing(s) shall be constructed of suitable nonerodible material in order to prevent any road materials from washing out if structure is overtopped during periods of high water.

D. Streambank disturbance shall be kept to a minimum and stabilized with indigenous vegetation within 20 days of final earthmoving to prevent erosion and provide cover, shading, and food source for aquatic life.

E. All disturbed areas are to be restored to the original or proposed contours and shall be replanted with indigenous plant species.

F. Demolition or excavated materials shall not be deposited in any wetland, watercourse, floodway, floodplain, or other body of water without applying for and receiving the written permit of DEP.

G. Water pumped from the construction area shall be diverted into a sediment trap or basin, or into an appropriate vegetated filter area to prevent sediment from being discharged into any waters of the Commonwealth.

H. Upon discovery of significant changes that could compromise the integrity of the project, the permittee shall immediately notify DEP and the Bucks County Conservation District.

This authorization does not give any property rights, either in real estate or material, nor any exclusive privileges, nor shall it be construed to grant or confer any right, title, easement, or interest in, to, or over any land belonging to the Commonwealth of Pennsylvania; nor any infringement of Federal, State, or local laws or regulations.

Regarding Federal authorization, we have determined that your proposed work, if accomplished in accordance with the enclosed terms and conditions, is authorized by the Pennsylvania State Programmatic General Permit-5 (PASPGP-5). This PASPGP-5 verification provides U.S. Army Corps of Engineers authorization pursuant to Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act. This authorization may be subject to modification, suspension, or revocation if any of the information contained in the application, including the plans, is later found to be in error.

The enclosed list of conditions must be followed for purposes of the PASPGP-5 (Enclosure 1). A PASPGP-5 Permit Compliance, Self-Certification Form must be completed and returned to the appropriate Corps of Engineers office upon completion of construction (Enclosure 2).

Proper erosion and sediment control measure are required during and after construction and the adequacy of the measures can be determined by contacting the Bucks County Conservation District at 215.345.7577.

If you have any questions, you may contact Mr. Jason Oseredzuk at the address located in the first page footer or by telephone at 484.250.5158.

