DRAFT RESTORATION PLAN and ENVIRONMENTAL ASSESSMENT

FOR THE

DAN RIVER COAL ASH SPILL
NATURAL RESOURCE DAMAGE ASSESSMENT AND RESTORATION

April 2019 DRAFT

Prepared by

Dan River Natural Resource Trustee Council:

United States Fish and Wildlife Service
North Carolina Department of Environmental Quality
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List of Acronyms and Abbreviations

CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Contaminants of Potential Concern
CWA	Clean Water Act (or Federal Water Pollution Control Act)
DOI	United States Department of the Interior
DRNRTC	Dan River Natural Resource Trustees Council
FORVA	Friends of the Rivers of Virginia
HEA	Habitat Equivalency Analysis
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NCDEQ	North Carolina Department of Environmental Quality
NCDWQ	North Carolina Division of Water Quality
NCWRC	North Carolina Wildlife Resources Commission
NEPA	National Environmental Policy Act
NRD	Natural Resource Damages
NRDAR	Natural Resource Damage Assessment and Restoration
PAS	Preliminary Assessment Screen and Determination
RP/EA	Restoration Plan and Environmental Assessment
SESD	Science and Ecosystem Support Division
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VADCR	Virginia Department of Conservation and Recreation
VADEQ	Virginia Department of Environmental Quality

1.0 INTRODUCTION

The United States Department of the Interior (DOI) acting through the U.S. Fish and Wildlife Service (USFWS), the Commonwealth of Virginia acting through the Virginia Department of Environmental Quality (VADEQ), and the State of North Carolina acting through the North Carolina Department of Environmental Quality (NCDEQ), collectively the Dan River Natural Resource Trustee Council (Trustees, or DRNRTC) initiated a natural resource damage assessment and restoration (NRDAR) process to determine and quantify injuries to natural resources and resource services resulting from the release of hazardous substances at and from the Duke Energy Dan River Steam Station in Rockingham County, NC to the waters of, and to the habitats associated with, the Dan River (Figure 1). As part of the NRDAR process, the Trustees must also identify and select restoration actions that will compensate for the injured resources and services and seek to recover compensation from the entity responsible for the injuries to natural resources and lost services.

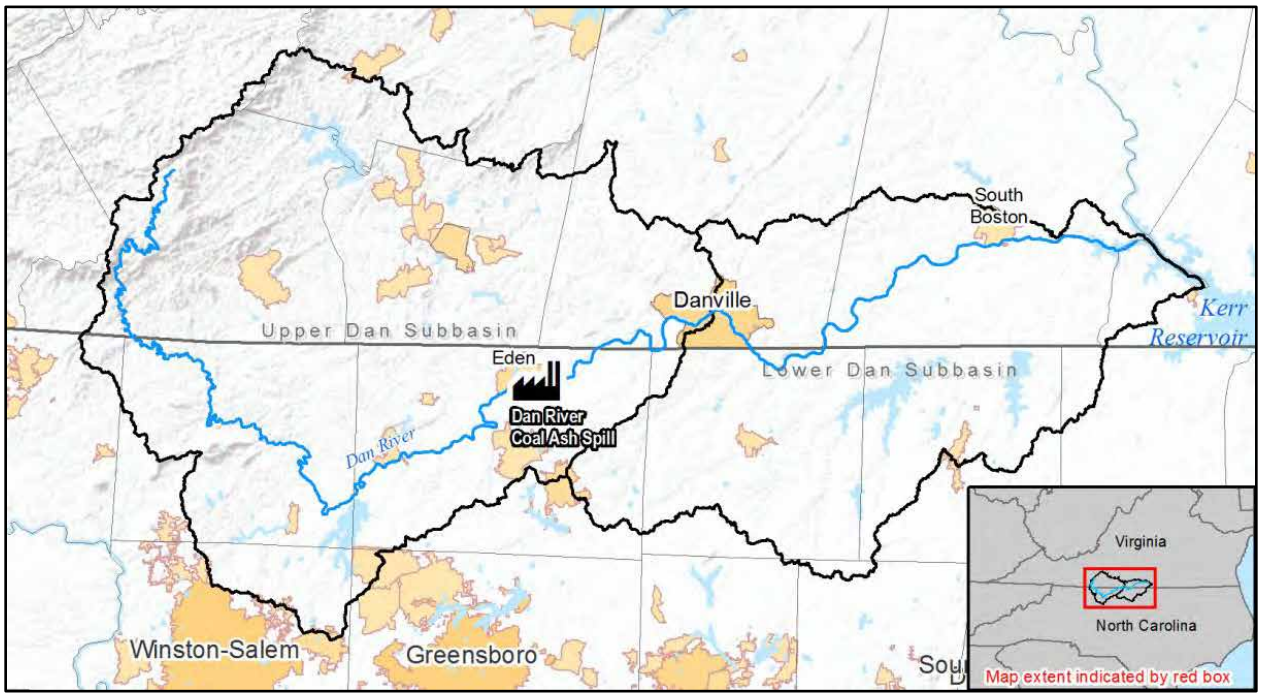

Figure 1. Watershed Map for the Dan River Coal Ash Spill

1.1 Purpose and Need for Restoration

This Draft Restoration Plan/Environmental Assessment (RP/EA) has been prepared by the Trustees to address natural resources injured and ecological services lost due to releases of hazardous substances associated with coal ash from the Dan River Steam Station in February 2014 (Spill). The purpose of this Draft RP/EA is to present the "preferred alternative" restoration project or projects that will accomplish the goal of restoring, rehabilitating, replacing and/or acquiring the equivalent of those natural resources, and the services those resources provide, that have been injured from the release. The Trustees developed this Draft RP/EA in accordance with 43 C.F.R. § 11.93 to inform the public as to the types and scale of

restoration to be undertaken towards compensating for injuries to natural resources. Consistent with the CERCLA NRDAR regulations, this Draft RP/EA includes a reasonable number of restoration alternatives and identifies a preferred alternative. Public comments are being sought on this Draft RP/EA and will be considered and incorporated in the final RP/EA as appropriate.

1.2 Natural Resource Trustees and Authority

Pursuant to the authority of Section 107(f) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, 42 U.S.C. § 9607(f); Federal Water Pollution Control Act (commonly known as the Clean Water Act), as amended, 33 U.S.C. § 1321(f)(4) and (5), (CWA); Subpart G of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. §§ 300.600, 300.605; and other applicable Federal and State laws, designated Federal and State authorities may act on behalf of the public as natural resource trustees to pursue natural resource damages for injury to, destruction of, or loss of natural resources and their services resulting from the release of hazardous substances to the environment.

The President has designated Federal resource trustees in the NCP, 40 C.F.R. § 300.600, and through Executive Order 12580, dated January 23, 1987, as amended by Executive Order 13016, dated August 28, 1996. Pursuant to the NCP, the Secretary of the DOI acts as a Trustee for natural resources and their supporting ecosystems, managed or controlled by the DOI. In this matter, the USFWS is acting on behalf of the Secretary of the DOI as Trustee for natural resources under its jurisdiction, including but not limited to migratory birds and endangered and threatened species.

In accordance with 42 U.S.C. § 9607(f)(2)(B) and the NCP, the Virginia Secretary of Natural Resources has been designated the natural resource Trustee by the Governor of Virginia. The State of North Carolina has designated the Secretary of the NCDEQ as its Natural Resource Trustee representative. The State Trustees act on behalf of the public as Trustee for natural resources, including their supporting ecosystems, within the boundaries of their state, or belonging to, managed by, controlled by, or appertaining to Virginia and North Carolina, respectively.

The State and Federal Trustees may have overlapping jurisdiction over the natural resources potentially affected in this matter. This shared trusteeship is reflected in the coordinated wildlife management practices of the USFWS, North Carolina, and Virginia, and is consistent with the management policies of North Carolina, Virginia, and the USFWS.

This Draft RP/EA was prepared jointly by the Trustees in accordance with Section 111(i) of CERCLA and its implementing regulations (43 C.F.R. § 11.93). In addition, federal trustees must comply with the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 et seq., and its regulations, 40 C.F.R. § 1500 et seq., when planning restoration projects. NEPA requires a federal agency to consider the potential environmental impacts of a planned federal action(s)

to determine if the proposed action(s) may significantly affect the environment and to inform and involve the public in the decision-making process. In compliance with NEPA, this Draft RP/EA summarizes the current environmental setting where the proposed restoration actions may take place, describes the purpose and need for restoration actions, and identifies alternatives and their potential environmental consequences and provides and environmental analysis of the restoration actions. As described in Sections 3.0 and 4.0, Duke Energy completed several of the preferred restoration alternatives voluntarily, without federal funds. These completed projects include the Abreu Grogan Park Improvements, Pigg River Power Dam Removal, and conservation of Mayo River through acquisition of property and conveyance to the Commonwealth of Virginia and the State of North Carolina. Prior to completing this subset of preferred restoration alternatives, Duke Energy complied with applicable environmental laws, and obtained permits and other approvals, where necessary. Consistent with federal laws, the DOI is continuing to evaluate the preferred restoration alternatives identified in this Draft RP/EA that are not yet complete for compliance with other applicable laws. Once finalized, these additional environmental compliance evaluations will be included as appendices to the Final Restoration Plan and Environmental Assessment for the Dan River Coal Ash Spill. For the Draft RP/EA, other potentially applicable laws and regulations include:

- *The Endangered Species Act (ESA), (16 U.S.C. § 1531, et seq.)*
- *Clean Water Act, (33 U.S.C. § 1251,* et seq.*)*
- *National Historic Preservation Act of 1966, (*16 U.S.C. § 470 *et seq.)*

1.3 Public Participation

Public participation is an important step in the NRDAR and NEPA processes. The Trustees have worked to engage local communities and other stakeholders in the NRDAR process since the Spill, beginning with meetings in the early stages of the Spill to introduce the NRDAR process to interested members of the public. The public was also invited to propose projects for review and incorporation into this Draft RP/EA. Public review of the Draft RP/EA Plan is an integral component of both NEPA and the CERCLA NRDAR process pursuant to 43 C.F.R. § 11.81(d)(2) and § 11.93. Through the public review process, the Trustees seek public comment on the restoration alternatives and the Trustees' preferred restoration alternatives to restore injured natural resources or replace resource services lost as a result of the Spill.

The Draft RP/EA will be open for public comment for 45 days from the date of publication of the Notice of Availability in the Federal Register. Interested individuals, organizations, and agencies may submit comments by writing or emailing either:

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Raleigh Ecological Services Field Office
Phone: 252-473-1132 Ext. 243
Email: Sara_Ward@fws.gov,

or

Susan Lingenfelser, U.S. Fish and Wildlife Service
Virginia Ecological Services Field Office
Phone: 804-824-2415
Email: Susan_Lingenfelser@fws.gov

The Trustees will review and consider all public comments and input on the Draft RP/EA received during the public comment period prior to finalizing the RP/EA. The Trustees will prepare a responsiveness summary to the comments that will be included as an appendix in the Final Dan River Restoration Plan and Environmental Assessment. The development of the Draft RP/EA, the public comment process, and finalization of the Restoration Plan and Environmental Assessment is performed solely by the Trustees. Based on the public's comments, or other information, the Trustees may amend the RP/EA if significant changes are made to the type, scope, or impact of the projects. In the event of a significant modification to the RP/EA the Trustees will provide the public with an opportunity to comment on that particular amendment.

The notice of availability of the Draft RP/EA and opportunity for the public to provide comments will be referenced in a Federal Register Notice of Availability and notice of availability will be published in Eden Daily News, Greensboro News and Record, and Danville Register & Bee.

Trustees have maintained records documenting the information considered and actions taken during this NRDAR process. These records are available on the Dan River Coal Ash NRDAR website. Physical copies of the records are also available for review by interested members of the public at the USFWS Virginia Field Office, 6669 Short Lane, Gloucester, VA 23061. However arrangements must be made in advance to review or obtain copies of these records by contacting:

Susan Lingenfelser, U.S. Fish and Wildlife Service
Virginia Ecological Services Field Office
Phone: 804-824-2415
Email: Susan_Lingenfelser@fws.gov

Access to and copying of these records is subject to all applicable laws and policies, including, laws and policies relating to copying fees and the reproduction or use of any material that is copyrighted.

1.4 Overview of the Dan River Coal Ash Spill

The Dan River Coal Ash Spill began on or around February 2, 2014, from the collapse of a stormwater pipe beneath a coal ash slurry impoundment at the Duke Energy Dan River Steam Station (Site).

Ash material and ash pond water within the reservoir were released into the Dan River as a result of failure of a 48-inch diameter stormwater pipe comprised of concrete and corrugated metal. Up to an estimated 39,000 tons of ash and 27 million gallons of ash pond water were released into the Dan River. Coal ash is a gray, powdery byproduct of burning coal to produce energy. Coal ash is composed of materials remaining after coal is burned, including fine sand (called silica), unburned carbon, and various trace metals such as arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc; compounds that have potential to be chemicals of concern associated with the Dan River Coal Ash Spill. The Facility is less than 10 river miles from Virginia, and USFWS reconnaissance documented ash or ash-like material co-mingled with native sediment as far as 70 river miles downstream in the days immediately following the Spill.

Three removal actions were conducted related to the Spill. On February 8, 2014, a coal ash bar about 75 feet long and 15 feet wide which had as much as five feet of ash or ash/sand mix over the natural stream bottom was identified and subsequently removed (February 11-13, 2014), resulting in the recovery of 15 tons of coal ash and native sediment. Completion of the removal of a coal ash deposit (258 tons of a coal ash and river sediment mixture) occurred on July 7, 2014 at a location approximately two miles downstream from the Site on a native sandbar delta at the mouth of Town Creek with the Dan River. Removal of 2,500 tons of coal ash comingled with native sediment in a larger deposit upstream of the Schoolfield Dam in Danville, VA began on May 6, 2014, and was also completed in early July 2014 (although Abreu Grogan Park, where cleanup equipment was mobilized, was closed to public use to support cleanup activities between April 1 - August 1, 2014). In addition to these removal actions, a total of about 466 cubic yards of solids (ash/sediment mix) were removed from the water treatment plants at Danville and South Boston, VA and properly disposed of along with dredged material from the Dan River.

Pursuant to the CERCLA NRDAR regulations (43 C.F.R. §§ 11.23-11.25), the Trustees completed a Preliminary Assessment Screen and Determination (PAS) for the Dan River Coal Ash Spill in March, 2014. Based on the information in the PAS, the Trustees determined to proceed with the NRDAR process, provided a Notice of Intent to Conduct a Natural Resource Damage Assessment to the potentially responsible party, Duke Energy, and invited Duke Energy to participate in a cooperative NRDAR process. Duke Energy and the Trustees agreed to enter into a cooperative assessment agreement in order to facilitate the resolution of any claims for natural resource damages (NRD)[1]. *See Funding and Participation Agreement Between [sic] the State of North Carolina, the Commonwealth of Virginia, the U.S. Department of the Interior, and Duke Energy Carolinas, LLC, Concerning Cooperative Natural Resource Damage Assessment, Restoration Planning, and Restoration Implementation Activities for the Duke Energy Dan River Steam Station Coal Ash Pond Site in Rockingham, NC. June 2014.*

[1] Although the NRDAR was cooperative with Duke Energy, this Draft RP/EA is solely the work of the Trustees and is not in any way attributable to Duke Energy.

Also in accordance with CERCLA NRDAR regulations (43 C.F.R. § 11.32), in June, 2015 the Trustees released a draft Assessment Plan for the Dan River Coal Ash Spill for public review and comment. A final Assessment Plan was completed in December 2015. As described in the Assessment Plan, the Trustees defined the Area of Assessment to include the point of discharge from the Facility's storm sewer management pipe in Rockingham County, North Carolina downstream (approximately 77 river miles) to and including Buggs Island Lake (John H. Kerr Reservoir), located in Virginia and North Carolina. In conducting the NRDAR, whenever possible, the Trustees coordinated damage assessment activities with other investigations to satisfy the Trustees' NRDAR objectives in a cost and resource efficient manner. The natural resources and services that were identified in the Assessment Plan to be of interest to the Trustees during the assessment are described further below (see "Summary of Injury to Natural Resources, Restoration Scaling, and Damages Determination").

1.5 Summary of the Proposed Settlement Agreement

A proposed settlement agreement among the Trustees and Duke Energy was documented in a consent decree which was lodged with the federal court and open for a forty-five (45) day public comment period concurrent with this Draft RP/EA. A Notice of Availability for the Consent Decree and draft RP/EA was published in the Federal Register. Under the terms of the proposed settlement, the Trustees will provide covenants not to sue to Duke Energy for NRD under CERCLA, the CWA, and applicable state laws. Duke Energy has performed several projects, and agrees to perform several additional restoration projects to compensate for the injured, lost, or destroyed resources and services resulting from the Dan River Coal Ash Spill. In addition, as part of the cooperative assessment process for the Dan River Coal Ash Spill NRDAR, Duke Energy has previously reimbursed the Trustees for assessment costs incurred. During the public comment period, the proposed consent decree will be available for public review and comment at https://www.justice.gov/enrd/consent-decrees.

1.6 Organization of the Dan River Restoration Plan and Environmental Assessment

Chapter 2 provides a brief summary of the Trustees' assessment of injury to natural resources and their services as a result of exposure to hazardous substances from the Dan River Coal Ash Spill. The Trustees assessed exposure of natural resources to coal-ash related hazardous substances and determined injuries to a variety of natural resources, including surface water, sediment, and various biota, as a result of that exposure. As part of the NRDAR, the Trustees evaluated the amount of restoration necessary to compensate the public for injuries to these resources for the period between the onset of injury and the resource's return to baseline (DRNRT 2015).

Chapter 3 describes the proposed restoration alternatives the Trustees identified and evaluated to return the resources injured by the Dan River Coal Ash Spill to their pre-release condition and to compensate for the interim loss pending restoration. This includes a summary of the restoration scoping activities the Trustees conducted in 2014 and 2015

and the criteria with which the Trustees evaluate possible restoration alternatives. 43 C.F.R. § 11.82(d) and § 11.93.

Chapter 4 describes the affected environment where the preferred restoration alternatives would be implemented and presents the Trustees' analysis of the environmental consequences of the preferred restoration alternatives.

Chapter 5 provides the monitoring and project fulfilment, Chapter 6 provides the Trustees' conclusions, and Chapter 7 contains the references identified in this Draft RP/EA.

2.0 SUMMARY OF INJURY TO NATURAL RESOURCES, RESTORATION SCALING AND DAMAGES DETERMINATION

Coal ash is produced through the burning of coal in coal-fired power plants, among other activities. Coal ash includes a number of by-products, such as fly ash, a fine, powdery material, or bottom ash, a coarse and angular ash particle. (*See* https://www.epa.gov/coalash/coal-ash-basics for more information). Coal ash is composed of materials remaining after coal is burned, including fine sand (called silica), unburned carbon, and various metals such as arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc. Various samples were collected from the ash pond, ash/native sediment deposit adjacent to the Site, and surface waters in the Dan River and analyzed for ash-related contaminants of potential concern (COPC). The data from these samples indicate that COPC levels (including, but not limited to, arsenic, copper, selenium, iron, turbidity, zinc, and lead) exceeded action and guidance levels for ecological receptors following the Spill (DRNRTC 2014a). Coal ash releases into the environment can create a suite of impacts to natural resources and the services they provide. In aquatic environments, coal ash can impact aquatic organisms through chemical (direct contact with suspended or dissolved hazardous substances in the water column, direct contact with sediments contaminated by hazardous substances associated with coal ash, direct contact with contaminated sediment interstitial pore water, exposure by re-suspended, pre-contaminated sediments, ingestion of contaminated sediment during foraging or feeding, and/or indirect contact through ingestion of contaminated prey species, including bioaccumulation) exposure. Natural resources and associated services under the jurisdiction of the Trustees that may have been injured by the Spill include:

- stream and wetland habitat
- surface water and sediment
- aquatic biota
- migratory birds
- human recreational uses

The Trustees conducted NRDAR activities, including: reviewing data from the Spill response efforts to assess injuries to natural resources at and downstream of the Site, to where the coal ash came to be located; preparing a natural resource damage assessment plan; soliciting input

from the public and interested stakeholders on the scoping document for restoration planning; and considering restoration project proposals submitted by the public (See Chapter 3.0, Proposed Restoration Alternatives, for additional information). Based on information developed and analyzed by the Trustees, the Trustees determined that the concentrations of hazardous substances in surface water and sediment of Dan River were at levels sufficient to cause injury[2] to fish and other aquatic biota, as evidenced by exceedances of freshwater aquatic life criteria and consensus-based probable effects concentrations for freshwater ecosystems (DRNRT 2014a).