Sincerely,

John Hohenstein, P.E.
Regional Manager
Waterways and Wetlands

Enclosure

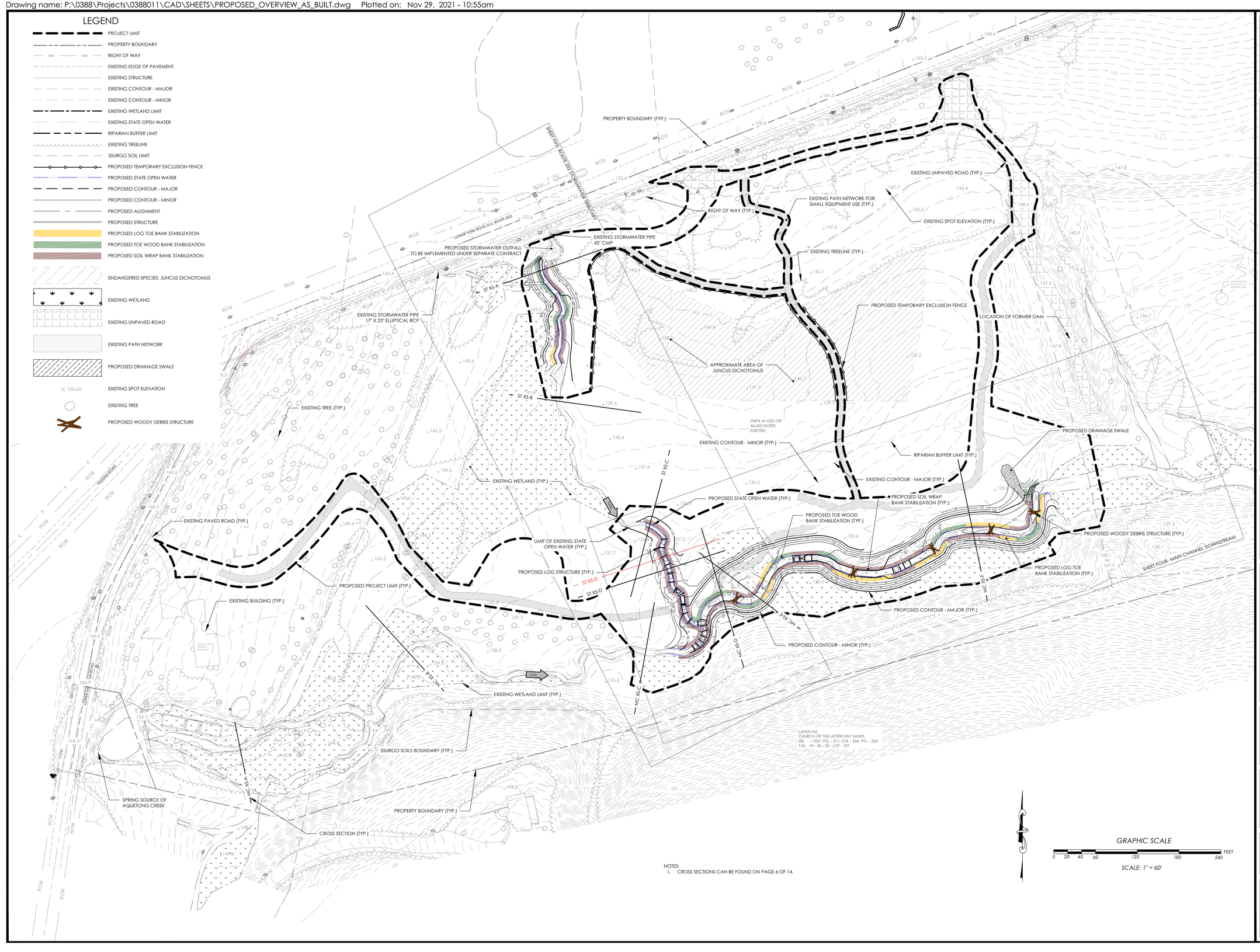
cc: Bucks County Conservation District
PA Fish and Boat Commission
Army Corps of Engineers
Mr. George - Princeton Hydro, LLC
Mr. Oseredzuk
Re 30 (GJS19WAW)296-10

APPENDIX V

SITE PLANS

LEGEND

- PROJECT LIMIT
- PROPERTY BOUNDARY
- RIGHT OF WAY
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING CONTOUR - MAJOR
- EXISTING CONTOUR - MINOR
- EXISTING WETLAND LIMIT
- EXISTING STATE OPEN WATER
- RIPARIAN BUFFER LIMIT
- EXISTING TREELINE
- SSURGO SOIL LIMIT
- PROPOSED TEMPORARY EXCLUSION FENCE
- PROPOSED STATE OPEN WATER
- PROPOSED CONTOUR - MAJOR
- PROPOSED CONTOUR - MINOR
- PROPOSED ALIGNMENT
- PROPOSED STRUCTURE
- PROPOSED LOG-TOE BANK STABILIZATION
- PROPOSED TOE WOOD BANK STABILIZATION
- PROPOSED SOIL WRAP BANK STABILIZATION
- ENDANGERED SPECIES: JUNCUS DICHOTOMUS
- EXISTING WETLAND
- EXISTING UNPAVED ROAD
- EXISTING PATH NETWORK
- PROPOSED DRAINAGE SWALE
- 105.63 EXISTING SPOT ELEVATION
- EXISTING TREE
- PROPOSED WOODY DEBRIS STRUCTURE



NOTES:
1. CROSS SECTIONS CAN BE FOUND ON PAGE 6 OF 14.

GRAPHIC SCALE
0 20 40 60 120 180 240 FEET
SCALE: 1" = 60'

CALL BEFORE YOU DIG!
PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL PENNSYLVANIA ONE CALL SYSTEM, INC. REFERENCE PENNSYLVANIA ACT 38
1-800-242-1776

PROJECT NOTES

1. THE VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), FEET. THE FOLLOWING CONVERSION FOR NAVD88 TO NGVD29 IS APPLICABLE FOR THIS LOCATION: NGVD29 = NAVD88 - 0.63 FT
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4. TOPGRAPHIC MAPPING OF THE STREAM PREPARED BY GEOTREK ENVIRONMENTAL AND SURVEYING, LLC IN APRIL OF 2019.
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6. FEMA FIRM NOT MAPPED SINCE DAM REMOVAL; NO FHA AREA AVAILABLE.
7. IN A RESPONSE DATED MAY 1, 2019 TO PNDI NO. 682836, PADCNR PROVIDED A MAP OUTLINING A POPULATION OF PA ENDANGERED JUCUS DICHOTOMUS. BY INSTALLING EXCLUSIONARY FENCING AROUND THIS AREA, NO IMPACT ANTICIPATED.
8. 150-FT RIPARIAN BUFFER DETERMINED IN ACCORDANCE WITH 25 PA CODE CHAPTER 102.14
9. AS-BUILT DATA COLLECTED BY PRINCETON HYDRO ON OCTOBER 22, 2020 AND OCTOBER 15, 2021.

DATE	DESCRIPTION
10/10/19	REVISED PER BUCKS COUNTY CONSERVATION DISTRICT COMMENTS
7/25/19	REVISED FOR CONSTRUCTION CLARITY

REVISIONS

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

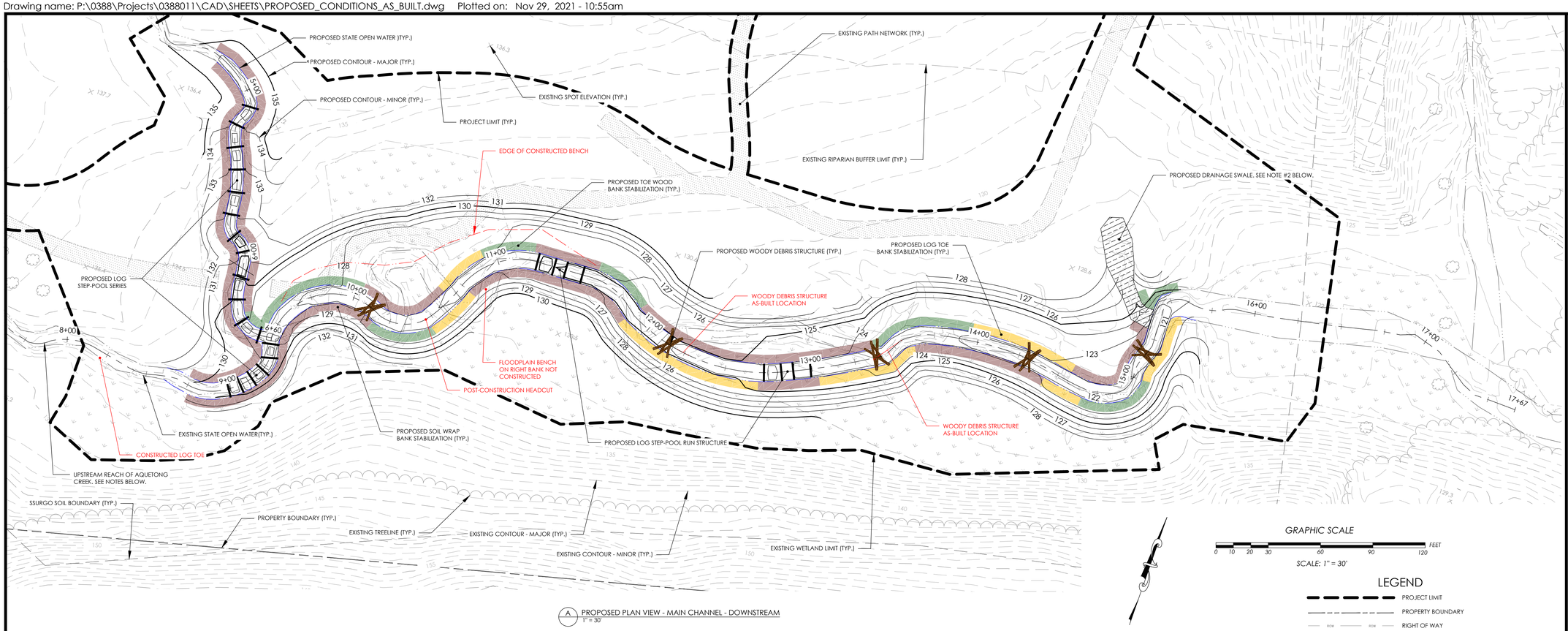
PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