In the damages determination phase of the NRDAR process, the Trustees identified and used procedures to determine the type and magnitude of restoration needed to bring injured natural resources to the appropriate baseline condition and to address the public's loss of natural resource services for the period from the time of release to restoration to baseline (the "interim loss") (DRNRT 2015). The scale (or size) of the restoration action(s) should be that which provides the value to adequately offset the natural resource and service losses. The process of determining the size of restoration is called restoration scaling. Restoration scaling requires a framework for quantifying the losses and for quantifying the benefits of restoration so the losses and benefits can be compared. For restoration scaling, the Trustees evaluated two decision support models: an ecological service model and a human-use services model. The ecological service model evaluates the ecological service losses associated with the Spill and the ecological service benefits of proposed restoration projects to offset the ecological service losses. The human-use services model evaluates the fishing and outdoor recreation losses associated with the Spill and the benefits of restoration projects that offset the human-use losses.

The ecological service model incorporated a Habitat Equivalency Analysis (HEA) that evaluated the interim losses and the expected service benefits of proposed restoration projects. HEA is a service-to-service or resource-to-resource approach to natural resource valuation that can account for changes in baseline[3] services while estimating interim losses of services. Baseline service losses include the loss of resources as compared to their baseline condition (i.e., the condition they would be in now had no contamination occurred). Interim losses include the losses over the time when resources are in an impaired condition and less available to the public. Primary restoration projects (including property acquisition) are used to bring resources to baseline condition, while compensatory restoration projects are used to offset the interim

[2] "Injury" as defined in CERCLA NRDAR regulations means "a measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance, or exposure to a product of reactions resulting from the discharge of oil or release of a hazardous substance. As used in this part, injury encompasses the phrases 'injury,' 'destruction,' and 'loss.'" 43 C.F.R. § 11.14 (v).

[3] "Baseline" is defined in CERCLA NRDAR regulations as "the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred." 43 C.F.R. § 11.14 (e).

loss. The fundamental concept in HEA is that compensation for lost ecological services can be provided by restoration projects that provide comparable services.

The Trustees estimated lost services of natural resources (e.g., benthic invertebrates, fish, mussels) resulting from the Dan River Coal Ash Spill including:

- exposure to suspended or dissolved hazardous substances through ash covering[4]
- ash removal[5]
- exceedance of selected U.S. Environmental Protection Agency (USEPA) screening criteria for arsenic and selenium in surface water[6]
- exceedance of selected USEPA screening criteria for arsenic and selenium in sediment[7]

The HEA accounted for the geographic scope of the affected area, estimates of ash deposits throughout the affected area, baseline conditions in the Dan River, service losses related to the three impacts identified above, and the timing of these impacts. The percent of coal ash that is deposited temporally and spatially throughout the affected area provides a pathway to suspended or dissolved hazardous substances exposure and was determined using data from the Sediment Transport Model (Altinakar et al. 2015) developed for the Spill. Other sources of data (DRNRTC 2015, HDR 2015) used to evaluate potential impacts include:

- surface water quality samples collected by Duke Energy, USEPA, NCDEQ, and VADEQ
- sediment quality samples
- pre-and post-spill benthic and fish community structure data including a post spill mussel survey (Alderman and Alderman 2014)
- fish-tissue metals concentrations

In addition to injuries to the natural resources, the release of hazardous substances at and from the Site negatively affected recreational uses and opportunities in the Dan River watershed such as sport fishing, water-contact recreation, boating, canoeing, hiking, nature observation, hunting, and other activities. Public use and access was restricted at the Abreu Grogan Park in

[4] A Sediment Transport Model was used to develop an estimate of the relative ash covering, the exposure pathway to suspended or dissolved hazardous substances, in defined river reaches (Altinakar et al. 2015). Field based confirmation of ash deposition was also performed.

[5] According to the May 2014 Administrative Settlement Agreement and Order on Consent for Removal Action, Duke Energy dredged a total of 3,062 cubic yards (or a total of 1.90 acre-feet of ash removal) in three different locations upstream of Schoolfield Dam (USEPA 2014).

[6] Surface water grab samples were collected by Duke Energy, USEPA (Superfund Technical Assessment and Response Team and Science and Ecosystem Support Division [SESD]), NCDENR, and VADEQ. At a subset of sediment sampling locations (with sufficient water depth), USEPA Region 4's SESD team collected water column samples (including a minimum of a surface and sediment/water interface grab sample). Results were compared to federal ambient water quality standards to determine areas affected by exceedances.

[7] Sediment samples were also collected from the river by USEPA at intervals along the Dan River in areas immediately downstream (including through Danville, VA) and then at greater spatial intervals throughout the remaining riverine portion of the Dan River system. Results were compared to USEPA screening levels for selenium and arsenic to determine areas affected by exceedances.

Danville, NC, which provides the only public boat access point on the Dan River between the Dan River Steam Station dam in Eden, NC and the Schoolfield Dam in Danville, VA. The Abreu Grogan Park was closed to public use while cleanup equipment was mobilized and during the removal of a coal ash deposit in the river in the vicinity of the Schoolfield Dam between May 6 and August 1, 2014). Closures, regulatory advisories, and other warnings occurring as a result of the release from the Site included: a recreational water advisory in North Carolina (between February 12 and July 22, 2014) and a fish consumption advisory in the counties of Rockingham and Caswell, NC (between February 12, 2014 and November 29, 2017, NCDHHS 2017).

An assessment of lost recreational uses as a result of the Spill and the benefits from proposed restoration projects for recreational uses was evaluated via benefit transfer. Benefit-transfer uses existing recreational use preference information from the economics literature to identify how changes in environmental quality or site characteristics could affect a recreational user's well-being (e.g., anglers). The benefit-transfer model combines this preference information with data on the potentially affected population, information on potential substitute sites, and information on the number of trips taken to the affected area and set of potential substitute sites. In general, the benefit-transfer model attempts to evaluate recreational use behavior (fishing and general outdoor use) under With- and Without-Release conditions to estimate the losses from the coal ash Spill, and With- and Without-Restoration to estimate the benefits of restoration.

3.0 RESTORATION ALTERNATIVES

Restoration of resources injured and services lost by the Spill is the goal of the Dan River Coal Ash NRDAR process. The purpose of the actions identified in this RP/EA is to restore, rehabilitate, replace, or acquire the equivalent of natural resources that were injured or destroyed and recreational use that was lost because of the Spill pursuant to the requirements of applicable federal and state laws and regulations.

3.1 Restoration Scoping

In October 2014, the Trustees released a Scoping Document for Restoration Planning (Scoping Document) (DRNRTC 2014b). The Scoping Document provided information on the Spill, the potential natural resource injuries resulting from the Spill, restoration project concepts for the resources affected by the Spill, and an explanation of the restoration planning process, including restoration project eligibility and evaluation criteria. Review of the projects described in the Scoping Document promoted public engagement early in restoration planning and provided the public an opportunity to show support for the types of projects under consideration to restore natural resources and their services or provide other restoration project ideas to the Trustees. Feedback from the public showed great support for public river access, land protection and conservation projects such as the Mayo Tract as well as dam removal and other projects that protect water quality in the river. A Restoration Scoping Response Summary of the feedback received by the Trustees on the Scoping Document for Restoration Planning was finalized in December 2014 (DRNRTC 2014c). The restoration scoping

process led to a final document that provided a comprehensive list of potential restoration projects and existing restoration opportunities in the Dan River watershed area, partnerships with stakeholders (e.g., conservation organizations and river users), more public engagement, and identification of potential concerns with possible restoration actions (DRNRTC 2014b). For purposes of this draft Restoration Plan, the Trustees are using the same *criteria* for evaluation of restoration alternatives as were used in the Scoping Document, as described in the next section. The Scoping Document also identified *potential restoration alternatives* to guide the restoration planning process, which are summarized in Section 3.4.

3.2 Restoration Alternatives Evaluation Criteria

Eligibility criteria for evaluation of restoration alternatives are outlined in the CERCLA NRDAR regulations (43 C.F.R. § 11.82(d)). The Trustees used additional case-specific alternative selection criteria to assess the potential restoration alternatives as follows:

- Nexus – the alternative has a connection to the restoration, rehabilitation, replacement, and/or acquisition of the equivalent of the injured natural resources or lost services.
- Relevance – the alternative effectively meets restoration goals and objectives.
- Cost Reasonableness – the cost of the proposed restoration alternative is reasonable in relationship to the injury, and benefits to the injured resources can be quantified; opportunities to share costs with other organizations and/or agencies may be available and are considered.
- Measurable – an alternative delivers tangible and specific resource restoration results that are identifiable and measurable.
- Efficacy – it is likely that a restoration alternative will be successful based on consideration of future operation and maintenance requirements and vulnerability of the alternative to natural or human-induced stresses following implementation.
- Legality – the restoration alternative complies with applicable/relevant Federal, State, and local laws and regulations.
- Ecological leverage – the restoration alternative promotes other environmental benefits, avoids collateral injury to natural resources as a result of implementation, and is not subject to an independent, prior obligation.
- Compatibility – the alternative is compatible with the surrounding land use.

3.3 Potential restoration alternatives identified during Restoration Scoping

Through consideration of the criteria described above and the natural resources and associated services affected by the Spill (habitat, surface water and sediment, aquatic biota, migratory birds, and human uses), the Trustees identified the following categories of restoration alternatives appropriate for consideration to offset injuries related to the Spill:

- Avoided Habitat Loss via Land Acquisition/Protection
- Restoration of In-stream Habitat/Fish Passage

- Restoration of Riparian and Wetland Habitat
- Rare and Nongame Species Restoration
- Improve quality of fishing experience
- Expand river-centered opportunities for public recreation and wildlife viewing

The Trustees identified proposed alternatives for restoration of natural resources and recreational opportunities based on an evaluation of the criteria and types of restoration alternatives described above. A description of the proposed restoration alternatives and their environmental benefits are described in Section 3.4.

3.4 Proposed Restoration Alternatives (and other alternatives considered but eliminated)

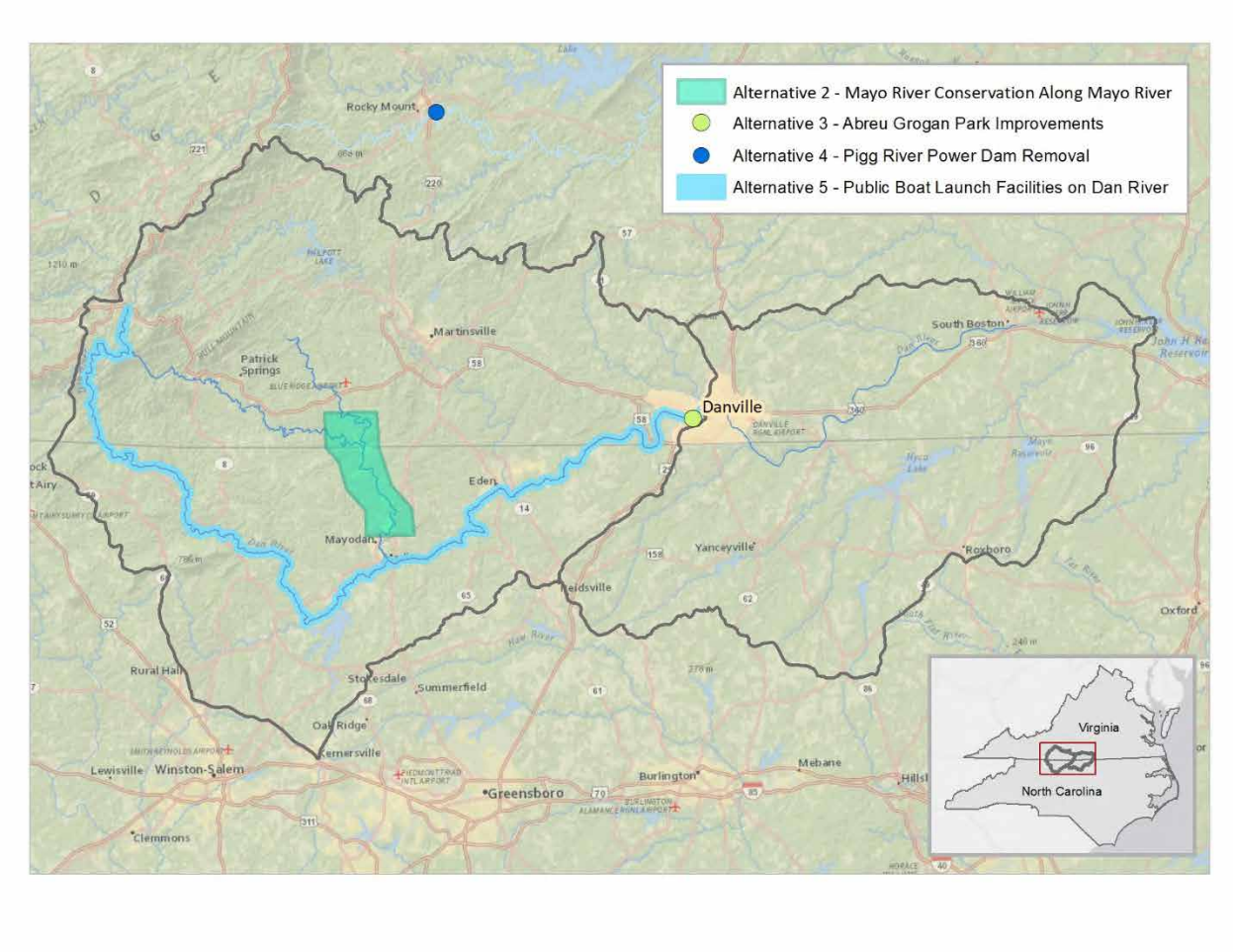
Each restoration alternative identified by the Trustees is described in more detail in this section. As a result of the public feedback generated by the Trustees' restoration scoping activities, Duke Energy has pursued implementation of several of the restoration alternatives. Consequently, in this document, the Trustees are evaluating the suitability of alternatives (some of which have already been implemented by Duke Energy and others which have yet to be implemented) to offset injuries to natural resources and services resulting from the Spill. Table 1 indicates the category or categories of restoration satisfied by each proposed alternative to compensate for natural resource injury and lost recreational use in the Dan River and highlights the completion status of the various alternatives. Table 1 also identifies the Trustees' preferred alternative restoration projects that will accomplish the goal of restoring, rehabilitating, replacing and/or acquiring the equivalent of those natural resources, and the services those resources provide. Figure 2 illustrates the locations of each of the preferred alternatives completed and area of focus for those in progress.

Table 1. Summary of Natural Resource and Service Benefits of Restoration Alternatives

Restoration Alternative	Restoration Categories	Natural Resources and Services Benefited	Status
1 - No Action	• None	None	Considered, but eliminated from further analysis
2 - Mayo River Conservation (preferred)	• Avoided habitat loss via land protection • Expand river centered opportunities for public recreation/wildlife viewing • Improve quality of the fishing experience	• habitat • surface water and sediment • aquatic biota • migratory birds • human uses	618.72 acres conserved and transferred to North Carolina and Virginia State Parks; up to 64.403 additional acres remaining to be acquired (in progress)
3 - Abreu Grogan Park Improvements (preferred)	• Improve quality of fishing experience	• human uses	Completed

	• Expand river-centered opportunities for public recreation and wildlife viewing		
4 - Pigg River Power Dam Removal (preferred)	• Restoration of In-stream Habitat/Fish Passage • Restoration of Riparian and Wetland Habitat • Rare and Nongame Species Restoration • Expand river centered opportunities for public recreation/wildlife viewing/fishing experience	• habitat • surface water and sediment • aquatic biota • migratory birds • human uses	Dam demolition completed; environmental monitoring ongoing
5 - New Public Boat Launch Facilities on the Dan River (preferred)	• Improve quality of fishing experience • Expand river-centered opportunities for public recreation and wildlife viewing	• human uses	Planning in progress
6A – Rare and Nongame Species Restoration (Mussels)	• Rare and Nongame Species Restoration	• aquatic biota	Community mussel restoration strategy considered but eliminated from further analysis
6B – Rare and Nongame Species Restoration (Roanoke logperch)	• Rare and Nongame Species Restoration	• aquatic biota	Considered, but eliminated from further analysis
7 – Water Quality Improvements (SL-6 Projects)	• Restoration of In-stream Habitat/Fish Passage • Restoration of Riparian and Wetland Habitat	• aquatic biota	Considered, but eliminated from further analysis

Figure 2. Locations of Preferred Restoration Alternatives



Alternative 1: No Action

Under this alternative, no restoration activities beyond what have been presented in the EPA-approved response and cleanup activities will be conducted at the Site (USEPA 2014). The underlying assumption of this alternative is that natural resources and the services they provide will recover over time through natural attenuation. This alternative is appropriate if/when no additional restoration projects are necessary to restore, rehabilitate, replace, and/or acquire the equivalent of the injured natural resources. This alternative has no cost.

The no action alternative is not appropriate for the Dan River Spill given that interim losses to natural resources and the services they provide (as evidenced by recreational and fish consumption resources and park closures) cannot be addressed through natural attenuation.

Alternative 2: Mayo River Conservation (preferred)

This restoration alternative involves the acquisition and conservation of up to 618.72 acres of floodplain and riverbank properties along the Mayo River and ultimate transfer to the Mayo River State Parks in North Carolina and Virginia for long term stewardship and conservation in

perpetuity as part of the North Carolina and Virginia Mayo River State Parks, respectively. Mayo River corridor parcels in North Carolina were frequently mentioned in responses to the Trustees' restoration scoping request in 2014. The acquisition and conservation of this corridor as part of the Mayo River State Park protects a significant aquatic habitat with high quality water and with at least 10 rare and listed aquatic species and adjacent terrestrial natural heritage features. This addition to the state parks would allow greater access and safety for the public to over 10 miles of the Mayo river for increased river-based recreation and fishing, as well as typical state park camping, hiking, and environmental education. In Virginia, the Virginia General Assembly in 2007 authorized a study of the feasibility of creating a state park on the North and South Forks of the Mayo River in Henry County (VADCR 2007). Investments in land and facilities are an identified need and interstate connectivity of park lands and waters would increase both the recreational and ecological impact of these investments.

Conservation contributing to this alternative includes the following recent acquisitions. Duke Energy funded the acquisition of the 340.317 acre Lower Trust Parcel, including the corresponding 3 miles of river corridor, and transferred title to North Carolina State Parks for long term stewardship and conservation in perpetuity as part of the Mayo River State Park. Duke Energy funded the acquisition of 214 acres of real property along the Mayo River in Henry County, VA, and transferred title to VADCR for long-term stewardship and conservation in perpetuity as part of Virginia's Mayo River State Park.

This alternative includes additional Mayo River land conservation up to 64.403 acres of floodplain and riverbank land along the Mayo River and conveyance of ownership of the land to the State of North Carolina for conservation as part of North Carolina's Mayo River State Park. The State will manage the property for long term stewardship and conservation in perpetuity. Conservation of such property within the state park system of North Carolina provides ecological and recreational benefits: preserving high-quality habitat for threatened or rare terrestrial and aquatic species, and providing public access and recreational opportunities for anglers, hikers, paddlers, and other outdoor recreationists.

The Environmental Assessment only applies to the not yet completed portion of Alternative 2 (i.e., acquisition and conveyance to the State of North Carolina of approximately 64.403 acres total of Mayo River riverplain and floodplain to be managed for long term stewardship and conservation in perpetuity). This action is a preferred alternative for this Draft RP/EA because it meets the all criteria identified by the Trustees for a good restoration project to address the injuries caused by the Spill. This alternative is expected to increase habitat quality and quantity, promote habitat connectivity, create new public use opportunities, and benefit public natural resources within the Dan River watershed. Acquisition and conservation of floodplain and riverbank properties along the Mayo River will protect miles of significant river habitat with at risk, rare and/or endangered aquatic species, adding greater access for the public to river-based recreation.

Alternative 3 - Abreu Grogan Park Improvements (preferred)

The three acre Abreu Grogan Park in Danville, VA (Pittsylvania County) is the only access to the 14-mile section of the Dan River designated as a Virginia Scenic River. As described above in Section 1.3, Abreu Grogan Park was closed April 1 - August 1, 2014 during the response to the Spill as it was used as a staging ground for removal of coal ash and contaminated sediment from Dan River. Improvements intended to add amenities to Abreu Grogan Park and increase recreation access to the river and use of the park by a broader population have been completed by Duke Energy and are detailed in Appendix A. New amenities include a courtesy dock, a fishing platform, a restroom building and an information kiosk. Handicapped accessible parking and sidewalks have been added to enable access to all of these park amenities. Other improvements to the park included a new headwall to stabilize the culvert, addition of rip-rap for river bank stabilization and relocation of the picnic table and grill. The park was re-opened with these completed improvements on May 26, 2016. The improvements to the park address recreational losses as a result of the closure of the park during the response effort.

Alternative 3 is a preferred alternative for this Restoration Plan because it meets the direct nexus criteria identified by the Trustees for a good restoration project. Abreu Grogan Park Improvements addresses the lost recreational opportunities when the park was closed to public use to support cleanup activities.

Alternative 4 - Pigg River Power Dam Removal (preferred)

Constructed in 1915 for power generation, the defunct Power Dam measured 25 feet high by 204 feet long and impounded 60 acre-feet of water over 25 acres. The Pigg River Power Dam Removal project is located just upstream of the Route 713 bridge over the Pigg River in Franklin, VA. The USFWS worked with the owner, Friends of the Rivers of Virginia (FORVA); Franklin County; Town of Rocky Mount; VADEQ; Virginia Department of Game and Inland Fisheries and others to remove the center section of the Power Dam. The purpose of this restoration alternative is to support recovery of the Roanoke logperch (*Rex percina*) through aquatic habitat restoration, fish passage, and restoration of aquatic connectivity within the Pigg River ecosystem. Duke Energy provided the funding to FORVA on August 23, 2016 and Power Dam breaching and removal was completed on September 27, 2016. Work related to the breaching included the cutting and removal of trees downed by down cutting of legacy reservoir sediment to prevent additional bank instability during the natural channel formation process.

This project removed the last impediment to fish passage within a 72 mile reach of the Pigg River from the headwaters downstream to Leesville Reservoir. The project restored 2.2 miles of aquatic instream habitat impounded upstream of Power Dam for the federally and state listed Roanoke logperch and other nongame and game fish such as smallmouth bass (*Micropterus dolomieu*). Another mile upstream of the impoundment for a total of 3.2 miles above Power Dam and 5 miles downstream of the Dam are in the process of being improved by the river's competency to transport sediment, increasing the complexity of instream habitat and facilitating the reestablishment of riparian vegetation. The remaining 45 mile river

segment downstream to Leesville Reservoir is also beginning to improve with regards to channel habitat, stability, and complexity through restored sediment transport capacity. In addition to on-going physical and biological monitoring, signage was constructed to provide the public assistance in interpreting the historic significance of the powerhouse and remnants of the Pigg River Power Dam. Other benefits of the project include the restoration of flood attenuation, public infrastructure protection for the Rocky Mount Wastewater Treatment Plant and the Route 713 Bridge, removal of a public safety and boating hazard, and the future establishment of a public access area and county park for recreational fishing and boating. Implications for the endangered Roanoke logperch had been extensively evaluated (USFWS 2016) and endangered species consultations and all applicable Federal, state and local regulatory reviews were completed prior to implementation. Additional details regarding the Power Dam removal and benefits are available at https://www.fws.gov/northeast/virginiafield/partners/powerdam.html and are included in Appendix B.

Alternative 4 is a preferred alternative for this Restoration Plan because it meets the Trustees' restoration goals and objectives criteria identified by the Trustees for a good restoration to address the injuries caused by the Spill. Breaching the Pigg River dam restores river habitat, improves water quality, re-establishes fish movement, and enhances fishing and recreational boating opportunities.

Alternative 5: Establishment of Public Boat Launch Facilities on the Dan River (preferred)

As described in Section 1.3, the Spill caused a loss of recreation as a result of fishing closures along the Dan River during the Spill and Spill response. Additionally, public responses to the Trustee's restoration scoping indicated that limited access in the Dan River impedes recreational use and enjoyment of the resource. This alternative includes the establishment of new public access location(s) within the upper Dan River Basin to address recreational losses from the Spill by increasing the access. The boat launch(es) may accommodate either motorized or non-motorized boats. The Trustees shall identify a maximum of one motorized boat access location or a maximum of two non-motorized boat access locations.

Alternative 5 is a preferred alternative for this Restoration Plan because it meets the all criteria identified by the Trustees for good restoration to address the injuries caused by the Spill.

Alternative 6A: Rare and Nongame Species Restoration (Mussels)

The Trustees considered a proposed approach for captive propagation and release of freshwater mussels into the wild, with the goal of developing connected, self-sustaining populations in North Carolina and Virginia. The approach is intended to advance conservation of the federally endangered James spinymussel. Furthermore, while not currently listed as threatened and endangered, many non-listed "at-risk" species also are imperiled and would benefit from strategies considered. In particular, four levels of species restoration, augmentation, expansion, reintroduction, and establishment were identified. In North

Carolina, only augmentation and expansion options within the state were evaluated, whereas all levels were considered in Virginia based on existing policies and opportunities. Species experts were consulted to identify species-specific and location-specific opportunities to advance restoration options. The primary determination of a suite of species to be restored at a specific reach was based on species accounts, ability to propagate the species under captive conditions, the number of specimens available, and the current information on a species' life history.

Ultimately, while the Trustees deem a community mussel restoration approach to be both important to consider and likely to deliver substantive benefits capable of offsetting natural resource injuries, specific timing and policy considerations limited the feasibility of implementing these efforts. In particular, because of the state and federal listing status of several of the species would necessitate policy approvals and designations for which the timing and outcome were not well aligned with the restoration planning and delivery effort for the Dan River NRDAR process. Accordingly, Alternative 6A, the community mussel restoration project is not a preferred restoration alternative.

Alternative 6B: Rare and Nongame Species Restoration (Roanoke logperch)

The Roanoke logperch, a federally-endangered fish, is known from the mainstem of the Dan River upstream of the Site, as well as in two tributaries to the Dan River downstream of the Site. Historically, populations of Roanoke logperch were likely widespread throughout tributaries and the mainstem of the Dan River. Declines are attributed to sedimentation and pollution which lead to decreased water quality as well as population fragmentation from dams and other barriers to passage. Captive propagation (for which successful rearing techniques are known) and release and/or translocation of Roanoke logperch individuals into suitable habitat are tools for restoring diversity and abundance. The Trustees considered potential opportunities for Roanoke logperch restoration in North Carolina and Virginia as identified by species experts.

In Virginia, Roanoke logperch populations are generally more stable than other locations throughout the species' range; however, the addition of new individuals, and thus more genetic variation, to enhance population viability (or augmentation) is desirable. The Trustees evaluated a proposed restoration project intended to facilitate: 1) an increase in genetic diversity and the genetically effective population size within the Goose Creek population; and 2) a decrease in genetic divergence between the Goose Creek and Roanoke River populations. In North Carolina, Roanoke logperch populations are vulnerable and unstable due to low densities and both limited and fragmented range. Accordingly, based on the low density of Roanoke logperch in candidate streams in North Carolina, the Trustees evaluated a restoration approach that entailed demographic augmentation (to boost the number of individuals to achieve effective population targets) through release of captive reared individuals. Candidate sites were identified based on field-based reconnaissance and screening of candidate areas by species experts since 2009.

Like the community mussel restoration approach (Alternative 6A), the Trustees consider the restoration opportunities for Roanoke logperch that were considered to be important and meaningful in terms of the ability to offset potential natural resource injuries; however, again the timing of policy tools and other designations precluded further consideration by the DRNRTC. Furthermore, one proposed restoration alternative (Alternative 4) has been determined to provide significant uplift for the Roanoke logperch and a higher immediate priority for Roanoke logperch conservation given potential for this action to support recovery efforts for the species.

Alternative 7: Water Quality Improvements via Supplemental Support for Virginia Agricultural Cost Share Program

Watershed improvement projects to address non-point source pollution and excessive sedimentation to Virginia waterbodies have been identified via the VADCR's Division of Soil and Water Conservation. Specifically, the number of proposed cost share projects addressing Stream Exclusion with Grazing Land Management (SL-6) practices typically exceed available funding. The Trustees considered whether implementation of projects that would otherwise be unfunded could result in sediment and non-point pollution reduction sufficient to offset natural resource injuries associated with the Dan River Spill.

This alternative was not identified for further consideration at this time given that supplemental funding support for SL-6 projects has been realized via alternative funding sources (above and beyond the original cost share program).

The overall objective of the restoration process is to make the environment and public whole for injuries to natural resources and/or service losses resulting from the Spill. To meet that objective, the benefits of restoration actions must be related, or have an appropriate nexus, to the natural resource injuries and losses. To achieve this fundamental objective, the Trustees are proposing restoration alternatives 2, 3, 4 and 5 to compensate the public for the natural resource injuries and lost recreation as a result of the Spill. Each alternative was evaluated against the same restoration priorities and factors described above. The Trustees believe that these alternatives represent a cost-effective and beneficial means by which to restore or replace the injured natural resources and the services they provided. These projects have the capacity to improve water quality, to provide improved habitat for a diversity of wildlife, and to enhance the recovery of endangered and rare species. Additionally, they will provide public river access for recreational activities including bird watching, nature photography, hiking, fishing, kayaking, picnicking and other uses; and create a link between local walking/biking tails and the nearby local or state parks.

4.0 ENVIRONMENTAL ASSESSMENT

This Chapter presents pertinent information about the affected area of the preferred restoration project alternatives that have not been completed and the Trustees' analysis of the

environmental consequences of implementing those projects. The Environmental Assessment only applies to Alternative 5, Boat Ramps, and the not yet completed portion of Alternative 2, acquisition and conveyance to the State of North Carolina of approximately 64.403 acres total of Mayo River riverplain and floodplain to be managed for long term stewardship and conservation in perpetuity. Alternatives 3 and 4, and a portion of Alternative 2, have previously been implemented by Duke Energy and thus are outside the scope of this Environmental Assessment.

4.1 Affected Environment

This section presents a brief description of the physical, biological, and cultural environment for the waterways and ecosystems adjacent to and in the vicinity of the preferred alternatives. The Dan River basin encompasses 3,739 square miles and 11,123 linear stream miles within North Carolina and Virginia. The affected area includes those lands immediately adjacent to the river that would be affected by proposed boat ramp(s) and floodplain and riverbank properties along the Mayo River in North Carolina and Virginia that qualify for long term stewardship and conservation in perpetuity as part of the North Carolina and Virginia Mayo River State Parks.

4.1.1 Physical Environment

4.1.1.1 Surface Water

The Dan River flows for 50.5 miles through Stokes County, NC and 39.5 miles through Rockingham County, NC. Major tributaries entering the Dan River along this reach include the Mayo and Smith rivers. Alternative 2 includes portions of the Mayo River in Henry, VA and Rockingham County, NC. The potentially affected surface water environment, at a minimum includes, the surface water pathway in the Dan River from the point of discharge from the Facility's storm sewer management pipe in Rockingham, NC downstream (approximately 77 river miles) to and including Buggs Island Lake (John H. Kerr Reservoir), located in Virginia and North Carolina. Likewise, it also includes the surface water environment in proximity to planned future restoration projects including the mainstem Dan and Mayo Rivers upstream of the Spill site, including surface waters in the counties of Stokes and Rockingham, NC. In total, the potentially affected surface water environment encompasses waters in the counties of Rockingham, Stokes, Caswell, Person, Granville, Vance, and Warren NC and Pittsylvania, Halifax, Charlotte, and Mecklenberg VA.

The presence of impaired waters in the Dan River Basin without high levels of development indicates a historic degradation of water quality conditions in the river and its tributaries and/or persistent agricultural or forestry non-point source pollution problems (PTRC 2012a). Over 20% of the Dan River Basin's assessed waters are listed as impaired with high levels of turbidity, poor ecological habitat conditions, and low dissolved oxygen levels as leading causes. However, over half (55%) of these impaired waters in the Dan River Basin are listed as failing to meet federal water quality standards for E. coli or fecal coliform bacteria, an indication of the presence of fecal material from human, livestock, and/or wildlife sources (PTRC 2012a). There is a Total Maximum Daily Load (TMDL) for E. coli on the Dan River in Virginia that recommends

reductions in sources of up to 40% from wildlife and agricultural sources (VADEQ 2007). North Carolina has adopted a similar TMDL for fecal coliform bacteria on the Dan River Basin to address their sources of E. coli contributing to water quality degradation as identified and assessed by VADEQ (PTRC 2012a). North Carolina Division of Water Quality (NCDWQ) has developed a TMDL for turbidity impairments in the Dan River that has determined that reductions in non-point sources of sediment pollution will be necessary to restore supportive water quality conditions to those waters.

4.1.1.2 Regional Geology and Soils

The affected area is located in the Piedmont region of North Carolina and Virginia. The geography is rolling, gentle hills and flat valleys with elevation ranging from about 300–400 feet (90–120 meters) in the east to over 1,000 feet (300 meters) in the west. Geology and soils are characterized by the Piedmont Belt, Triassic Basin, and Milton Belt that are defined as occupying an area of rocks that have similar features and come from the same point in geologic history (PTRC 2012b). According to the 2012 Eden Area Watershed Assessment:

Soils formed from the poorly-draining sedimentary rock of the Triassic Basin overlap with the soils formed from the more porous but more erodible metamorphic rock of the Piedmont Plateau (including the Inner Piedmont, Western Piedmont and Milton Belts) creating a complex landscape. The soils derived from the Triassic Basin ecoregion tend to be high in clay with low permeability and moderate to high shrink-swell potential, such as the Clover or Mayodan soils group. Soils derived from the Triassic Basin include Ayersville (not hydric, slightly erodible), Leaksville (all hydric, moderately to highly erodible), Clover/Mayodan (not hydric, moderately erodible), Spray (not hydric, slightly erodible) and Stoneville (not hydric moderately erodible) (US Department of Agriculture [USDA], 2012). Due to weathering processes the soils derived from the Triassic Basin geology are often located on top of the ridges while the older, more erodible metamorphic derived soils exposed on the sides of the slopes. The alluvial soils along the Smith and Dan Rivers are thus formed from a weathered material from sedimentary, igneous and metamorphic rock from surrounding uplands. The soil composition of the watershed ensures that the receiving waters will be extremely prone to sediment pollution.

4.1.1.3 Climate

Climate is humid subtropical characterized by mild winters, long pleasant periods of spring and fall, and warm summers. Average annual temperature is 59 degrees, average annual rainfall is 41 inches, and average annual snowfall is 8 inches.

4.1.2 Biological Environment

4.1.2.1 Terrestrial and Aquatic Habitat

The upper portion of the Dan River basin in North Carolina (including the Dan River mainstem) is primarily forested, but a significant portion is also in use as cultivated cropland and pasture (PTRC 2012). The affected area is typically characterized by a low slope freshwater perennial river channel containing a heterogenous substrate of sand, gravel, and cobble bordered low banks of riparian forests that grade up into upland or floodplain hardwood forests, depending

on valley type and slope. Less than 50% of the floodplains have been converted to agriculture or pasture. Natural Heritage inventories conducted in Stokes and Rockingham, NC were able to identify nineteen unique natural areas that are significant on the regional, state and national level. These characteristics and relatively low human disturbance levels maintain high biological diversity and ecological function rom natural resources in the Dan River Basin.

4.1.2.2 Fish and Wildlife

A variety of endemic game and non-game mammals, birds, reptiles, amphibians, invertebrates, freshwater fish, crustaceans and fresh water mussels occur in the Dan and Mayo River basins. Wildlife species known to occur within the Roanoke River basin, of which the Dan and Mayo rivers are a part of, includes 18 mammal species, 41 species of amphibians/reptiles, and 143 species of birds. Wildlife in the vicinity of the proposed Mayo River conservation project include managed small and large game species, such as white tailed deer and wild turkey, and non-game species common to the region, including a variety of non-game animals, such as mussels, amphibians, aquatic invertebrates and upland, riparian, and wetland birds. Fishing pressure is relatively light, but fishing opportunities exist for sunfish, largemouth bass, smallmouth bass and catfish.

Common game animals include black bear (*Ursus Americanus*), white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), American crow (*Corvus brachyrhynchos*), groundhog (*Marmota monax*), ruffled grouse (*Bonasa umbelius*), northern bobwhite (*Colinus virginianus*) , common pheasant (*Phasianus colchicus*), rabbit (*Oryctolagus cuniculus*), the grey (*Sciurus carolinensis*), red (*Tamiasciurus hudsonicus*), and fox squirrel (*Sciurus niger*), migratory waterfowl, bobcat (*Lynx rufus*), coyote (*Canis latrans*), fox (*Vulpes vulpes*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), and raccoon (*Procyon lotor*). Game fish in inland waters comprise more than 29 species that include black bass (largemouth [*Micropterus salmoides*], smallmouth [*Micropterus dolomieu*] and spotted [*Micropterus punctulatus*]), crappie (white [*Pomoxis annularis*] and black [*Pomoxis nigromaculatus*]), Sunfish (bluegill, [*Lepomis macrochirus*] redbreast sunfish [*Lepomis auritus*], redear sunfish [*Lepomis microlophus*], pumpkinseed (*Lepomis gibbosus*], warmouth [*Lepomis gulosus*], green sunfish [*Lepomis cyanellus*], Roanoke bass [*Ambloplites rupestris*], rock bass [*Ambloplites rupestris*], flier [*Centrarchus macropterus*], and all other species of the family Centrarchidae), Mountain trout (including but not limited to brook [*Salvelinus fontinalis*], brown [*Salmo trutta*] and rainbow trout [*Oncorhynchus mykiss*]), Kokanee salmon (), walleye (*Sander vitreus*), sauger (*Sander canadensis*), pickerel (chain [*Esox niger*] and redfin [*Esox americanus*]), muskellunge (*Esox masquinongy*), white bass (*Morone chrysops*), Bodie bass (*Morone saxatillis x Morone chrysops* - striped bass hybrid), striped bass (*Morone saxatillis*), shad (American [*Alosa sapidissima*] and hickory [*Alosa mediocris*]), white perch (*Morone americana*), yellow perch (*Perca flavescens*), spotted sea trout (*Cynoscion nebulosus*), flounder (*Paralichthys dentatus*), red drum (*Sciaenops ocellatus* - channel bass, red fish and puppy drum) and the endemic Cape Fear shiner (*Notropis mekistocholas*).

A portion of the 76 species of reptiles and 96 species of amphibians known in North Carolina occur in the Dan and Mayo River basins. Bird species that frequent the area include American

goldfinch (*Carduelis tristis*), Canada goose (*Branta canadensis*), great blue heron (*Ardea herodias*), osprey (*Pandion haliaetus*), northern cardinal (*Cardinalis cardinalis*) and many other songbirds common to the eastern US. A few examples of amphibians and reptiles common to the area are green frog (*Rana clamatans*), American toad (*Bufo americanus*), copperhead (*Agkistrodon contortrix*), black racer (*Coluber constrictor*), Eastern box turtle (*Terrapene carolina*) and yellow-bellied slider (*Trachemys scripta scripta*) (Van Alstineet al. 1999).

4.1.2.3 Rare, Threatened, Endangered, and Special Concern Species

The Dan and Mayo River basins provide habitat for rare and endangered plants, animals and aquatic organisms. Six federally listed species occur within the Affected area and 79 species of plants and 55 species of insects, birds, amphibians and reptiles, fish, mussels, and mammals that are considered rare, threatened, endangered or of special concern were identified by the USFWS' Information, Planning and Conservation System (IPaC 2018) and the North Carolina Natural Heritage Data Explorer (2018) (Appendix C). Federally listed species include the Northern long eared bat (*Myotis septentrionalis*), James spinymussel (*Pleurobema collina*), Roanoke logperch (*Rex percina*), Schwenitz's sunflower (*Helianthus schweinitzii*), small-anthered bittercrest (*Cardamine micranthera*) and smooth coneflower (*Echinacea laevigata*). USFWS Birds of Conservation Concern in the vicinity of the Mayo River Conservation project include bald eagle (*Haliaeetus leucocephalus*), eastern whip-poor-will (*Antrostomus vociferous*), Kentucky warbler (*Geothlypis formosa*), prairie warbler (*Dendroica discolor*), prothonotary warbler (*Protonotaria citrea*), red-headed woodpecker (*Melanerpes erythrocephalus*), rusty blackbird (*Euphagus carolinus*), and wood thrush (*Hylocichla mustelina*).

4.1.3 Socioeconomic and Cultural Environment

4.1.3.1 Demographics

The Dan and Mayo River basins are primarily rural, with less than five percent of land mass having seen city or town development (DRBA 2018). The counties in the proposed action area have experienced little growth in recent years. Rockingham (population 90,949 in the 2017 census) and Stokes (population 45,717) are characterized by relatively comparative poverty rates (18.1 and 12.4%) to the State average (15.4%) (USCB, 2018). The population growth has been more rapid to the south of Rockingham County (i.e., northwest Guilford County) while negative growth rates are common in the Virginia counties in the northern portion of the affected area (Rockingham County 2010). Incorporated human settlements include Danbury, Walnut Cove, Pine Hall, Madison, Mayodan and Eden.