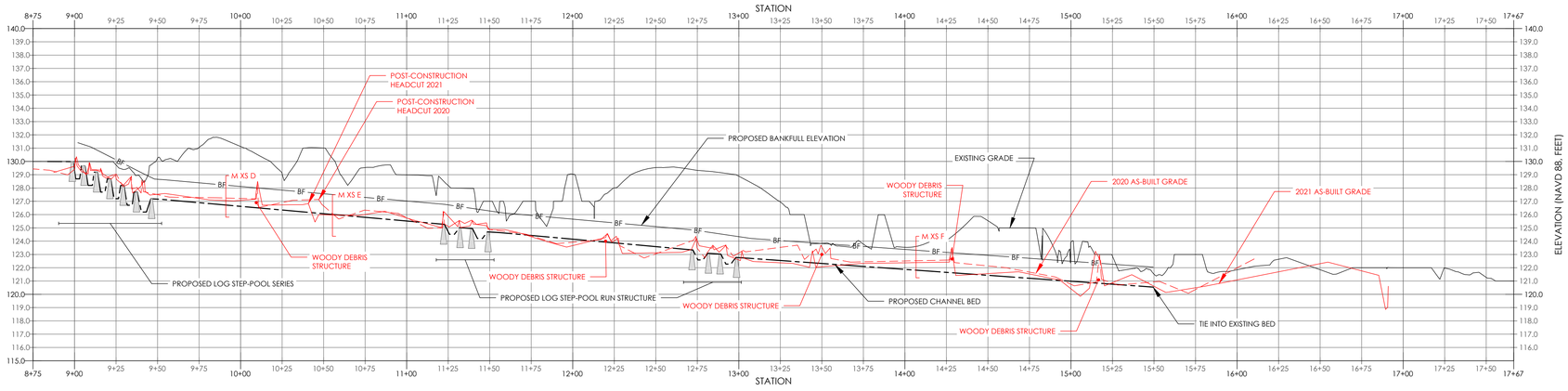
DRAWING NAME:
PROPOSED CONDITIONS OVERVIEW

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	1"=60'
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

SHEET NO.
3 OF 15



A PROPOSED PLAN VIEW - MAIN CHANNEL - DOWNSTREAM
1" = 30



B PROPOSED PROFILE - MAIN CHANNEL - DOWNSTREAM
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (8X VERT. EX.)

GRAPHIC SCALE
H: 1" = 40'
V: 1" = 5'
(8X VERT. EXAG.)
0 10 20 30 40 80 FEET

NOTES:

1. ACTIVE EROSION IS OCCURRING THROUGHOUT THE REACH OF AQUETONG CREEK UPSTREAM OF STATION 08+75, HOWEVER NO TREATMENT OR ACTIVE RESTORATION IS CURRENTLY PROPOSED. IF TREATMENT IS NEEDED IN THE FUTURE, IT SHALL BE COMPLETED UNDER SEPARATE COVER.
2. THE DRAINAGE SWALE SHALL BE STABILIZED USING STEP POOLS CONSTRUCTED FROM EXCESS LOGS AND ROCKS. THESE STEP POOLS SHALL BE FIELD FIT BASED ON THE FIELD CONDITIONS AT THE TIME OF CONSTRUCTION AND AS DIRECTED BY ONSITE ENGINEER. THE STEP POOLS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A ON SHEET 7 OF 15.
3. THE TWO CULVERTS UNDER ROUTE 202 DRAINING INTO THE 202 STORMWATER TRIBUTARY SHALL BE STABILIZED UNDER A SEPARATE CONTRACT.