4.1.3.2 Recreation

Local, state, and national parks and recreation areas existing in or near the Affected area include Hanging Rock State and Mayo River State Parks in North Carolina and Philpott Lake, Fairystone State Park, the Blue Ridge Parkway and Rocky Knob National Recreation Area in Virginia. Counties and municipalities have embraced efforts to create recreational amenities that highlight the unique heritage of the area and networks of Greenways and Blueways have been planned and established throughout the basin. Examples are the Richmond & Danville Rail Trail in Pittsylvania County and the Dick & Willie Passage in Martinsville/Henry County on the

route of the old Danville & Western Railroad. The number of river access points on the Dan and its tributaries has greatly increased, providing more opportunities for fishing and boating enthusiasts and several commercial outfitters offer guided and self-guided trips. Prior to 2002, only one river access on the Smith River in Henry County existed, today there are eight. The basin offers paddlers fast-moving white-water runs of the Dan River in Kibler Valley or slow, relaxing floats as the Dan crosses the Virginia/North Carolina border- where historic batteau navigation structures make it easy to paddle the rivers even in low water (DRBA 2018). The many lakes and reservoirs of the basin serve as attractions for outdoor enthusiasts who enjoy fishing, paddling or wildlife viewing. The North Carolina Mountains-to-Sea Trail and the Virginia Beaches to Bluegrass Trail provide hikers and cyclists a contiguous off-road path from the Blue Ridge Mountains to the Atlantic Ocean (PTRC 2012).

4.1.3.3 Cultural and Historic Resources

Aside from plant and animal habitat, the Dan River Basin also supports a culture that has been historically rich in farming and forestry. Tobacco was an important cash crop in the area; the Brightleaf tobacco curing process originated in Caswell County, bringing great wealth to the area. Prior to the Civil War, Caswell was one of the wealthiest counties in North Carolina as evident by its significant collection of antebellum homes. In the late 18th century and early 19th century, transportation was largely by water. Improvement of the river for batteau navigation spurred economic development and the founding of South Boston and Danville, VA and Milton, Leaksville (Eden) and Madison, NC. Railroads arrived in the mid-19th century, connecting the basin to wider commerce and bringing tobacco marketing and manufacturing to the towns. The railroads also made timber production more viable and companies moved in to harvest timber from the Basin, which was used to meet demand in the Northeastern and Midwestern U.S, where forest resources had been greatly depleted. While forestry still plays an important role in economy of the Basin, the advent of companies like R.J. Reynolds and American Tobacco Company meant the consolidation of small farms and factories. With the decrease in tobacco farming came the proliferation of furniture and textile industries. Cities like Bassett, Martinsville, Danville, Eden and Roxboro saw an industrial boom; however, many of these jobs would be outsourced globally beginning in the 1970s. This decline in manufacturing led to a major economic slump and the move toward more diverse industries.

4.2 Environmental Consequences of the No Action Alternative and Preferred Alternatives

NEPA requires that a federal agency evaluate the potential impacts of its proposed actions. This includes evaluation of what would happen if the Trustees did nothing further, referred to as the “No Action Alternative”. This section of the Draft RP/EA sets out the potential impacts of both the No Action Alternative and the two restoration type alternatives evaluated and identified as preferred in Chapter 3 as meeting the Trustees’ Restoration Evaluation Criteria. The analysis presented here considers the range of potential environmental consequences that may be anticipated to occur as a result of implementation of activities within the scope of the Preferred Alternatives.

The following definitions are used in this section to characterize the nature of the various impacts evaluated in this Draft RP/EA:

- Short-term or long-term impacts. These characteristics are determined on a case-by-case basis and do not refer to any rigid time period. In general, short-term impacts are those that would occur only with respect to a particular activity or for a finite period. Long-term impacts are those that are more likely to be persistent and chronic.

- Direct or indirect impacts. A direct impact is caused by a proposed action and occurs contemporaneously at or near the location of the action. An indirect impact is caused by a proposed action and might occur later in time or be farther removed in distance but still be a reasonably foreseeable outcome of the action. For example, a direct impact of erosion on a stream might include sediment-laden waters in the vicinity of the action, whereas an indirect impact of the same erosion might lead to lack of spawning and result in lowered reproduction rates of indigenous fish downstream.

- Minor, moderate, or major impacts. These relative terms are used to characterize the magnitude of an impact. Minor impacts are generally those that might be perceptible but, in their context, are not amenable to measurement because of their relatively minor character. Moderate impacts are those that are more perceptible and, typically, more amenable to quantification or measurement. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in CEQ regulations (40 CFR § 1508.27) and, thus, warrant heightened attention and examination for potential means for mitigation to fulfill the requirements of NEPA.

- Adverse or beneficial impacts. An adverse impact is one having adverse, unfavorable, or undesirable outcomes on the man-made or natural environment. A beneficial impact is one having positive outcomes on the man-made or natural environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource.

4.2.1 Environmental Consequences of the No Action Alternative

NEPA requires a federal agency to consider a “no action” alternative. Under this alternative, the Trustees would take no direct action to restore injured natural resources or compensate for lost services pending natural recovery. Instead, the Trustees would rely on natural processes for recovery of the injured natural resources and their associated services. While natural recovery would occur over varying time scales for the injured resources services, the interim losses suffered would not be compensated under the “no action” alternative.

The principal advantages of this approach are the ease of implementation and low cost. This approach relies on the capacity of ecosystems to “self-heal.” CERCLA, however, establishes

Trustee authority to seek compensation for interim losses pending recovery of the natural resources. Further, lost ecosystem services during the "self-heal" period would not be addressed under this approach. The "no action" alternative is rejected for compensatory restoration, as it does not meet the purpose and need for action. Losses were suffered and impacts continue during the period of recovery from the Spill. Technically feasible, cost-effective alternatives exist to compensate for these losses.

4.2.2 Environmental Consequences of the Preferred Alternatives

A summary of environmental consequences of the preferred Alternatives is provided in Table 2. In general, adverse impacts associated with implementation of Alternative 2 are anticipated to be minor and temporary. Outside of minor and mostly temporary adverse impacts during construction, implementation of Alternative 5 is anticipated to provide benefits, primarily in the form of improved recreational access to the upper Dan River.

4.3 Summary of Cumulative Impacts

The Council on Environmental Quality's (CEQ) regulations to implement NEPA require the assessment of cumulative impacts in the decision-making process for federal projects, plans, and programs. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 C.F.R. §1508.7). As stated in the CEQ handbook, "Considering Cumulative Effects" (CEQ, 1997), cumulative impacts need to be analyzed in terms of the specific resource, ecosystem, and human community being affected and should focus on effects that are truly meaningful. The cumulative effects analysis of the preferred alternatives in this Draft RP/EA is commensurate with nature and the degree of direct and indirect effects anticipated from implementation of the projects. For the purpose of this analysis, the cumulative impact spatial boundary includes the upper Dan River Basin, shown in Figure 1, since that is where projects described would occur. The preferred alternatives being evaluated in this Environmental Assessment are anticipated to result in predominantly beneficial impacts to recreational uses, with potential minor benefits to riverine and riparian habitat as a result of conservation activities at the Mayo River conservation site.

Implementing the alternatives as proposed and analyzed in this Draft RP/EA would have no major adverse impacts on upper Dan River Basin habitats, on adjacent lands and waterways, or on the natural resources within each. As described above, the proposed projects may result in minor, short term adverse impacts and both short- and long-term beneficial impacts. When considered with other past, present, and reasonably foreseeable future actions within the upper Dan River Bain, the preferred alternatives are not anticipated to have adverse cumulative impacts. Direct and indirect adverse impacts, as discussed previously, are likely to be short term and will occur primarily during periods of active construction activities. Periods of active construction for one or more boat ramps are anticipated to be less than one month, and individually and cumulatively, would result in only short-term impacts. The Preferred Alternatives are not expected to result in significant cumulative impacts on the human

environment since they alone, or in combination with other current and future activities (described below) in the vicinity, would not significantly change the larger current hydrological patterns of discharge, recreational use, economic activity or land-use in the upper Dan River Basin.

Other activities in the upper Dan River Basin that may be undertaken by other entities, private and public, vary widely. However, the Dan River Basin is largely rural and has experienced little growth and development in recent years. Activities on private parcels may include maintenance of utilities, development of housing on nearby or adjacent uplands, and/or agriculture practices on adjacent uplands. These types of activities are expected to result in short- and long-term adverse impacts within the upper Dan River Basin. Maintenance of public utilities, such as power lines, and pipelines in easements within state or federally-owned lands will not be impeded as a result of the Preferred Alternatives. State agencies may undertake land or wildlife management activities on parcels under their control throughout the project area. These activities may include restoration activities similar to those proposed under this Draft RP/EA and others such as road maintenance. These activities would result in both short- and long-term adverse and beneficial impacts.

Table 2. Summary of Environmental Consequences of the No Action and Preferred Alternatives.

Environmental Consequences	Alternative 1: No Action	Preferred Alternatives	
		Alternative 2 – Remaining Mayo River Conservation	**Alternative 5 - Establishment of Public Boat Launch Facilities on the Dan River**
Physical Resources			
Hydrology and Water Quality	Project area water, air, and geological/sediment conditions would not be affected since no restoration would occur. Any ecological benefits that may result from Alternative 2 would not occur, and the trajectory of any ecologically degraded areas would remain unchanged.	Long-term, indirect, minor and beneficial impacts since conservation activities could enhance habitat quality and return to natural conditions. Increase human use could result in increased trash in waterways.	Short-term, minor, direct and localized impacts to water quality could occur during construction. Construction activities could increase turbidity in the immediate project vicinity, although best management practices (BMPs) would minimize impacts.
Air Resources		No impact to local or regional air quality is expected.	Short-term, direct, minor, and adverse impacts during construction as a result of heavy equipment emissions and dust.
Sediment/ Geology		Conservation activities have potential to maintain or enhance natural conditions over time. Improved sediment transport and surface runoff following conservation activities could improve aquatic habitat. Impacts are expected to be long-term, indirect, minor and beneficial.	Minor permanent impacts to habitat within the boat ramp footprint area and immediately adjacent to the ramp would occur. Localized disturbance of sediments during boat ramp construction is anticipated.
Biological Resources			
Fish and Wildlife	Project area fish, wildlife, vegetation, and special species would not be affected since no restoration would occur.	Long-term minor benefits to fish and wildlife are anticipated since the acquired land will be removed from development or conversion pressure and management can be implemented to control invasive species or complete other activities beneficial to fish and wildlife.	Short-term, direct, and minor adverse impacts to fish and other aquatic biota during construction due to increased turbidity and sedimentation from excavation. BMPs would be employed to reduce impacts.

Table 2 Continued

Environmental Consequences	Alternative 1: No Action	Preferred Alternatives	
		Alternative 2 – Mayo River Conservation	**Alternative 5 – Establishment of Public Boat Launch Facilities on the Dan River**
Biological Resources (cont.)			
Vegetation	Project area fish, wildlife, vegetation, and special species would not be affected since no restoration would occur. Any biological improvements that may occur from Alternative 2 would not be realized	Long-term, indirect, and minor benefits to vegetation are expected because habitats would be conserved and potentially enhanced, including control of invasive species.	Construction activities such as clearing and earth moving would directly impact plants within the boat ramp footprint. Affected vegetation adjacent to the construction area may be disturbed, but effects are likely to be short-term.
Special Status Species		Same consequences as listed for Fish and Wildlife	No impacts are anticipated. A survey will be completed to ensure no special status species are present. Appropriate permits or permissions would be sought, if necessary.
Socio-economics			
Economic	Project area socio-economic variables would not be affected since no restoration would occur. Potential economic benefits as a result of the enhanced recreational opportunities would not be realized.	Permanent public open space areas may have the effect of increasing nearby residential land values, and increases in recreational activity on the acquired land may result in increased economic activity. Thus, the economic impacts are expected to be long-term, direct and indirect, minor and beneficial.	Except for the resources necessary to plan, construct, and maintain the boat ramp, there are no economic impacts associated with this project.
Aesthetics and Noise		Minor long-term benefit to aesthetic and scenic qualities and values associated with acquired lands since they will be conserved. There may be a minor increase in traffic and/or recreational noise due to increased human use.	Minor, temporary, and adverse impact to aesthetics are expected during construction. Minor to moderate and temporary increase in noise is anticipated during construction.

Table 2 Continued

Environmental Consequences	Alternative 1: No Action	Preferred Alternatives	
		Alternative 2 – Mayo River Conservation	**Alternative 5 – Establishment of Public Boat Launch Facilities on the Dan River**
Socio-economics (cont.)			
Recreation	Project area socio-economic variables would not be affected since no restoration would occur. Recreational benefits would not be realized since access opportunities would not be created.	New or improved access to river and riparian habitat are expected. Resource-based recreational activities, such as for bird watching, canoeing, kayaking, fishing, and other similar activities, may result from this alternative.	Users of small power boats, kayaks and other small water craft are expected to benefit from one or more boat ramps along the Dan River.
Transportation		Increased traffic in the vicinity of acquired area could be minor to moderate if recreational access is enhanced. Although uncertainty remains until state park management identify specific actions, impacts are anticipated to be long-term, indirect, minor and adverse.	A minor and permanent increase in traffic in the vicinity of one or more boat ramps is possible since recreational access would be enhanced. A minor and short-term increase in contractor vehicles would occur at construction site(s).
Cultural and Historical		The potential for impacts to historic and cultural resources is very location-dependent. Activities will be subject to review under Section 106 of the National Historic Preservation Act of 1966.	Same evaluation as for Alternative 2.

Table 2 Continued

Environmental Consequences	Alternative 1: No Action	Preferred Alternatives	
		Alternative 2 – Mayo River Conservation	**Alternative 5 – Establishment of Public Boat Launch Facilities on the Dan River**
Socio-economics (cont.)			
Public Health and Safety	Public health and safety would not be impacted since no restoration activities would be undertaken.	Land acquisition and conservation poses no health and safety risk. Improvements to the acquired land may result in improved safety conditions at the park.	There are no anticipated impacts to public health and safety as a result of constructing one or more boat ramps.
Environmental Justice	Project area socio-economic variables would not be affected since no restoration would occur.	The project, in general, does not create a disproportionately high or adverse effect on any minority or low-income populations. An increase in public use of the newly acquired land could result in downstream economic activity in the project area and thus be generally beneficial to local economies.	Environmental justice communities will not be negatively impacted through this project. This project will create recreational benefits along the Dan River to area residents.

5.0 PROJECT FULFILMENT AND MONITORING

As described earlier, Duke Energy has completed several of the preferred restoration alternatives. Summaries of some of the completed restoration are included as Appendices to this Restoration Plan. Appendix A includes photo documentation of completed restoration of proposed Alternative 3, Abreu Grogan Park Improvements. Appendix B includes photo documentation of proposed Alternative 4, the Pigg River Dam Removal Project.

Monitoring activities for the Pigg River Dam Removal project are detailed below:

Photographic documentation of project activities occurred throughout construction. Qualitative and quantitative monitoring, which began November 2016, will be conducted annually for a period not to exceed 5 years post-construction. The purpose of monitoring is to evaluate project stabilization and inform future natural resources management decisions.

Stabilization metrics include the formation of stable channel morphology up to 3.2 miles upstream and 5 miles downstream of the dam that consists of riffles, pools, bars, benches, banks vegetated above high water level, deposition, instream habitat, mobilization of sediment, and fish passage. Initial monitoring and subsequent site visits have indicated that these metrics already indicate channel morphology downstream is transitioning to more stable riverine configuration. Once downcutting and transport of legacy sediments is completed, the upstream reach is also anticipated to reach equilibrium.

Pursuant to the Consent Decree, Duke Energy will submit semi-annual reports to the Trustees on its progress to complete the remaining preferred restoration alternatives, a portion of Alternative 2, and Alternative 5, if selected.

6.0 REFERENCES

Alderman, John M. and Joseph D. Alderman. 2014. Dan River Mapping, Habitat Assessments, and Mussel Surveys. Prepared for the Duke Energy Corporation. November 26. Pittsboro, NC: Alderman Environmental Services, Inc.

Altinakar, Mustafa. 2015—"Sediment Transport Model of Coal Ash Deposition in the Dan River from February 9, 2014 Coal Ash Spill at Duke Energy's Dan River Station." University of Mississippi National Center for Computational Hydroscience & Engineering.

Dan River Basin Association (DRBA). 2018. Dan River Basin Overview. Available http://www.danriver.org/content/danriver/uploads/PDF/basin_overview_final.pdf. (Accessed: 8/31/2018).

Dan River Natural Resource Trustee Council (DRNRTC). 2014a. Pre-Assessment Screen Determination for Dan River Coal Ash Spill in North Carolina and Virginia. March. 19 pp. Available https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=984. (Accessed: 10/30/2018).

Dan River Natural Resource Trustee Council. 2014b. Dan River Coal Ash Release Natural Resource Damage Assessment and Restoration: Scoping Document for Restoration Planning for Public Review and Comment. October. 26 pp. Available https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=984. (Accessed: 10/30/18).

Dan River Natural Resource Trustee Council. 2014c. List of Restoration Project Proposals Submitted by Public in Response to the Dan River Coal Ash Release Scoping Document for Restoration Planning. December. 3 pp. Available https://www.cerc.usgs.gov/orda_docs/CaseDetails?ID=984. (Accessed: 10/30/2018).

Dan River Natural Resource Trustee Council. 2015. Dan River Natural Resource Damage Assessment Plan. Available: https://www.cerc.usgs.gov/orda_docs/DocHandler.ashx?task=get&ID=1555. (Accessed: 9/22/2017).

HDR. 2015. Dan River Steam Station Coal Ash Release Summary of Environmental Data Representing Conditions Pre- and Post- Coal Ash Release. 146 pp. September.

North Carolina Department of Health and Human Services (NCDHHS). 2014. Current Fish Consumption Advisories for North Carolina. Available http://epi.publichealth.nc.gov/oee/fish/advisories.html#D. (Accessed: August 22, 2014).

North Carolina Department of Health and Human Services. 2017. Current Fish Consumption Advisories for North Carolina. Available http://epi.publichealth.nc.gov/oee/fish/advisories.html. (Accessed: October 11, 2017).

North Carolina Natural Heritage Data Explorer. 2018. (https://ncnhde.natureserve.org/). (Accessed: 9/24/2018).

Piedmont Triad Regional Council (PTRC). 2012a. Dan River Basin Watershed Prioritization Report. With support from North Carolina Division of Water Quality 205(j)/604(b) program. 86 pp.

PTRC. 2012b. Eden Area Watershed Assessment. 159 pp.

Rockingham County. 2010. A Land Use Plan for Managing Growth: Rockingham County, North Carolina. Available http://www.co.rockingham.nc.us/pview.aspx?id=14918. (Accessed: 8/31/2018).

U.S. Census Bureau (USCB). 2018. Quick Facts Rockingham County, North Carolina; North Carolina. Available https://www.census.gov/quickfacts/fact/table/rockinghamcountynorthcarolina,nc/PST045217. (Accessed: 8/31/2018).

U.S. Census Bureau. 2018. Quick Facts Stokes County, North Carolina; North Carolina. Available https://www.census.gov/quickfacts/fact/table/stokescountynorthcarolina/PST045217. (Accessed: 8/31/2018).

U.S. Fish and Wildlife Service (USFWS). 2018. Information, Planning and Conservation System (http://ecos.fws.gov/ipac/). (Accessed: 9/25/2018).

USFWS. 2016. Pigg River Restoration at Power Dam, Franklin County, VA, Project #2015-F-2742. Virginia Field Office, Gloucester, VA. Available http://www.fws.gov/northeast/virginiafield/pdf/PARTNERS/power_dam/Website%20Posts/2016_Power_Dam_biological_opinion.pdf. (Accessed: 1/18/ 2016).

Van Alstine, N.E., G.P. Fleming, and H.E. LeGrand Jr. 1999. *A Natural Heritage Inventory of John H. Kerr Reservoir, Virginia and North Carolina*. Natural Heritage Technical Report 99-07. Raleigh, NC: Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA, and North Carolina Department of Environment, Health and Natural Resources, North Carolina Natural Heritage Program.

Virginia Department of Conservation and Recreation (VADCR). 2007. Feasibility Study for a State Park on the Mayo Rivers in Henry County and Mayo Scenic Rivers Study Henry County, Virginia. Prepared by the Virginia Department of Conservation and Recreation for the Governor and the General Assembly of Virginia. Richmond, VA. 49 pp.

Virginia Department of Health. 2014. Coal Ash Release Fact Sheet. Available http://www.vdh.virginia.gov/CoalAsh.pdf. (Accessed: August 27, 2014).