GRAPHIC SCALE
0 10 20 30 60 90 120 FEET
SCALE: 1" = 30'

LEGEND

- PROJECT LIMIT
- PROPERTY BOUNDARY
- RIGHT OF WAY
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING CONTOUR - MAJOR
- EXISTING CONTOUR - MINOR
- EXISTING WETLAND LIMIT
- EXISTING STATE OPEN WATER
- RIPARIAN BUFFER LIMIT
- EXISTING TREELINE
- SSURGO SOIL LIMIT
- PROPOSED TEMPORARY EXCLUSION FENCE
- PROPOSED STATE OPEN WATER
- PROPOSED CONTOUR - MAJOR
- PROPOSED CONTOUR - MINOR
- PROPOSED ALIGNMENT
- PROPOSED STRUCTURE
- PROPOSED LOG TOE BANK STABILIZATION
- PROPOSED TOE WOOD BANK STABILIZATION
- PROPOSED SOIL WRAP BANK STABILIZATION
- PROPOSED CHANNEL BED
- PROPOSED BANKFULL ELEVATION
- ENDANGERED SPECIES: JUNCUS DICHOTOMUS
- EXISTING WETLAND
- EXISTING UNPAVED ROAD
- EXISTING PATH NETWORK
- PROPOSED DRAINAGE SWALE
- EXISTING SPOT ELEVATION
- EXISTING TREE
- PROPOSED WOODY DEBRIS STRUCTURE
- 2020 AS-BUILT GRADE
- 2021 AS-BUILT GRADE

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1-800-242-1776

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7/25/19	REVISED FOR CONSTRUCTION CLARITY

REVISIONS

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

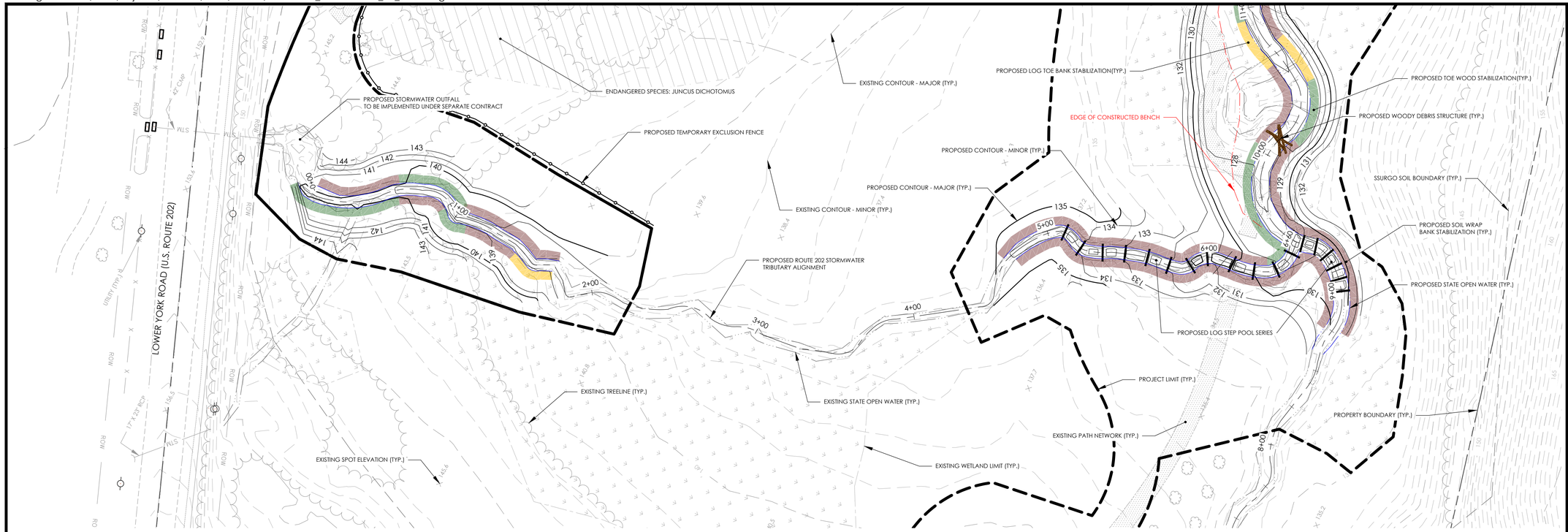
PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