APPENDICES

APPENDIX A: Abreu Grogan Park Amenity Summary

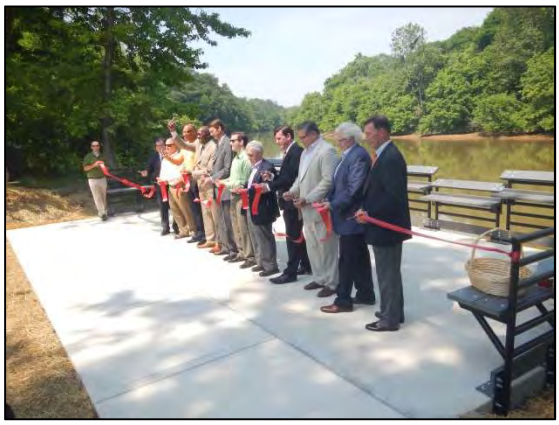
DUKE ENERGY CAROLINAS, LLC.

ABREU-GROGAN PARK

AMENITY SUMMARY

EXISTING AND PROPOSED AMENITY ENHANCEMENTS

Abreu-Grogan Park
2020 Memorial Drive
Danville, VA 24541



ENHANCEMENTS COMPLETED MAY 26, 2016

DUKE ENERGY®

Picture 1: Existing floating dock and canoe launch. No enhancements planned.

Existing Condition

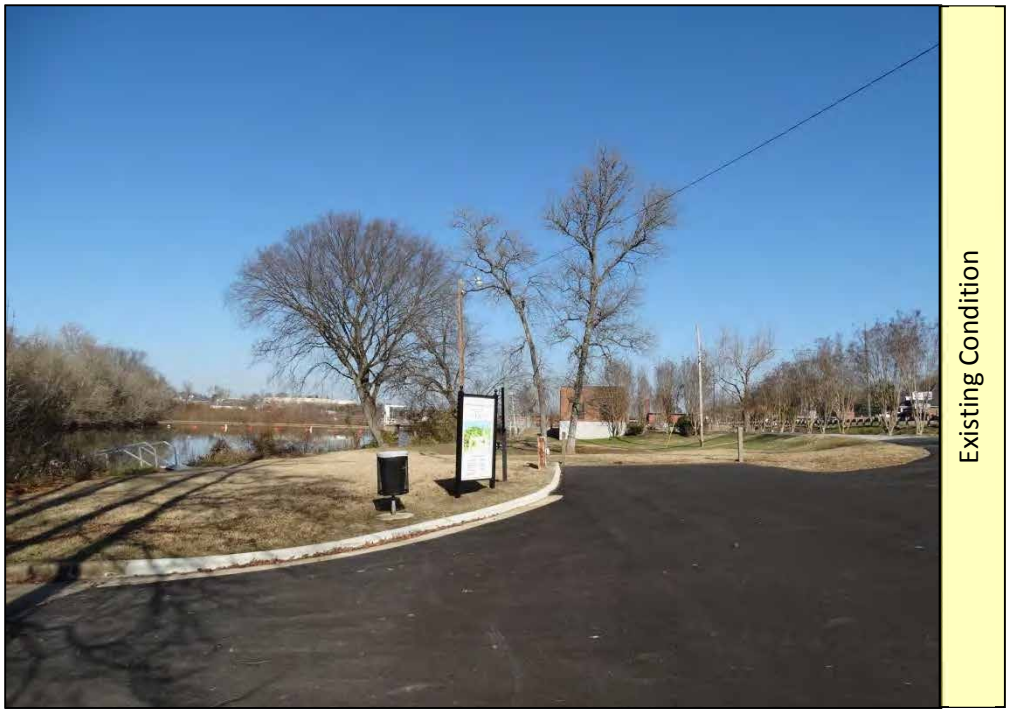
Picture 2: Added accessible parking and accessible sidewalk leading to the floating dock and canoe launch. Accessible sidewalk also leads to kiosk and courtesy dock.

Enhanced Condition

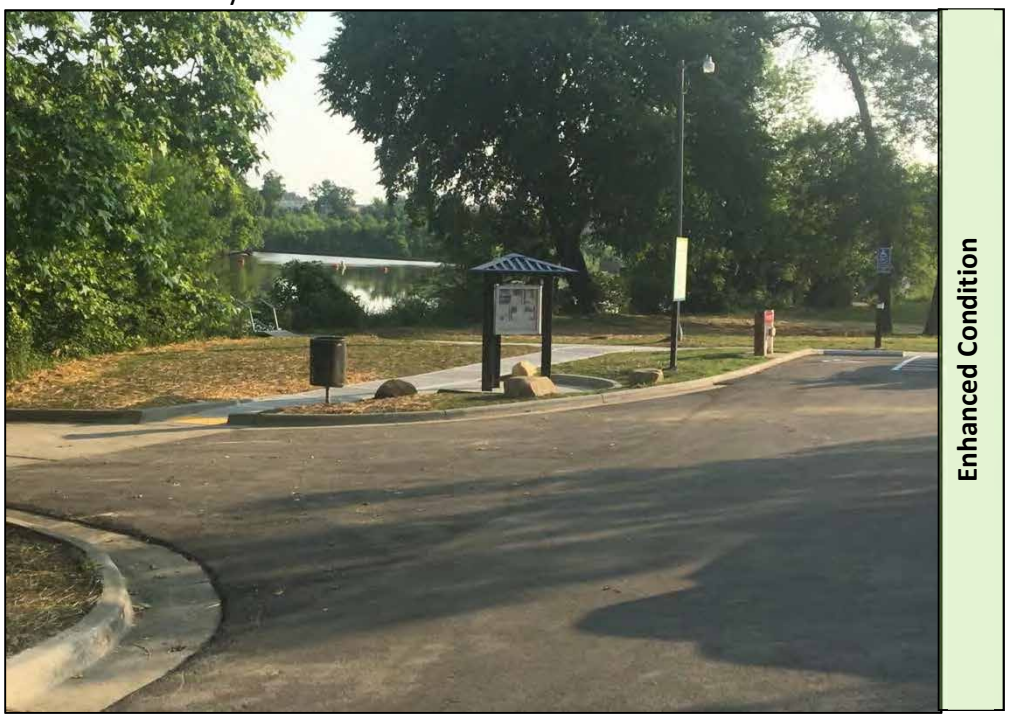
Picture 3: Added new accessible kiosk.

Picture 4: Added new accessible sidewalk leading to the kiosk and courtesy dock.

Picture 5: Existing parking spaces for the floating dock and canoe launch. Accessible sidewalk to be added. Future kiosk to be added in the vicinity of the existing trash can.



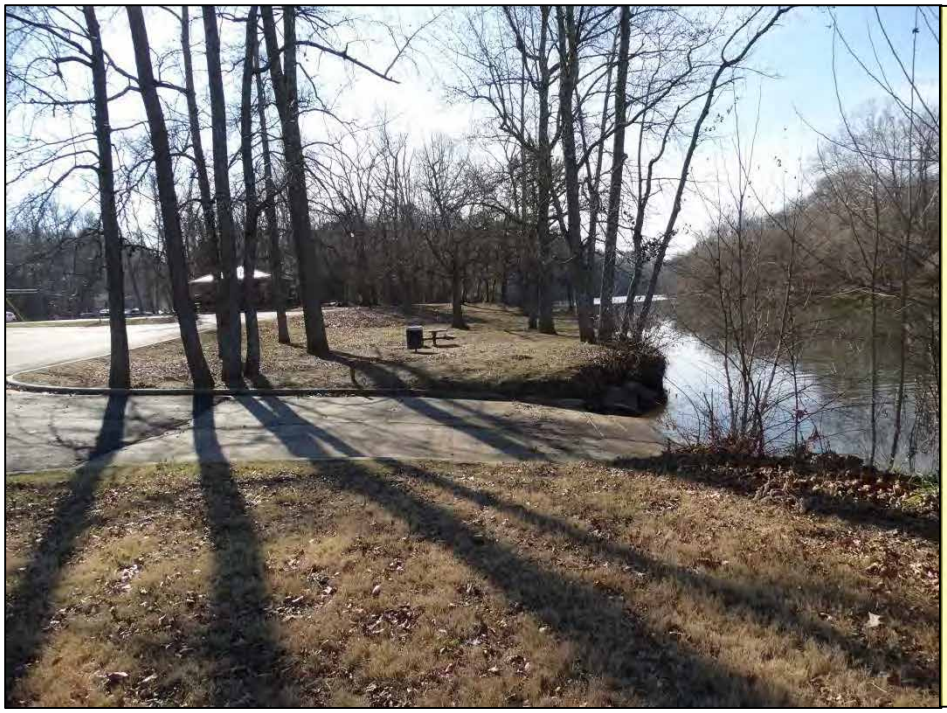
Picture 6: Additional view of accessible parking and accessible sidewalk leading to the existing floating dock and canoe launch along with accessible sidewalk leading to the kiosk and courtesy dock.



Picture 7: Existing culvert to receive new headwall.

Picture 8: New headwall added to existing culvert.

Picture 9: Existing boat ramp. Courtesy dock and connecting sidewalk to be added.

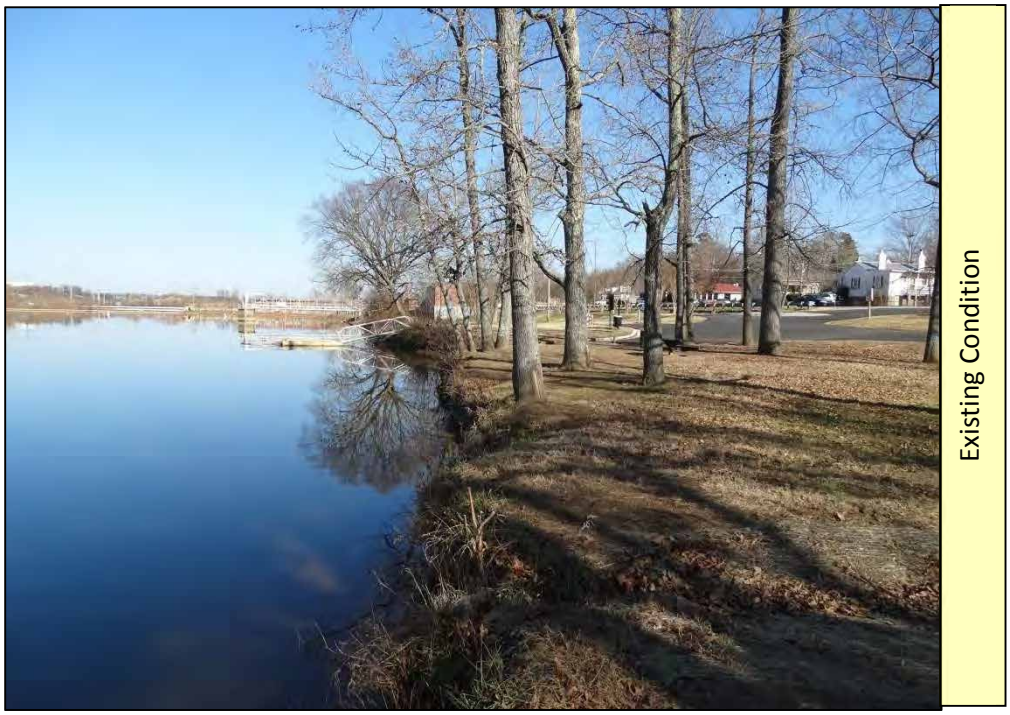


Picture 10: New accessible courtesy dock and connecting sidewalk.

Picture 11: Additional view of existing boat ramp also showing area for proposed courtesy dock and fishing platform.

Picture 12: New courtesy dock.

Picture 13: Area for proposed fishing platform and view of the existing floating dock and canoe launch.



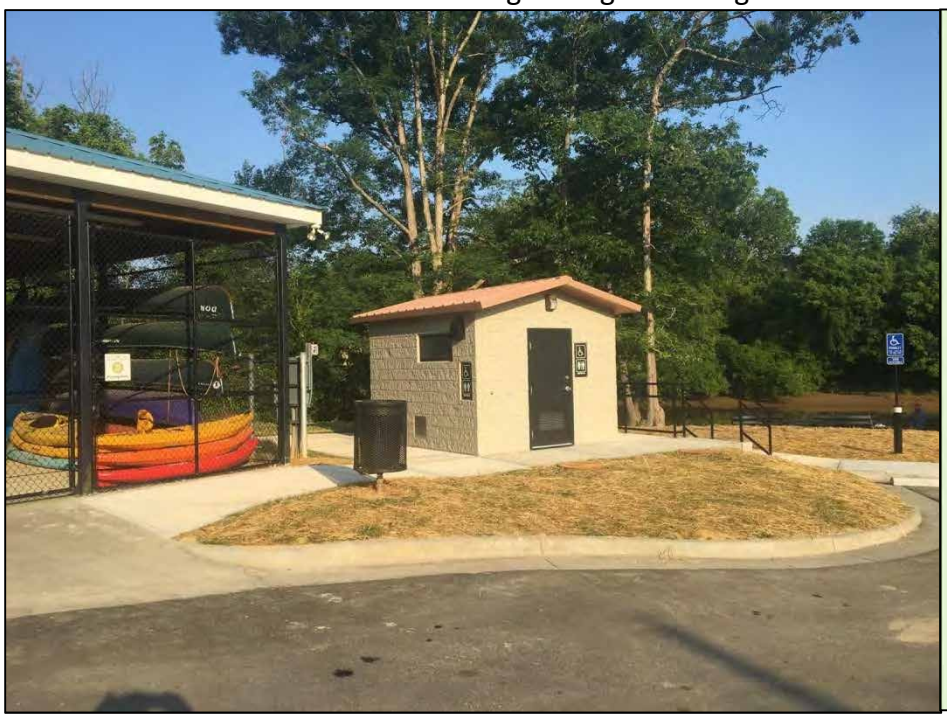
Picture 14: New courtesy dock.

Picture 15: New accessible fishing platform.

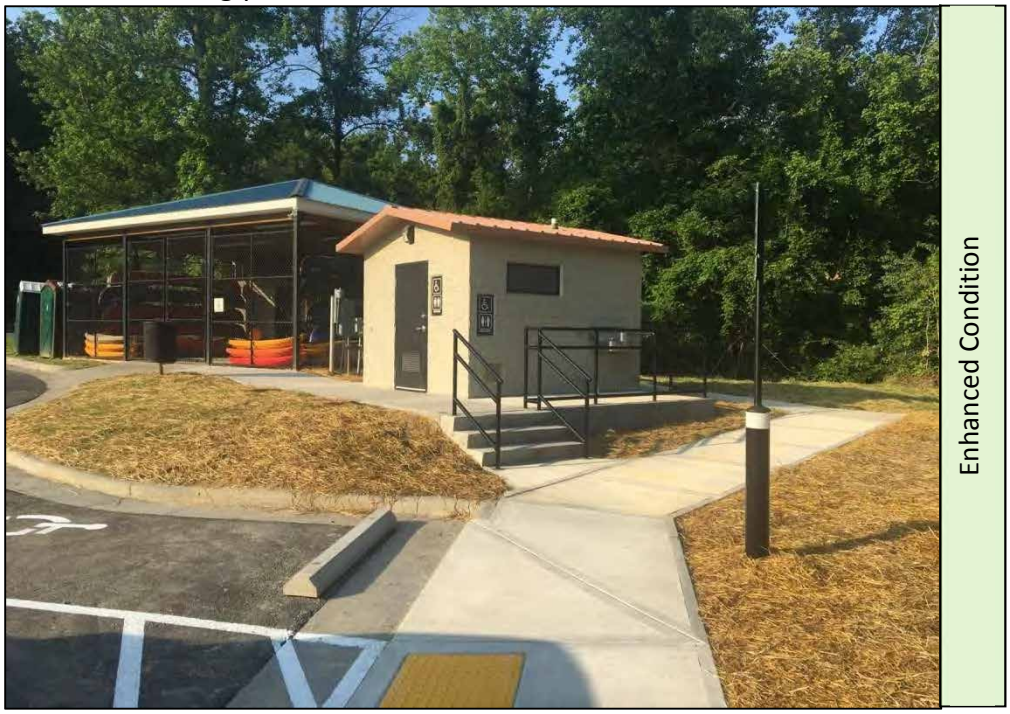
Picture 16: Additional view of the new accessible fishing platform.

Picture 17: Existing storage building and proposed area for restroom.

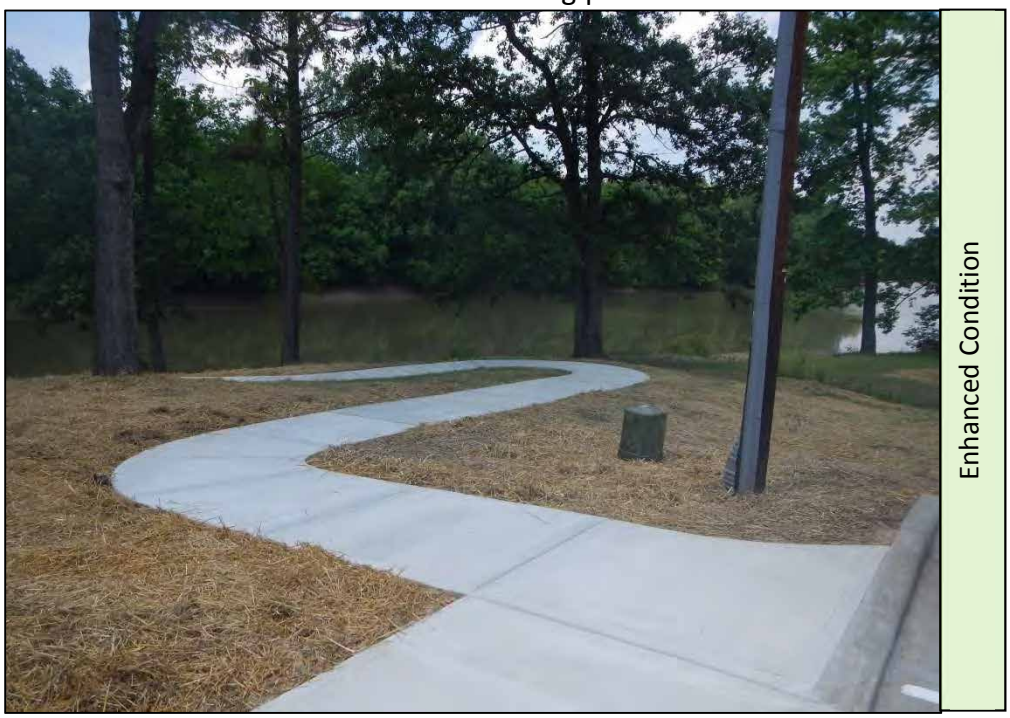
Picture 18: New restroom next to the existing storage building.



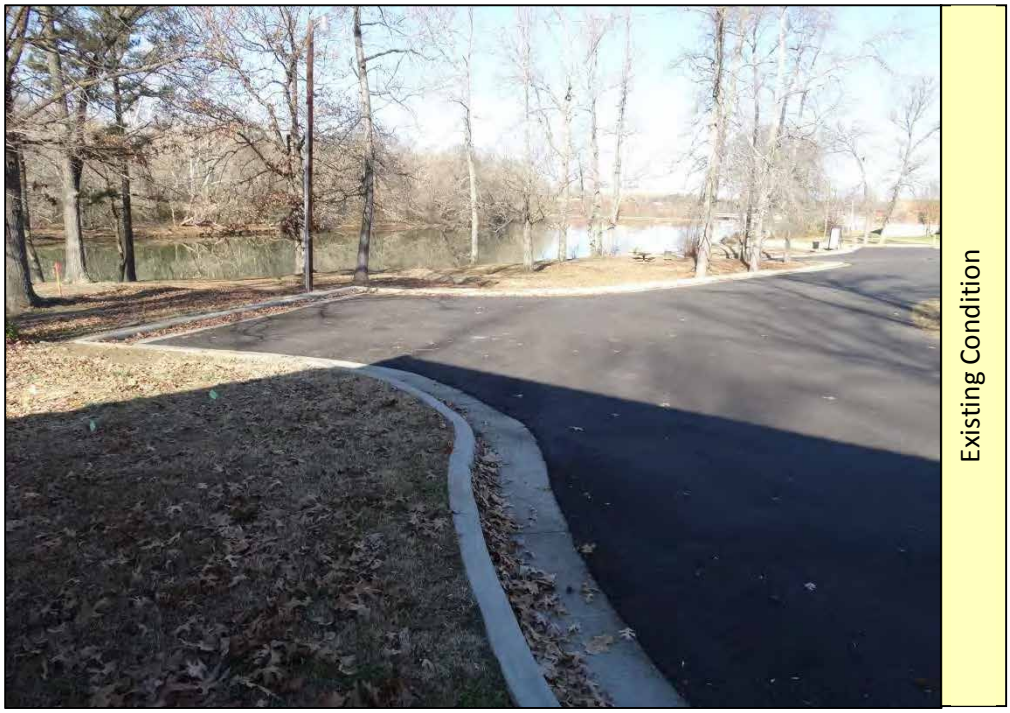
Picture 19: New accessible parking spaces with accessible sidewalk connecting to the restroom and fishing platform.



Picture 20: New accessible sidewalk to the fishing platform.



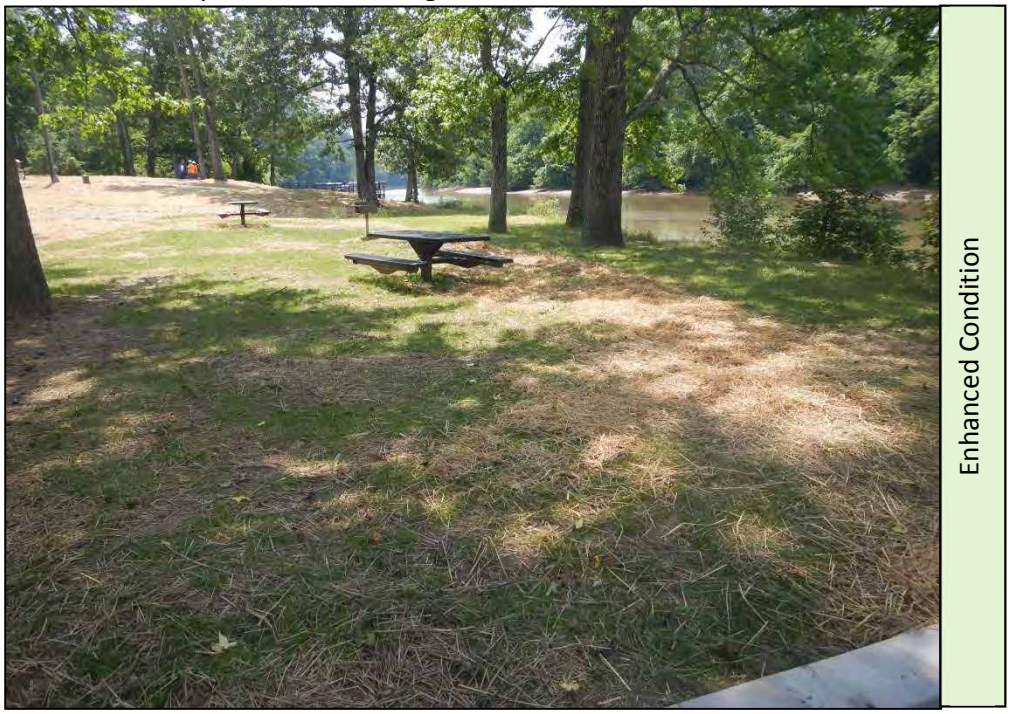
Picture 21: Existing parking spaces. Portion of curb to be removed to create accessible parking for future sidewalk to connect to the restroom and fishing platform.



Picture 22: New accessible parking spaces with accessible sidewalk connecting to the restroom and fishing platform.

Picture 23: Existing picnic table and grill near the City of Danville Water Pumping Building.

Picture 24: Relocated picnic table and grill.



APPENDIX B: Pigg River Dam Restoration at Power Dam; Year 1 Monitoring Report[8]

[8] Appendices available upon request

AFTER ACTION REPORT
FOR
DAM BREACHING

Pigg River Power Dam
Franklin County, Virginia

January 2018

Prepared by:
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Coordinator, Virginia Partners for Fish and Wildlife Program
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6669 Short Lane
Gloucester, Virginia
23061

Table of Contents

1.0 INTRODUCTION

1.1 BACKGROUND

Constructed in 1915 by the Rocky Mount Power and Light Company for power generation, Rocky Mount Power Dam (dam), also known as the Pigg River Power Dam, measured 25 feet (ft) high by 204 ft long (Figure 3, Photos 1, 2) and impounded 60 acre-ft of water over 25 surface acres (Figures 1, 2, Photos 1, 2). The dam was subsequently sold to Appalachian Electric Power in 1935 and decommissioned sometime in the middle 1950s.

The U.S. Fish and Wildlife Service (Service) developed an interest in removal or breaching of the dam due to the presence of the federally listed endangered Roanoke logperch (*Percina rex*). The recovery plan for the Roanoke logperch (Service 1992) lists construction of impoundments as one of the major causes for the species decline. Breaching the dam removed the last impediment to fish passage within a 75-mile reach of the Pigg River from the headwaters downstream to Leesville Reservoir, and also restored 2.2 miles of aquatic instream habitat impounded upstream of the dam for the Roanoke logperch and smallmouth bass (*Micropterus dolomieu*). Improvements to an additional mile upstream of the impoundment (for a total of 3.2 miles above the dam) and 5 miles downstream of the dam are resulting from the development of increased complexity of instream habitat, riparian vegetation establishment, and increased competency of the river to transport sediment. The remaining 45-mile river segment downstream to Leesville Reservoir are also improving with regards to channel habitat, stability, and complexity through restored continuity to the headwaters. Other benefits of the project include the restoration of flood attenuation, public infrastructure protection for the Rocky Mount Wastewater Treatment Plant and the Route 713 Bridge, removal of a public safety and boating hazard, and creating the conditions necessary for the future establishment of a public access area and county park for recreational fishing and boating.

The Service began working with the Natural Resources Conservation Service, Virginia Department of Game and Inland Fisheries, Franklin County, FishAmerica Foundation and other partners in 2005 to develop a plan for the removal of the dam. Significant progress was made in fundraising to support dam removal through Service and other partner funding. An architectural historic resource survey was conducted (Pezzoni and Associates 2007) and the dam and associated powerhouse were determined to be eligible for the National Register of Historic Places. Sediment quality and quantity sampling and analysis were completed for the legacy sediment impounded behind the dam (Froehling and Robertson 2007). While slightly elevated levels of cadmium and chromium were detected in several samples, above Threshold Effects Limits but below Potential Effects Limits, levels were insufficient to warrant concern from the Virginia Department of Environmental Quality (VDEQ) or the Service (Froehling and Robertson 2007). Pre-removal water quality sampling, a physical habitat assessment, and biomonitoring above and below the dam were completed (Hitt et al. 2009). Further efforts to study and

ultimately remove or breach the dam ceased in 2009 due to differences in partner priorities and insufficient funding.

Interest in dam removal or breaching was renewed in 2012 after a change in ownership to the Friends of the Rivers of Virginia (FORVA), a river restoration and access advocacy organization, and in 2013 following removal of Veteran's Memorial Park Dam upstream. On February 2, 2014, shortly after removal of Veterans Memorial Park Dam, an estimated 39,000 tons of coal ash spilled from a containment facility at Duke Energy's Dan River Steam Station into the Dan River in Eden, North Carolina, resulting in ash being transported over 80 miles to the Kerr Reservoir within a few days. Duke Energy began discussions with Federal and North Carolina and Virginia regulatory and natural resource agencies regarding possible voluntary restoration projects to compensate for the loss or injury to natural resources within the upper Roanoke River watershed. Duke Energy expressed interest in projects that were "shovel ready," including the Pigg River Power Dam breaching project. Duke representatives met with FORVA and other conservation partners on October 8, 2015 to discuss the project and remaining requirements for breaching or removal.

Concurrent with those activities, additional funding was provided by the Service to complete several studies needed to support removal or breaching without sediment removal. A Federal Emergency Management Agency required floodplain study was performed (Mattern and Craig 2015). The hydraulic analysis was used to determine impacts of breaching the dam on the adopted Flood Insurance Rate Maps and as a component of the input required for a sediment transport analysis to estimate the sediment transport modes and sediment loads downstream of the dam. The study indicated that removal of the dam would not result in an increase in the base flood elevation at the dam, the existing bridge located just downstream of the dam, at cross sections located downstream of the dam and bridge, and at cross sections located upstream of the dam. A geomorphic and sediment transport analysis (Kris Bass Engineering 2015) concluded in part: the Pigg River is in a disturbed state due to watershed development, human alteration, and sediment imbalances, with greater than 90% of the river downstream of the dam impacted due to sediment transport issues; a (sequential) notching strategy will not be an effective way of controlling the release of sediment and recommended a full dam breach with no notching strategy resulting in the more rapid restoration of the upstream channel and accelerating downstream recovery; the upstream channel could equilibrate in a matter of months, while downstream redistribution of sediments will continue for at least a year, with increases in sediment concentrations after storms expected for several years; and the most significant changes, including several feet of deposition, would be expected just downstream of the dam, resulting in a new baseflow channel with point bars, terraces, and new floodplains. A Memorandum of Agreement was signed among the State Historic Preservation Office (SHPO), FORVA, and the Service on May 2, 2016 authorizing impacts to the historic structure. Final regulatory permitting was completed on August 5, 2016, and SHPO approval of the intensive Phase I architectural survey was received on August 19, 2016. Fish sampling utilizing backpack electroshockers, seines, and dip nets to locate and

remove Roanoke logperch in the downstream scour hole prior to construction in compliance with the Service's October 28, 2015 non-jeopardy biological opinion for the project, was completed on August 25, 2016 (Photo 8). No logperch were collected in the scour hole, though 2 were collected in the riffle beneath the Route 712 bridge crossing. FORVA received funding from Duke Energy for the project, including monitoring, on August 29, 2016.

1.2 COMPLETED WORK

One hundred and forty ft of the upper 8.5 ft of concrete across the dam was removed to match adjacent floodplain elevations to restore flood capacity and protect and maintain riparian habitat upstream. Below this floodplain notch, 95 ft (48%) of the center of the dam was removed to restore river flow (Photo 26). The breach size and configuration was designed to match the stable channel dimension for this reach surveyed 100 yards (yd) downstream.

A section of dam 50 ft long on the north side of the Pigg River remains undisturbed to preserve and protect the power house and dam section for historic preservation and interpretation (Photo 26). A 35 ft section of the south side of the dam was also undisturbed and approximately 70% of the base of the dam remains intact (Photos 35 and 35). This approach provided for enhanced maintenance of channel stability, sediment carrying capacity and competency, and preservation of cultural resources, while achieving project goals.

1.3 SITE DESCRIPTION

The Pigg River Power Dam (Photos 1 and 2) is located on the Pigg River in Franklin County approximately 0.5 mile east of the Town of Rocky Mount, in the Piedmont region in southwestern Virginia (Figures 1-3). The dam is constructed on a bedrock outcrop 120 ft upstream of the State Route 712 (Power Dam Road) crossing of the Pigg River. Prior to breaching, the concrete gravity dam measured 25 ft high and 204 ft long, with a top width of 7 ft and a bottom width of 20 ft, not including the buttresses. Additional details of the dam and powerhouse can be found in the architectural description of the dam (Pezzoni and Associates 2007, Hill Studios 2016).

2.0 SITE ACTIVITIES

2.1 SITE PREPARATION

The contractor (Shenandoah StreamWorks LLC) began mobilizing to the site the week of August 8, 2016. Excavators equipped with both hydraulic hammers and buckets, as well as dump trucks were transported to the site. StreamWorks added No. 4 stone to the existing farm field access road leading to the site to support heavy equipment, replacing an 18 inch aluminum culvert pipe at the downslope end of the access road to provide improved drainage from the adjacent slope toward the river and installing silt fencing

(Photos 9, 16). A construction causeway/access consisting of riprap, beginning in upland under the Route 712 Bridge and terminating along the downstream face of the dam was started on August 18 and completed on August 23, 2016 (Photo 10).

2.2 DAM BREACHING/CONCRETE REMOVAL

Demolition of the dam began on August 29, 2016 (Photo 11). Initially 1 excavator with a hydraulic hammer was used to begin breaching operations. During the demolition process, concrete demolition debris was used initially to extend the work causeway along the dam face (Photo 12). After a sufficiently large platform was constructed, an additional excavator was utilized to transfer the remaining concrete rubble to the scour hole on river below the dam to form the base of the proposed wetland restoration area (Photos 13, 17, and 19). The concrete rubble utilized in the causeway widening was also placed in the scour hole prior to placement of soil and organic material within the proposed wetland restoration site. Dam breaching was completed on September 9, 2017 (Photo 19), with the exception of some remaining fine-scale concrete removal along the base of the channel breach (Photo 23), and continued through September 21, 2017, as exposed high points were removed. Approximately 715 yd^3 of concrete rubble was removed during the breaching process.

2.3 WOODY DEBRIS/SEDIMENT REMOVAL

An estimated 3,000 yd^3 of woody debris was located upstream of the dam (Photo 3). Quantities were based upon field observation and previous coring during sediment quantity and quality analysis. During breaching operations, the contractor began removal of the woody material to allow the river channel to return to pre-removal dimensions and completed woody debris removal after breaching was complete (Photos 13 and 15). Woody debris consisted of living trees, trunks and branches at the surface, and degraded into decomposed material at depth. Larger logs and branches were removed and stockpiled at a nearby location (Photo 16), prior to being transported offsite for disposal. Due to the degraded condition of the lower layers of woody debris, substantially less woody debris was removed than the anticipated.

Sediment and decomposed woody debris suitable for vegetation establishment were excavated behind the breach and placed in the scour hole proposed for wetland restoration area immediately downstream of the dam on river right (Photos 17 and 19).

Sediment removed behind the dam to re-establish the channel dimensions, and not utilized in the floodplain wetland restoration below the dam, remained in place to be transported by the river downstream to reestablish natural stream channel pattern; profile and dimension features including channel narrowing, riffles, pools, glides, runs and, bankfull benches (Photos 21, 26, 28, 29, 30, 35, and 36).

An unknown quantity of small and large woody debris was transported downstream during precipitation events during the breaching process and continues to be transported after project completion, as is typical with natural river channels, comprising an important component of aquatic habitat establishment (Photos 19, 21, 23, 24, 29, 30, and 35).

2.4 RESTORATION

Site restoration initially consisted of grading the proposed wetland restoration site and removal of the structural erosion and sedimentation controls. Subsequent flood flow deposition added approximately 3-4 ft of elevation to the proposed wetland restoration area, effectively precluding any potential for wetland restoration, though reestablishing a more stable floodplain elevation (Photos 25 and 26). The improved access road was left in place at the request of the Town of Rocky Mount to provide better access to the farm field adjacent to the road terminus.

During breaching operations, an area immediately upstream of the dam on river left (adjacent to the powerhouse) was identified as having a significant scour hole due to turbulent flow adjacent to the dam prior to breaching (Photo 14). Additional scouring and bank failure after breaching threatened to form a headcut into the 9-acre wetland, effectively draining it. Restoration of the slope was completed though placement of stacked stone toe protection on September 20, 2016. Backfilling the scour hole to restore a stable slope configuration, placement of coir matting, and seeding with a native seed mix was completed on September 27, 2017.

River flow mitigated restoration through channel bed and bank feature adjustment began immediately after demolition work commenced and continues to progress, particularly during high flow events (Photos 18, 20-22, 26-32, and 35-41). Natural revegetation of banks is ongoing as bank slopes stabilize.

Subsequent restoration work entailed cutting downed trees that were blocking the upstream channel in several areas and causing significant bank stress and erosion. On March 2 and July 24, 2017, work crews used chainsaws to cut tree trunks into small sections to facilitate transport downstream. This work will be ongoing as bank adjustment continues to occur through headcuts and initial channel widening, prior to channel narrowing and stabilization at the restored floodplain and stream channel elevations.

3.0 MONITORING

3.1 GENERAL

In addition to the pre-breach monitoring, qualitative and quantitative monitoring will be conducted annually for 5 years. The purpose of monitoring is to monitor the formation of stable channel morphology up to 3.2 miles upstream and 5 miles downstream of the project and inform future management decisions. Stabilization metrics include the

formation of riffles, pools, bars, benches, vegetated stream banks above ordinary high water; deposition; instream habitat; mobilization of sediment; and fish passage. A monitoring plan with methodology was submitted to interested regulatory agencies as part of VDEQ and U.S. Army Corps of Engineers permit requirements and included permanent surveyed channel cross sections, pebble counts, photography stations, sediment monitoring, and instream habitat quality assessments. Baseline studies conducted to evaluate the physical habitat, water chemistry, and biotic communities in the vicinity of the dam will be utilized for post-project monitoring. Fish sampling to determine upstream and downstream use of the restored sections of the Pigg River by Roanoke logperch and other fish species will be completed on an occasional basis. The first post-removal fish sampling occurred on August 22, 2017 (Photo 34). No Roanoke logperch were collected, though this was not unexpected given the high sediment load that continued to be transported through the restoration area. Roanoke logperch are expected to recolonize these areas once channel stability is achieved throughout the restoration reach.

3.2 PHYSICAL

Post-dam breaching monitoring by Wetland Studies and Solutions, Inc. (WSSI) began in November 2016. A total of 12 cross sections were established. Six cross sections were taken upstream, including areas far enough upstream to be beyond former backwater effects created by the dam and 6 below the breached dam downstream to where effects of the sediment transported as a result of the dam breaching were anticipated to be minimal. Spacing of the cross sections was adjusted to focus on areas around the dam where the most significant river channel and bank adjustments were expected to occur (WSSI 2016). Cross section locations were also selected to correspond with previous sediment transport and biomonitoring (Hitt et al. 2009, Kris Bass Engineering 2015).

A comparison of cross section surveys between Year 0 and 1(Appendix B) shows slight streambed incision of approximately 1 ft at Cross Section 1, upstream of the former pool extent with increased degradation (downcutting) in Cross Sections 2-4 ranging from 2 to 7 ft at Section 4, approximately 0.8 mile upstream of the dam. Changes in channel cross sections at Sections 5 and 6 (0.37 and 0.05 mile, respectively) were less significant as a result of channel evolution that occurred between completion of dam breaching activities and post-construction monitoring when significant high flow events occurred. Colonization by herbaceous vegetation has provided stabilization in those areas where banks have ceased significant mass wasting. However, tension cracks are visible at cross sections where steep banks still exist and are exhibiting signs of mass failure (WSSI 2017).

3.3 BIOLOGICAL

Monitoring was conducted along 3 biological monitoring reaches for the project. The baseline conditions for this biomonitoring program were established by the Conservation Management Institute and the U.S. Geological Survey (Hitt et al. 2009). WSSI re-established the previously monitored biomonitoring reaches, which were monitored

October 2017 as post-construction Year 1 and will be monitored again in Year 5. Each monitoring reach was collocated with a cross section: Reach A is at Cross Section 1, Reach B is at Cross Section 7, and Reach C is at Cross Section 8. Results of benthic sampling showed a slight decrease in Stream Condition Index scores at 2 of the 3 monitoring locations (WSSI 2017) in comparison to previous monitoring results (Hitt et al. 2009). The level of variation observed from pre-removal sampling events is within the range that may be reasonably expected and attributable to independent factors such as normal climatic variation. Future monitoring events will be necessary to determine the influence of dam removal on benthic communities (WSSI 2017).

3.4 HABITAT

The stream habitat assessment by WSSI was conducted in October 2017 using guidance established in the VDEQ Standard Operating Procedures for stream habitat assessment (VDEQ 2008) and the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol for habitat (Barbour et al. 1999). Habitat conditions were assessed by qualitatively rating 10 habitat parameters, including epifaunal substrate/available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, frequency of riffles, bank stability, vegetative protection, and riparian vegetative zone width. The overall habitat quality of each reach was determined by adding together the individual metric scores to provide a Total Habitat Score at each reach, with a maximum of 200 points possible. Each reach was then assigned a narrative rating according to the total habitat score, where "Optimal" is 200-160, "Sub-Optimal" is 159-107, "Marginal" is 106-54, and "Poor" is 53-0. Reach A was determined to be in "Poor" condition primarily due to bank erosion with heavy deposits of material in the reach, increasing embeddedness, and resulting in an unstable substrate. Reach B was in "Marginal" condition, exhibiting moderately unstable banks with a lack of vegetation. Sediment deposition was also present in Reach B with various velocity/depth regimes and a fairly wide riparian zone. Reach C was in "Marginal" condition with moderately unstable banks, bare soil present and heavy deposition of fine material in the riverbed (WSSI 2017).

3.5 WETLAND

Hydrology, vegetation, and soil monitoring was initiated at 3 wetland sites adjacent to the former pool as a requirement of the VDEQ Water Protection Permit for the project. Moderate drought conditions were present during sampling. Soils at both Sites 3 and 4 (adjacent to Cross Section 2 and Cross Section 4, respectively) were a uniform sandy loam texture with no water or saturation observed in test pits. Two sampling locations were established at Wetland Site 2 (river left, just upstream of the dam) and hydric soil indicators were seen in both locations. No water or saturation was seen at Site 2, Point 1. Water was present at approximately 6 inches below surface elevation at Site 2 Point 2. Qualitative observations made during monthly monitoring well data collection has shown the Site 2 wetland area to be largely dry at the surface since June 2017. Wetland (hydrophytic) vegetation dominated all wetland sites (WSSI 2017).