DRAWING NAME:
PROPOSED CONDITIONS-MAIN CHANNEL DOWNSTREAM

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

SHEET NO.
4 OF 15



A PROPOSED PLANVIEW - STORMWATER TRIBUTARY
1" = 30'

GRAPHIC SCALE
0 10 20 30 60 90 120 FEET
SCALE: 1" = 30'

LEGEND

- PROJECT LIMIT
- PROPERTY BOUNDARY
- RIGHT OF WAY
- EXISTING EDGE OF PAVEMENT
- EXISTING STRUCTURE
- EXISTING CONTOUR - MAJOR
- EXISTING CONTOUR - MINOR
- EXISTING WETLAND LIMIT
- EXISTING STATE OPEN WATER
- RIPARIAN BUFFER LIMIT
- EXISTING TREELINE
- SSURGO SOIL LIMIT
- PROPOSED TEMPORARY EXCLUSION FENCE
- PROPOSED STATE OPEN WATER
- PROPOSED CONTOUR - MAJOR
- PROPOSED CONTOUR - MINOR
- PROPOSED ALIGNMENT
- PROPOSED STRUCTURE
- PROPOSED LOG TOE BANK STABILIZATION
- PROPOSED TOE WOOD BANK STABILIZATION
- PROPOSED SOIL WRAP BANK STABILIZATION
- PROPOSED CHANNEL BED
- BF — PROPOSED BANKFULL ELEVATION
- ENDANGERED SPECIES: JUNCUS DICHOTOMUS
- EXISTING WETLAND
- EXISTING UNPAVED ROAD
- EXISTING PATH NETWORK
- PROPOSED DRAINAGE SWALE
- × 105.63 — EXISTING SPOT ELEVATION
- EXISTING TREE
- PROPOSED WOODY DEBRIS STRUCTURE
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- 2021 AS-BUILT GRADE

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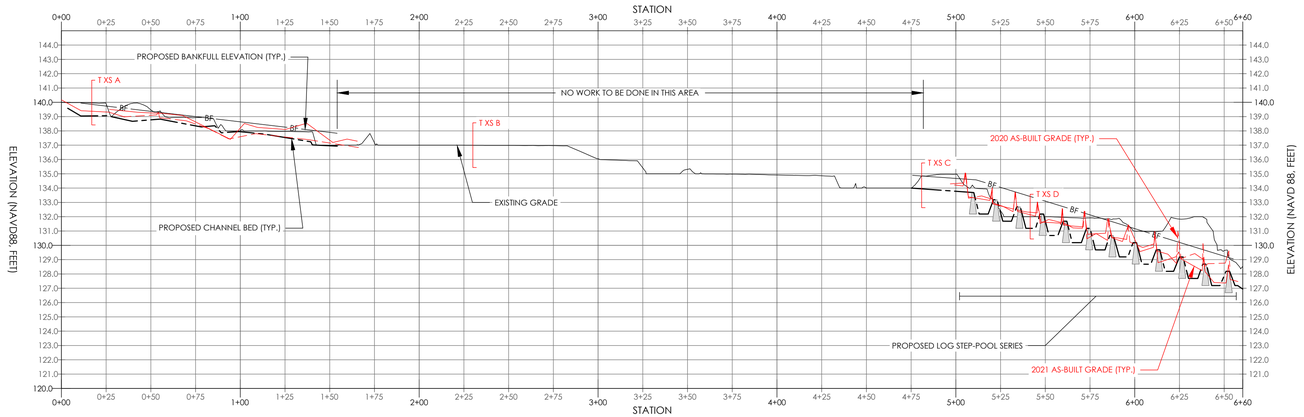

B PROPOSED PROFILE - STORMWATER TRIBUTARY
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (8X VERT. EX.)