All monitoring reports and other project related documents are available at: https://www.fws.gov/northeast/virginiafield/partners/powerdam.html

4.0 OUTSTANDING REQUIREMENTS AND RELATED FUTURE WORK

In addition to the required monitoring, signage will be completed to provide the public assistance in interpreting the historic significance of the powerhouse and remnants of Pigg River Power Dam. That work is expected to be completed in 2018.

Future work at the site may include enhanced public boating and fishing access and the possible creation of a Franklin County public park.

5.0 CONCLUSIONS

The dam breaching and associated work is considered a success. The subsequent sediment transport downstream is resulting in reestablishment of more stable channel features, including channel narrowing, floodplain and inner berm benches, point bars, riffles, and pools (Photos 35 and 36). The former reservoir upstream of the dam is rapidly adjusting to a more stable channel (Photos 37-41), though complete stabilization is taking longer than anticipated in the sediment transport study and may take another year or more to fully stabilize.

6.0 REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for use in streams and wadeable rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water, Washington, D.C. 339 pp.

Froehling & Robertson, Inc. 2007. Sediment sampling and analysis study, Pigg River Power Dam, Franklin County, VA. Report to FishAmerica Foundation, Alexandria, VA.

Hill Studios. 2016. Phase II Survey Report, Rocky Mount Dam and Powerhouse, Franklin County, Virginia. Report to Friends of the Rivers of Virginia, Roanoke, VA.

Hitt, N.P., J. Jones and K. Convery. 2009. Biomonitoring for the Rocky Mount Power Dam removal project: Establishing baseline conditions. Conservation Management Institute, Blacksburg, VA.

Kris Bass Engineering. 2015. Power Dam sediment capacity and fate modeling. Report to the Service, Friends of the Rivers of VA, and Town of Rocky Mount, VA.

Mattern and Craig. 2015. Hydraulic Analysis Summary Report Pigg River Power Dam Removal, Franklin County, VA. Report to Friends of the Rivers of Virginia, Roanoke, VA.

Pezzoni and Associates. 2007. Rocky Mount Dam and Powerhouse (033-0016), Franklin County, Virginia, Survey Report and National Register Evaluation. Report to FishAmerica Foundation, Alexandria, VA.

U.S. Fish and Wildlife Service. 1992. Roanoke Logperch (*Percina rex*) Recovery Plan. Newton Corner, MA. 34 pp.

Virginia Department of Environmental Quality. 2008. Biological monitoring program quality assurance project plan for wadeable streams and rivers. Richmond, VA. 43 pp.

Wetland Studies and Solutions, Inc. 2016. Pigg River Restoration at Power Dam, Post Construction Monitoring Report. Report to Friends of the Rivers of Virginia, Roanoke, VA.

Wetland Studies and Solutions, Inc. 2017. Pigg River Restoration at Power Dam, Year-1 Monitoring Report. Report to Friends of the Rivers of Virginia, Roanoke, VA.

Figure 1

Power Dam Location Map

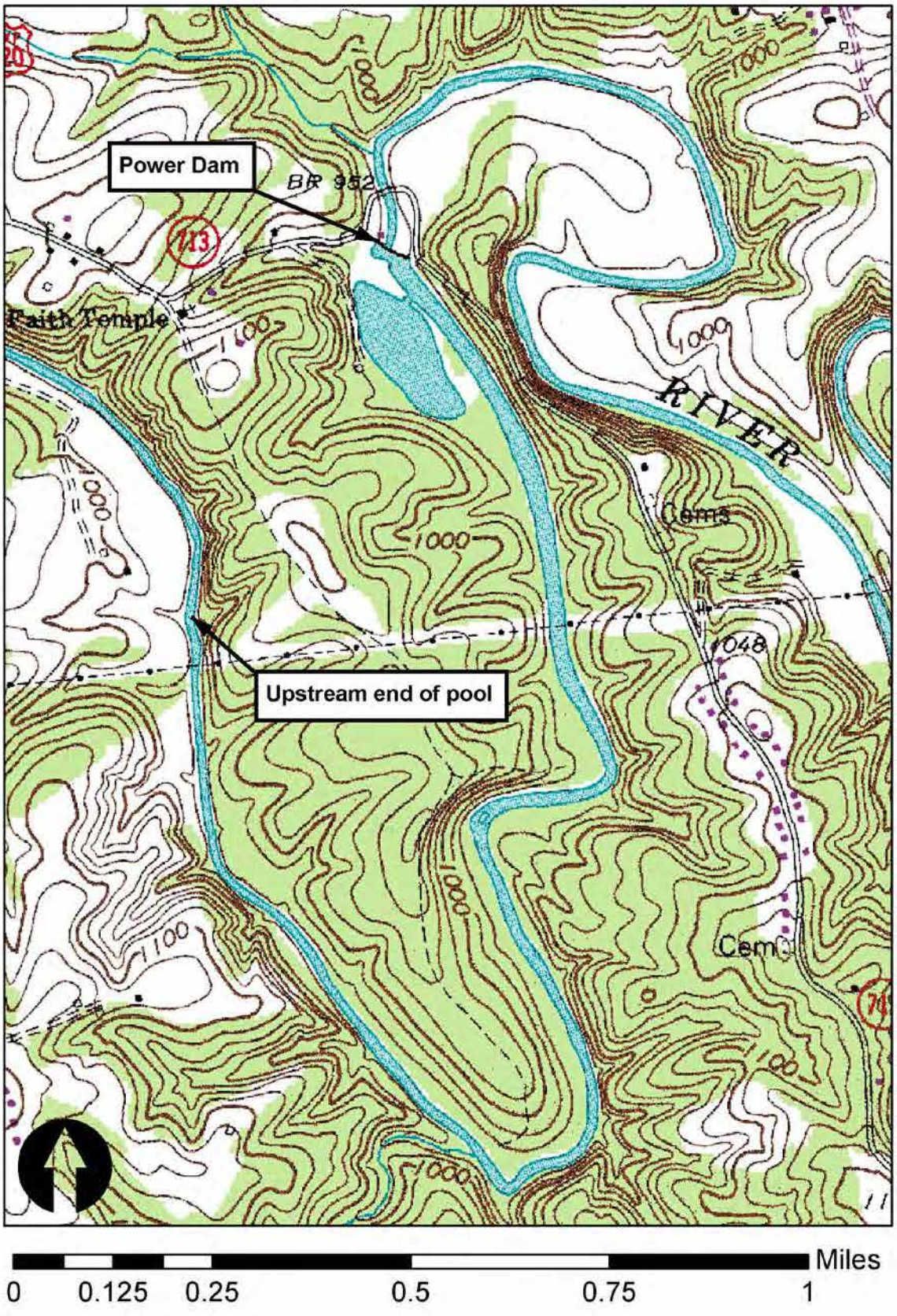


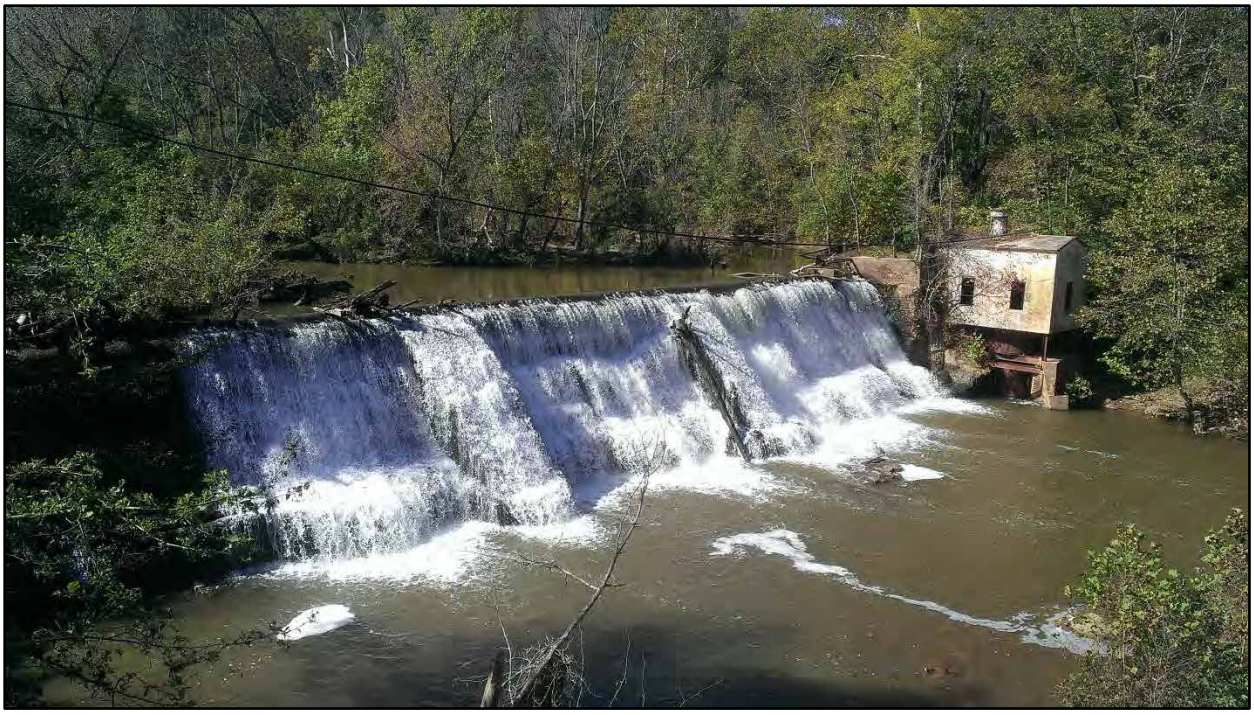
Figure 2
Power Dam Location Map

Figure 3. Proposed Sequential Notching and Final Notch Configuration Plan

Figure 4. Post Construction Monitoring Locations

APPENDIX A

Photo documentation



1. Power Dam pre-removal view southwest from Route 7124 Bridge (10/8/15)

2. Power Dam during 3 inch rainfall event, view southwest (3/16/07)

3. Woody debris upstream of Power Dam blocking river channel pre-breach, causing adjacent flooding (1/26/06)

4. Typical levee formations on both right and left banks upstream of Power Dam pre-breach (11/17/15)

5. Typical upstream river channel within pool with high levees and shallow, sediment filled channels (11/17/15)

6. Over-widened channel and scour hole on right bank below Power Dam, view east (4/16/15)

7. View north, downstream of Power Dam depicting over-widened, sediment starved channel (4/16/15)

8. Pre-breach fish sampling in the scour pool below Power Dam, view east (8/25/16)

9. Access road down to floodplain causeway with silt fencing in place, view north (9/7/16)

10. Construction access causeway in place prior to removal, view north (8/25/16)

11. Initial dam breach, view southeast (8/29/216) (credit Franklin News Post)

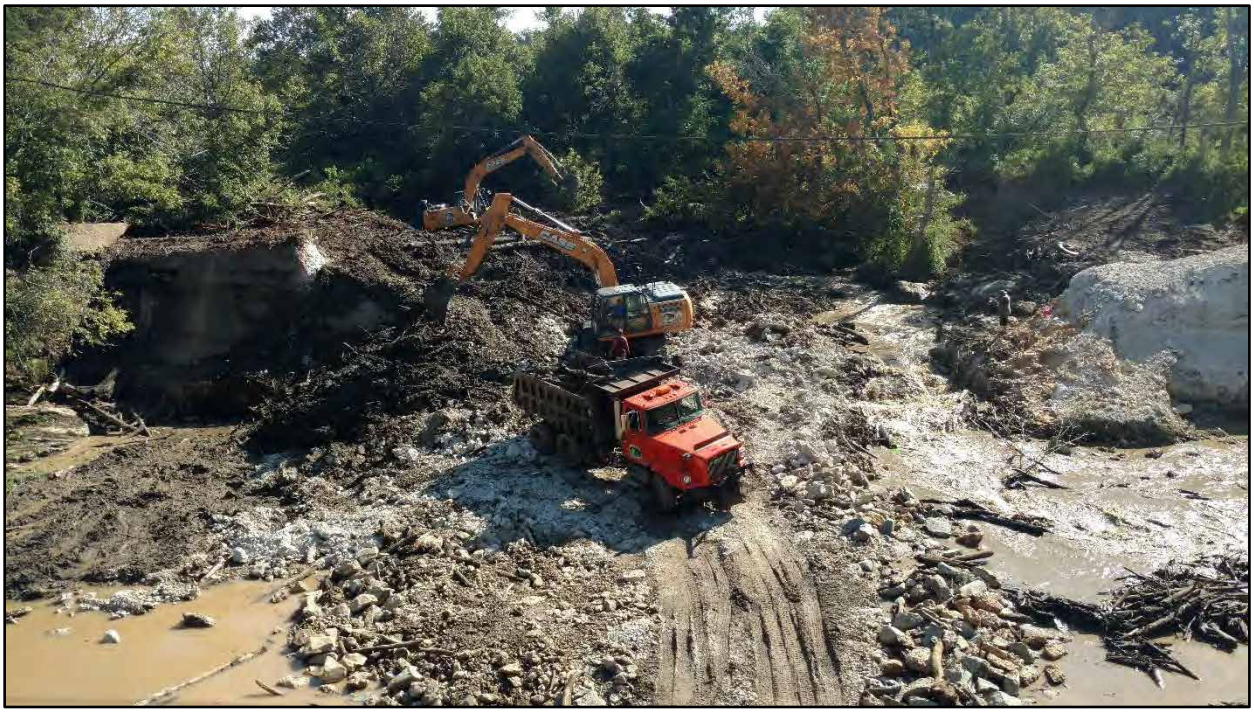
12. Progress of breaching activities after one day of work, view southeast (8/30/16) (credit FORVA)

13. Woody debris removal behind Power Dam breach begins, view east (9/7/16)

14. Exposure of existing scour hole (red arrow) above Power Dam, potentially leading to wetland headcut (9/7/16)

15. Removal of woody debris above Power Dam (9/9/16)

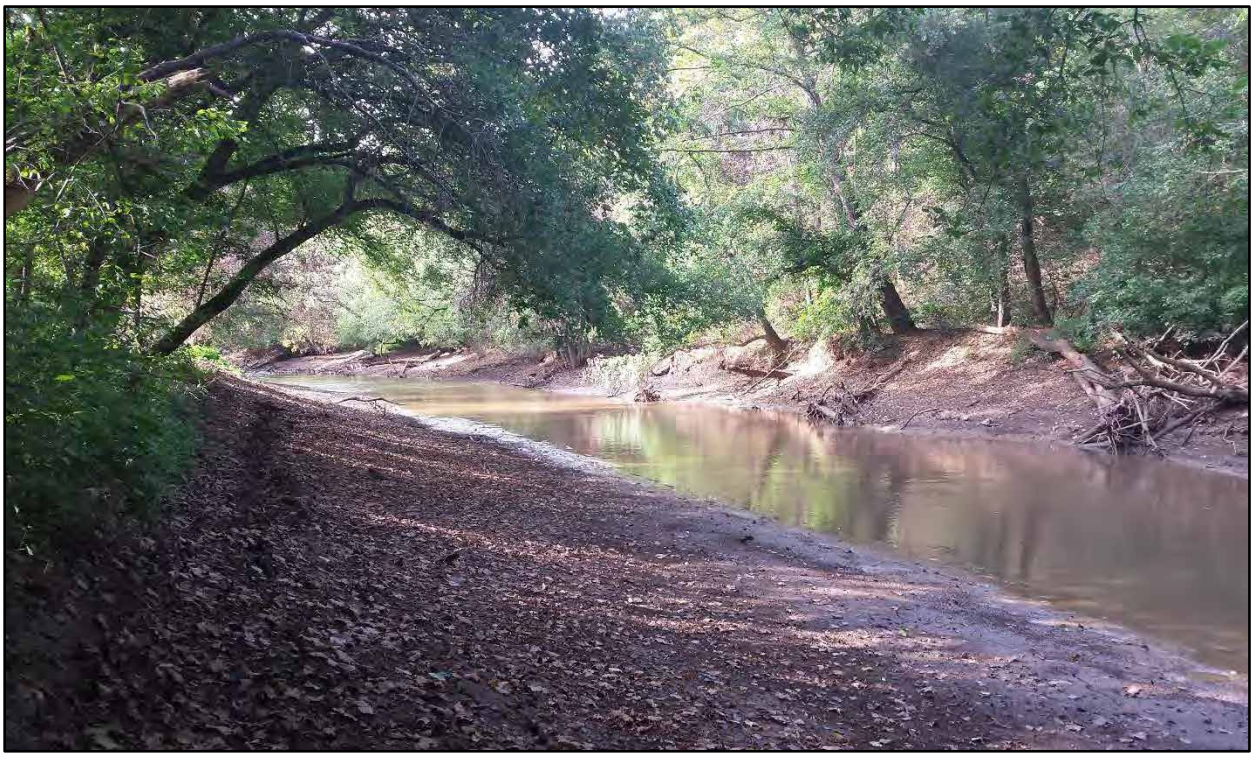
16. Woody debris stockpile area, view northwest (9/9/2016)



17. Breach nearly complete, woody debris removal continues, view southeast (9/8/16)

18. River cutting channel through relict sediment immediately upstream of breach, view east (9/12/16) (credit FORVA)

19. Fine-tuning breach opening and stockpiling of material in former scour hole to restore floodplain bench (9/12/16)



20. View southeast (upstream) of dewatering of former pool upstream of breach (9/20/16)

21. View downstream (north) from Route 712 Bridge showing channel filling and formation (9/21/16)

22. View southeast (upstream) of channel formation in former pool sediment (9/21/16) (credit FORVA)

23. Sixty-five foot width base flow channel completed through Power Dam (9/22/16) (credit FORVA)

24. View of left bank upstream of dam after stacked stone toe, backfilling, and matting stabilization (10/5/16)

25. Floodplain deposition in downstream scour area during high flow event, view southeast (11/9/16) (credit FORVA)

26. Floodplain deposition on left and right banks below breach (2/2/17)

27. Bank sloughing and new floodplain bench upstream of the breach (2/2/17)

28. Narrowing of channel and restoration of meanders downstream below Route 712 Bridge (2/2/17)

29. Cobble and gravel sediment transport through breach in dam (5/25/17)

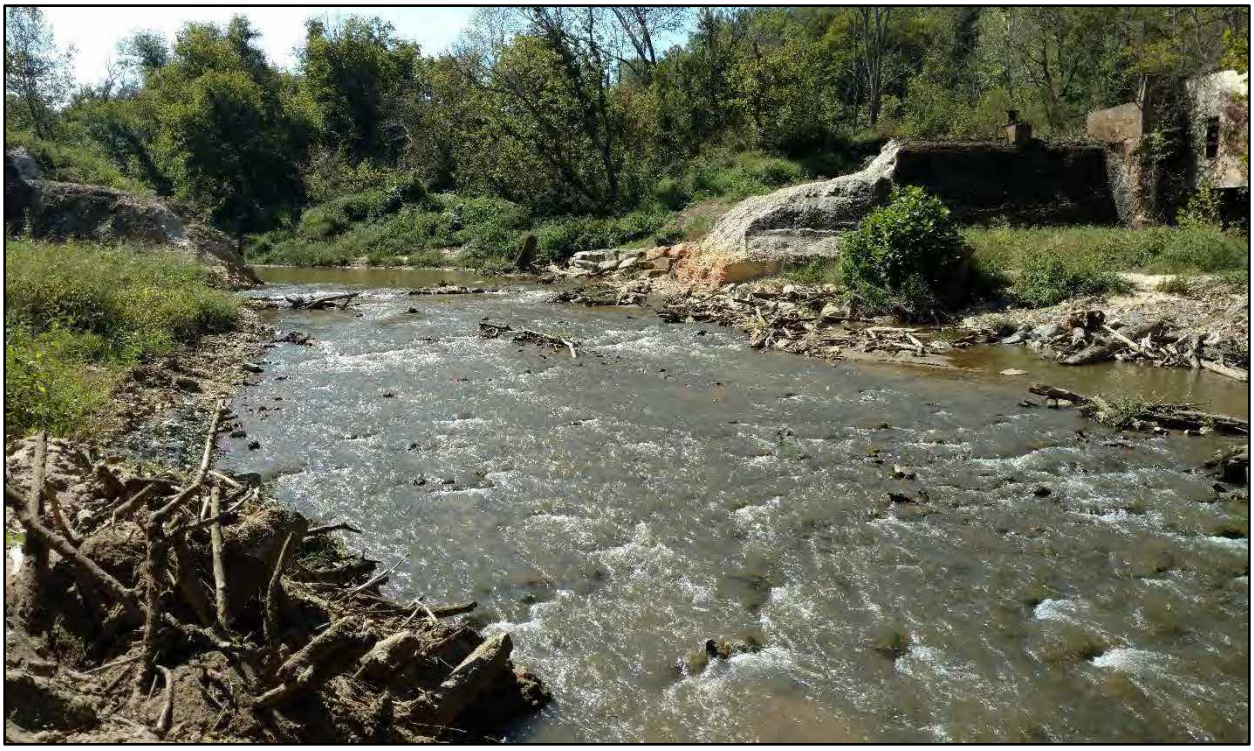
30. Additional coarse material deposition downstream between breach and Route 712 Bridge (5/25/17)