GRAPHIC SCALE
H: 1" = 40'
V: 1" = 5'
(8X VERT. EXAG.)
0 10 20 30 40 80
0 5 10

CALL BEFORE YOU DIG!
PENNSYLVANIA LAW REQUIRES 3 WORKING DAYS NOTICE FOR CONSTRUCTION PHASE AND 10 WORKING DAYS IN DESIGN STAGE - STOP CALL PENNSYLVANIA ONE CALL SYSTEM, INC.
REFERENCE PENNSYLVANIA ACT 38
1-800-242-1776

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7/25/19	REVISED FOR CONSTRUCTION CLARITY

REVISIONS

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

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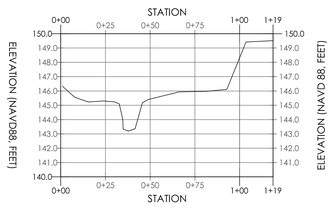
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

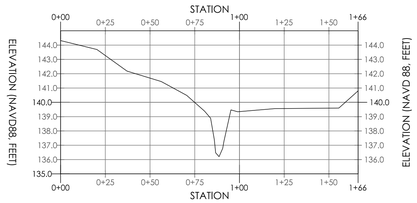
DRAWING NAME:
PROPOSED CONDITIONS-
ROUTE 202 STORMWATER
TRIBUTARY

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

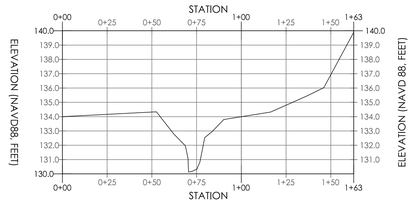
SHEET NO.
5 OF 15



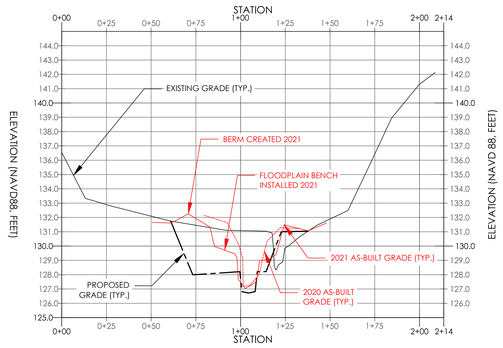
A MAIN CHANNEL CROSS SECTION A (MC XS-A)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



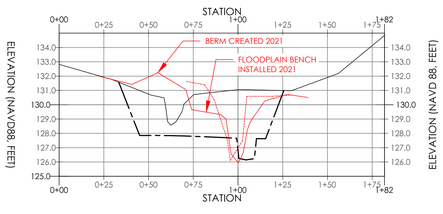
B MAIN CHANNEL CROSS SECTION B (MC XS-B)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



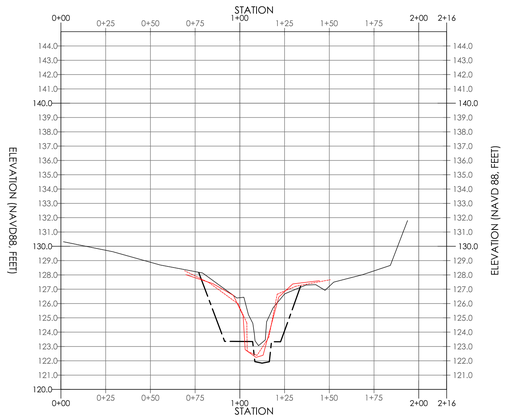
C MAIN CHANNEL CROSS SECTION C (MC XS-C)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



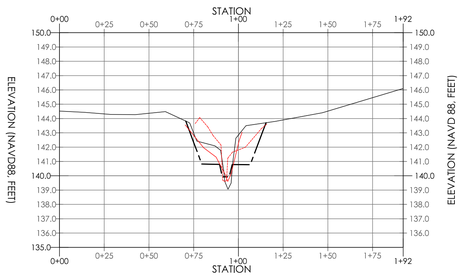
D MAIN CHANNEL CROSS SECTION D (MC XS-D)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



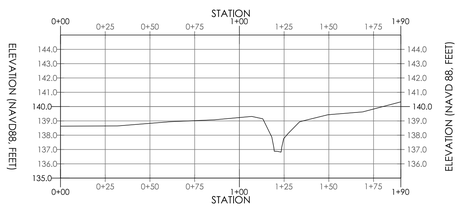
E MAIN CHANNEL CROSS SECTION E (MC XS-E)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



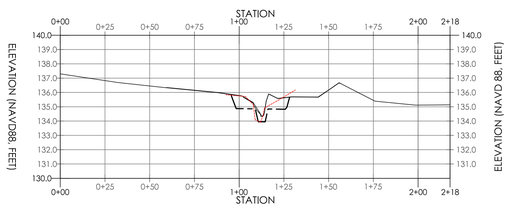
F MAIN CHANNEL CROSS SECTION F (MC XS-F)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



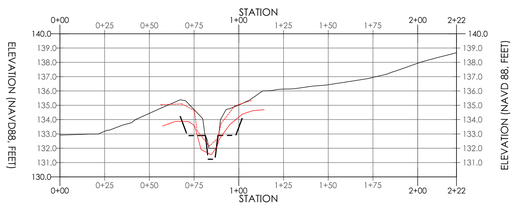
G STORWATER TRIBUTARY CROSS SECTION A (ST XC-A)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



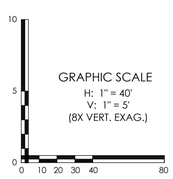
H STORWATER TRIBUTARY CROSS SECTION B (ST XC-B)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



I STORWATER TRIBUTARY CROSS SECTION C (ST XC-C)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



J STORWATER TRIBUTARY CROSS SECTION D (ST XC-D)
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: 1" = 5' (VERT. EXAG. = 8X)



GRAPHIC SCALE
H: 1" = 40'
V: 1" = 5'
(8X VERT. EXAG.)

NOTES:
1. ALL CROSS SECTIONS ARE DEPICTED FROM LEFT BANK TO RIGHT BANK LOOKING DOWNSTREAM.
2. CROSS SECTION LOCATIONS CAN BE FOUND ON PAGE 3 OF 15.

LEGEND
- EXISTING GRADE
- PROPOSED GRADE
- 2020 AS-BUILT GRADE
- 2021 AS-BUILT GRADE

CALL BEFORE YOU DIG!
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DATE	DESCRIPTION
10/10/19	REVISED PER BUCKS COUNTY CONSERVATION DISTRICT COMMENTS
7/25/19	REVISED FOR CONSTRUCTION CLARITY

REVISIONS

GEOFFREY M. GOLL
Professional Engineer
PA Lic. No. PE-050997-E

11/19/2021
DATE

PRINCETON HYDRO
SCIENCE ENGINEERING DESIGN
1108 OLD YORK RD, SUITE 1
RINGOES, NEW JERSEY 08551
PHONE: 908.237.5660
PRINCETONHYDRO.COM

PROJECT NAME/LOCATION:
AQUETONG CREEK RESTORATION
AQUETONG SPRING PARK
TOWNSHIP OF SOLEBURY
BUCKS COUNTY, PENNSYLVANIA
AS-BUILT PLANS

DRAWING NAME:
CROSS SECTIONS

DATE:	12/21/2020
PROJECT NO.:	0388.011
SCALE:	AS SHOWN
DRAWN BY:	CPS/BS
CHECKED BY:	GG/AEM/CC

SHEET NO.
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