31. Floodplain bench and channel post fallen tree removal (breach in background) (8/2/17) (credit FORVA)

32. Establishment of a meander bend and bank revegetation upstream of breach (8/2/17) (credit FORVA)

33. Narrowed channel upstream and revegetation of newly formed floodplain (8/2/17) (credit FORVA)

34. Post-removal fish sampling with VDGIF and VDOT below breach (8/22/17)



35. Riffle re-established in former scour hole below Power Dam breach (9/26/17)

36. Stable cobble/gravel point bar on the inside of a meander bend downstream of breach below Route 712 Bridge (9/26/17)

37. Re-established river channel and vegetated floodplain upstream of breach. Arrow depicts pool elevation (9/26/17)

38. River channel and floodplain approximately 580 feet upstream of breach. Arrow depicts pool elevation (10/25/17)

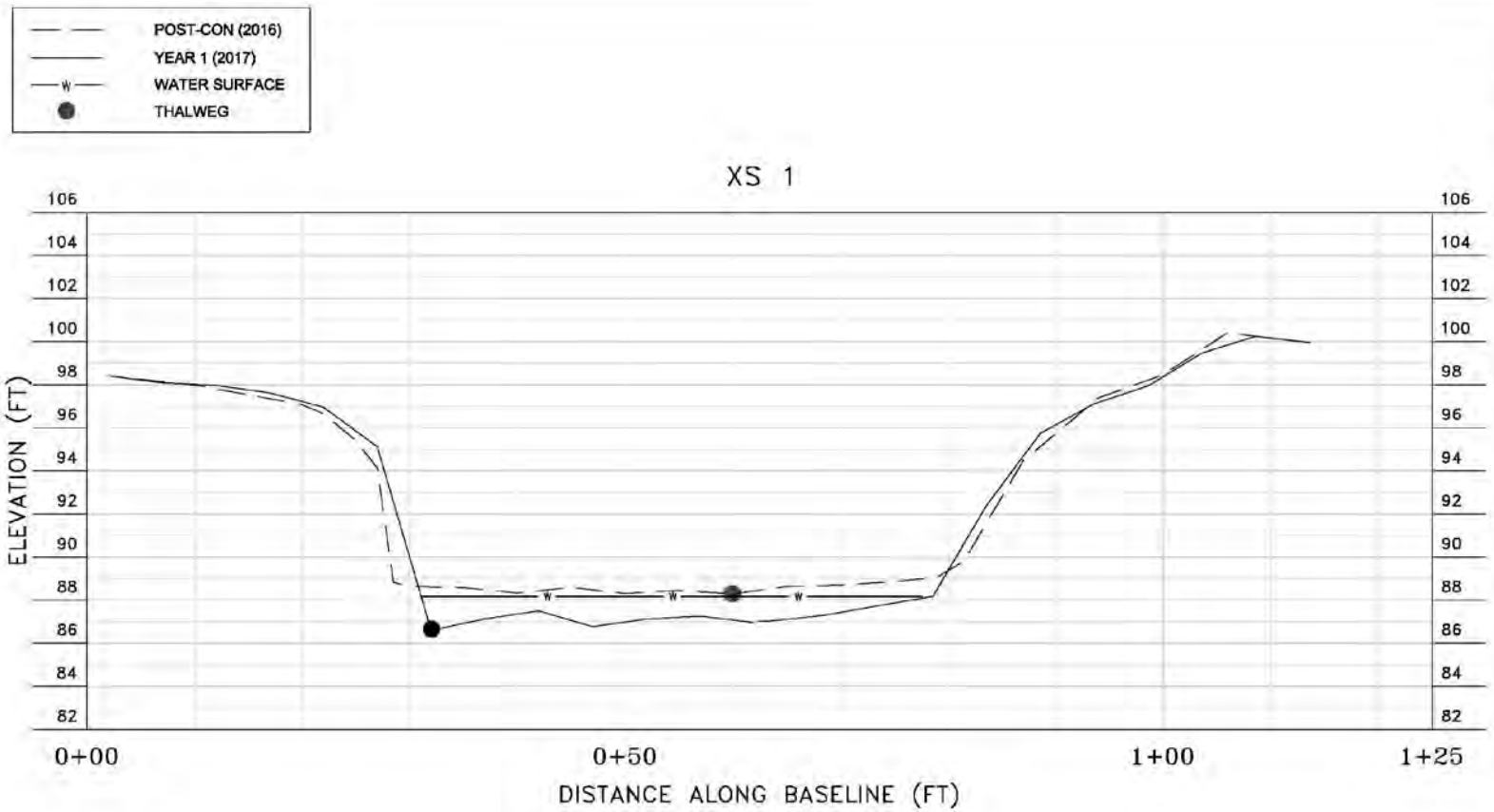
39. Same area from opposite side of the Pigg River illustrating high banks in area. Arrow depicts pool elevation (10/25/17)

40. Re-established river channel and vegetated floodplain 2,800 feet upstream of breach. Arrow depicts pool elevation (10/25/17)

41. Re-established meander bend and exposed rock outcrop approximately 3,100 feet upstream of breach (10/25/17)

APPENDIX B

Pre- and Post-Construction Cross Sections



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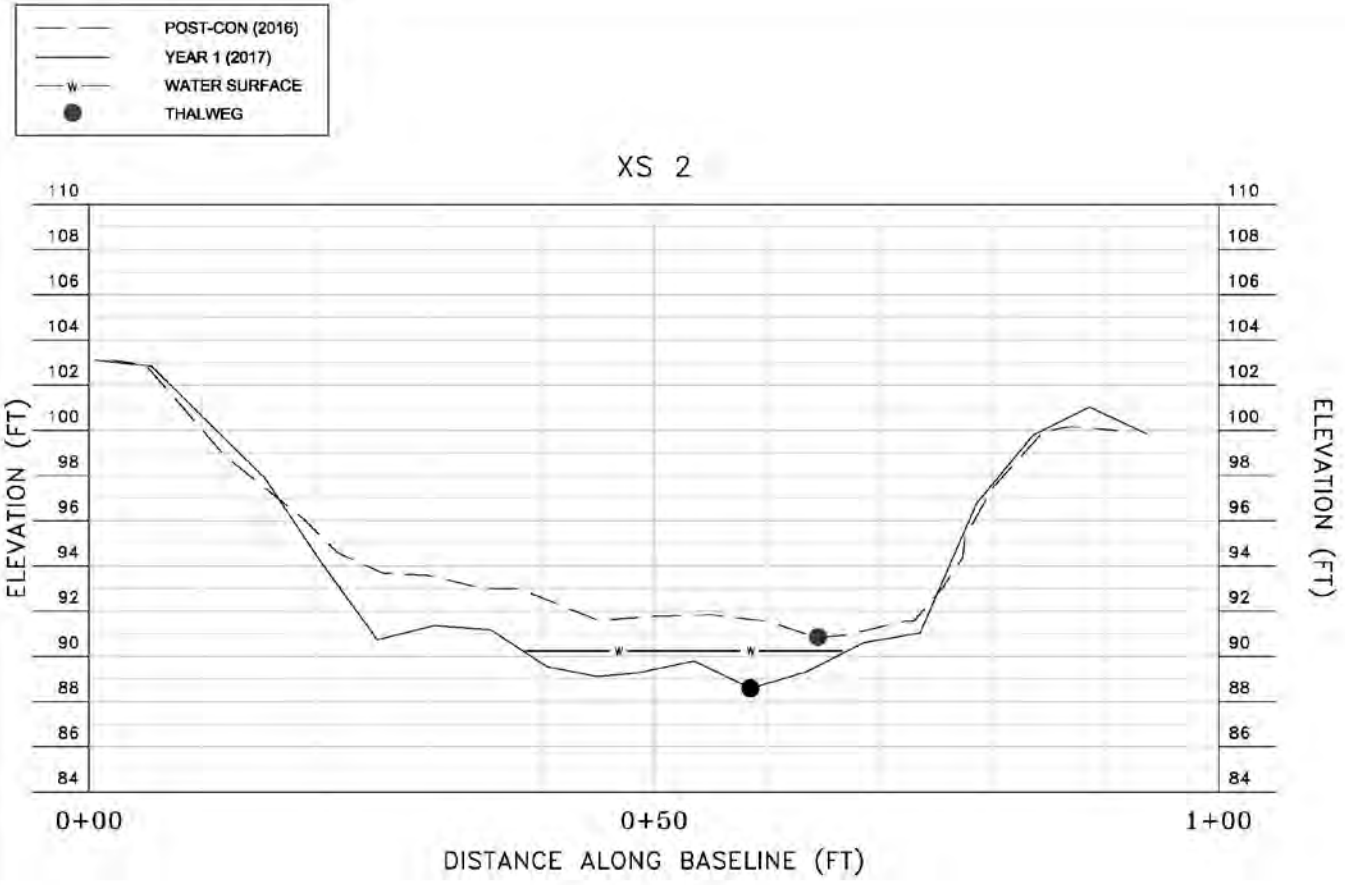
Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 1

1 of 11



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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 2

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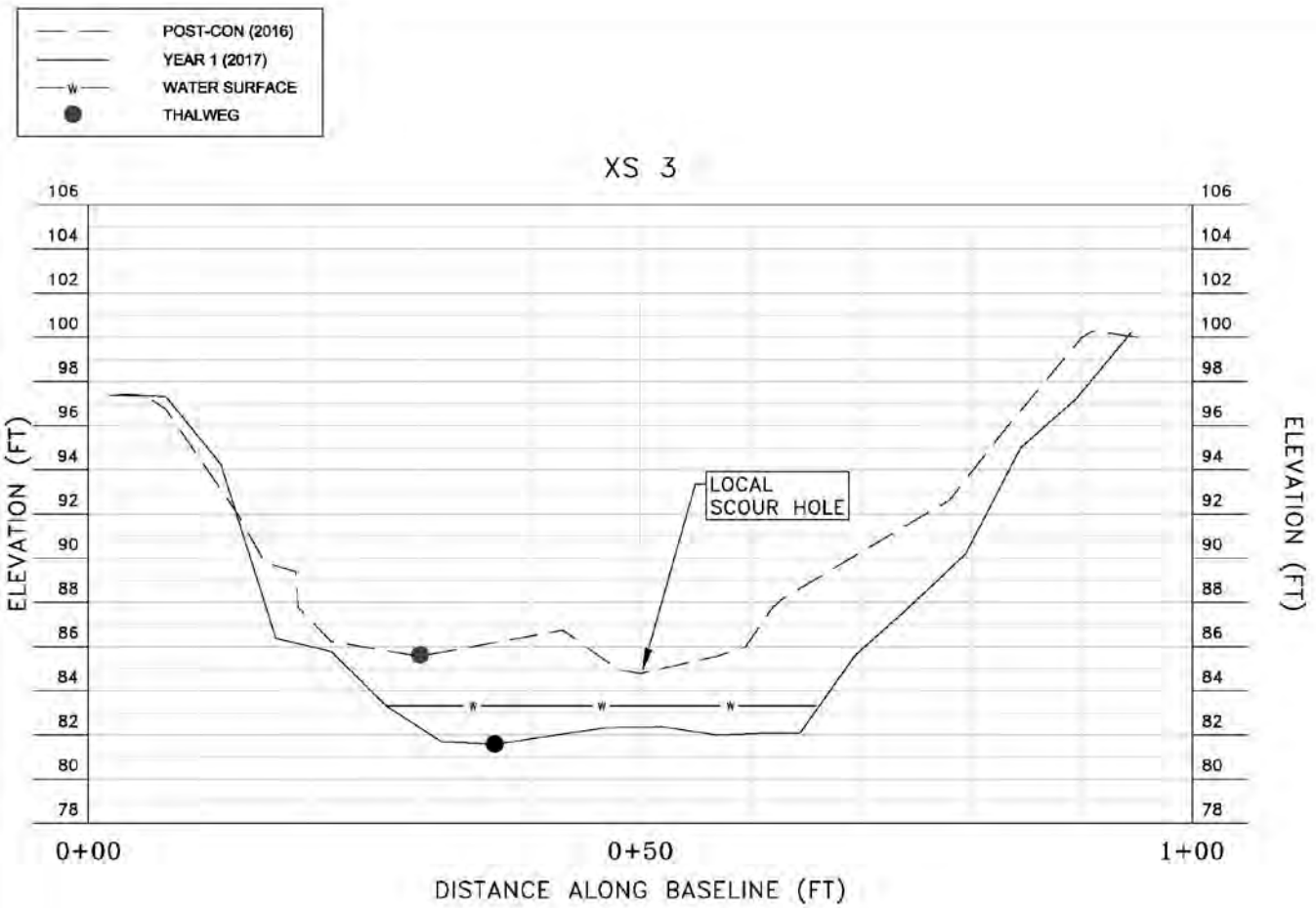

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 3

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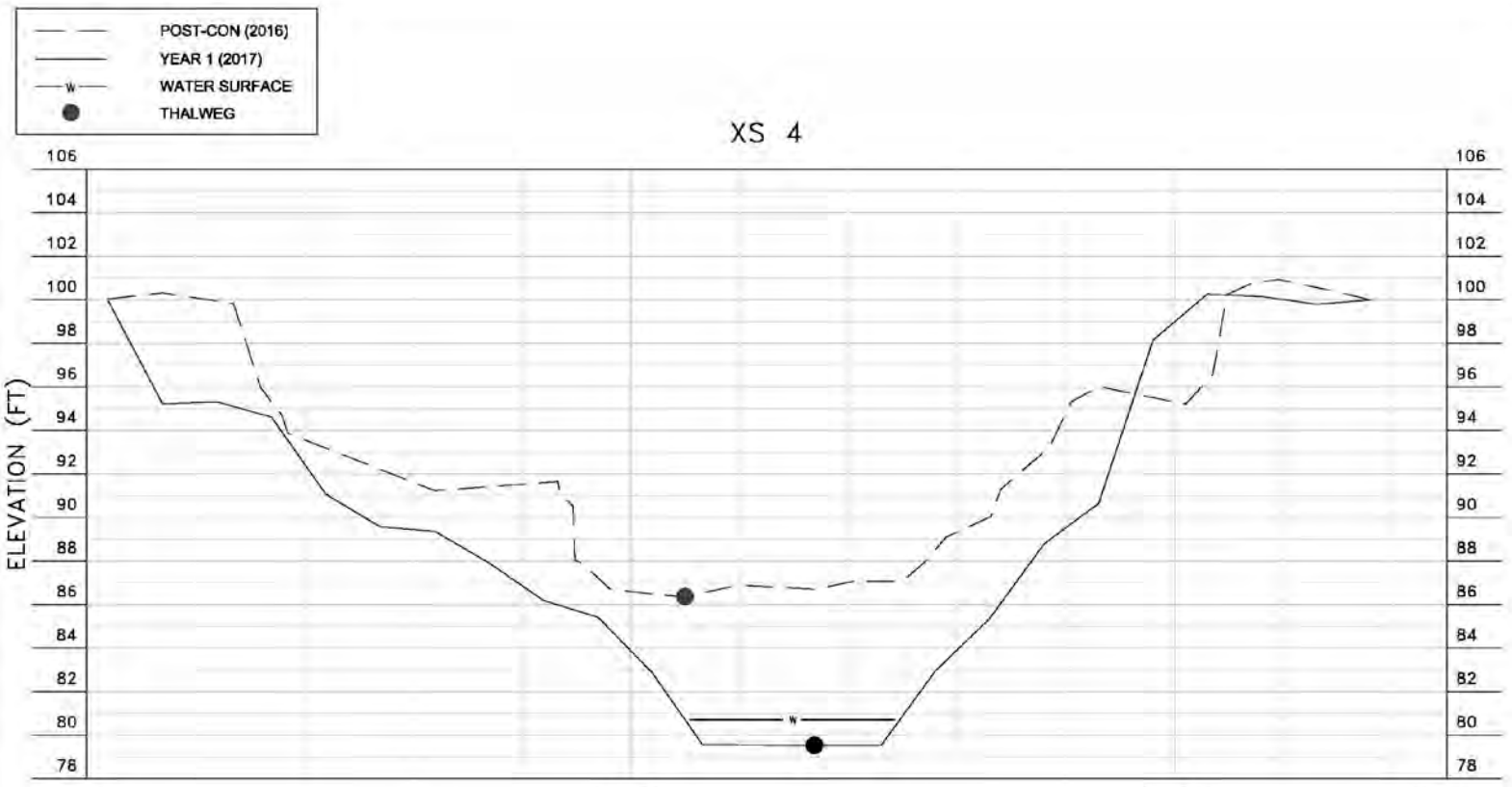

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 4

REVISIONS
No. | Date | Description | Appr'd By

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NGVD- and Orange County Data

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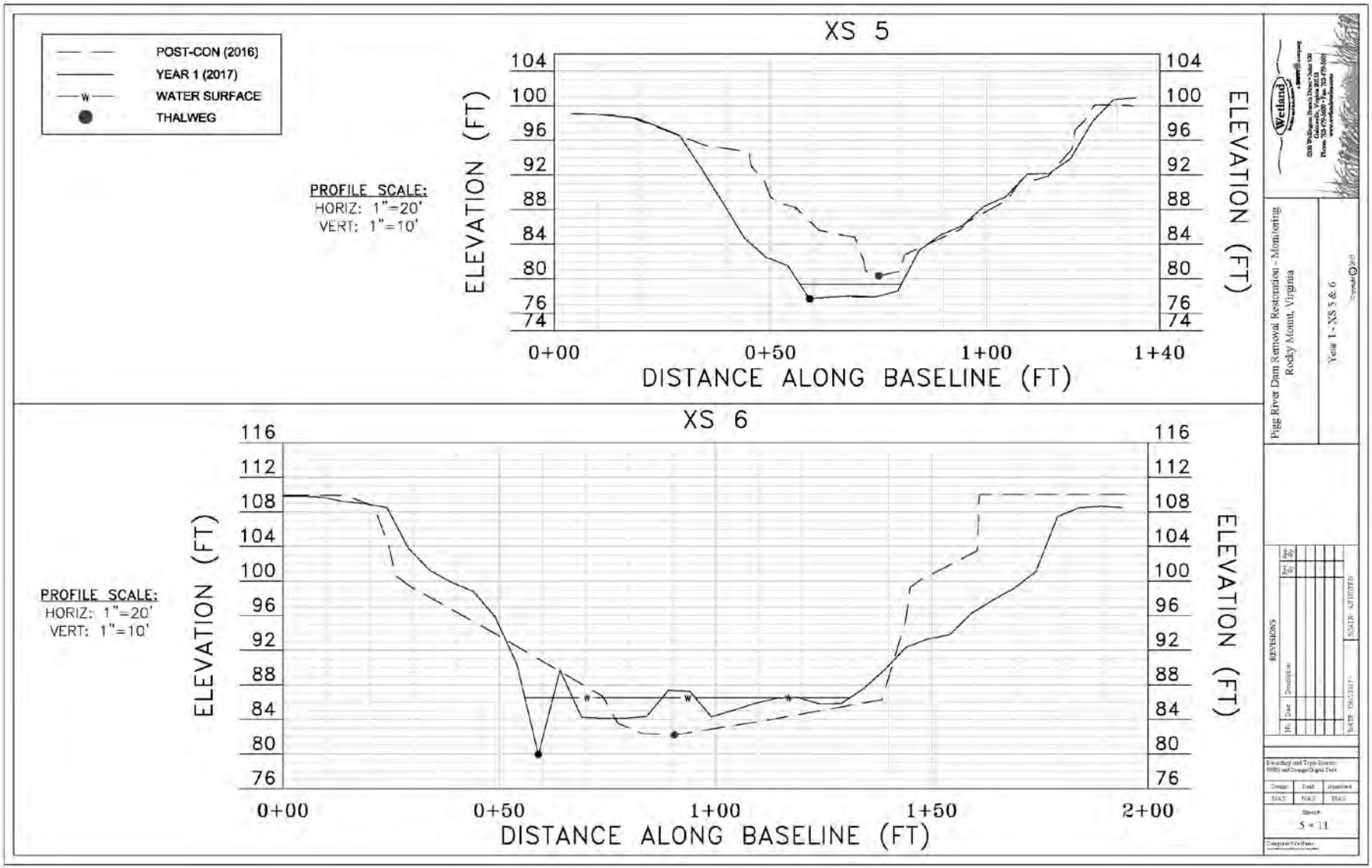

Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 5 & 6

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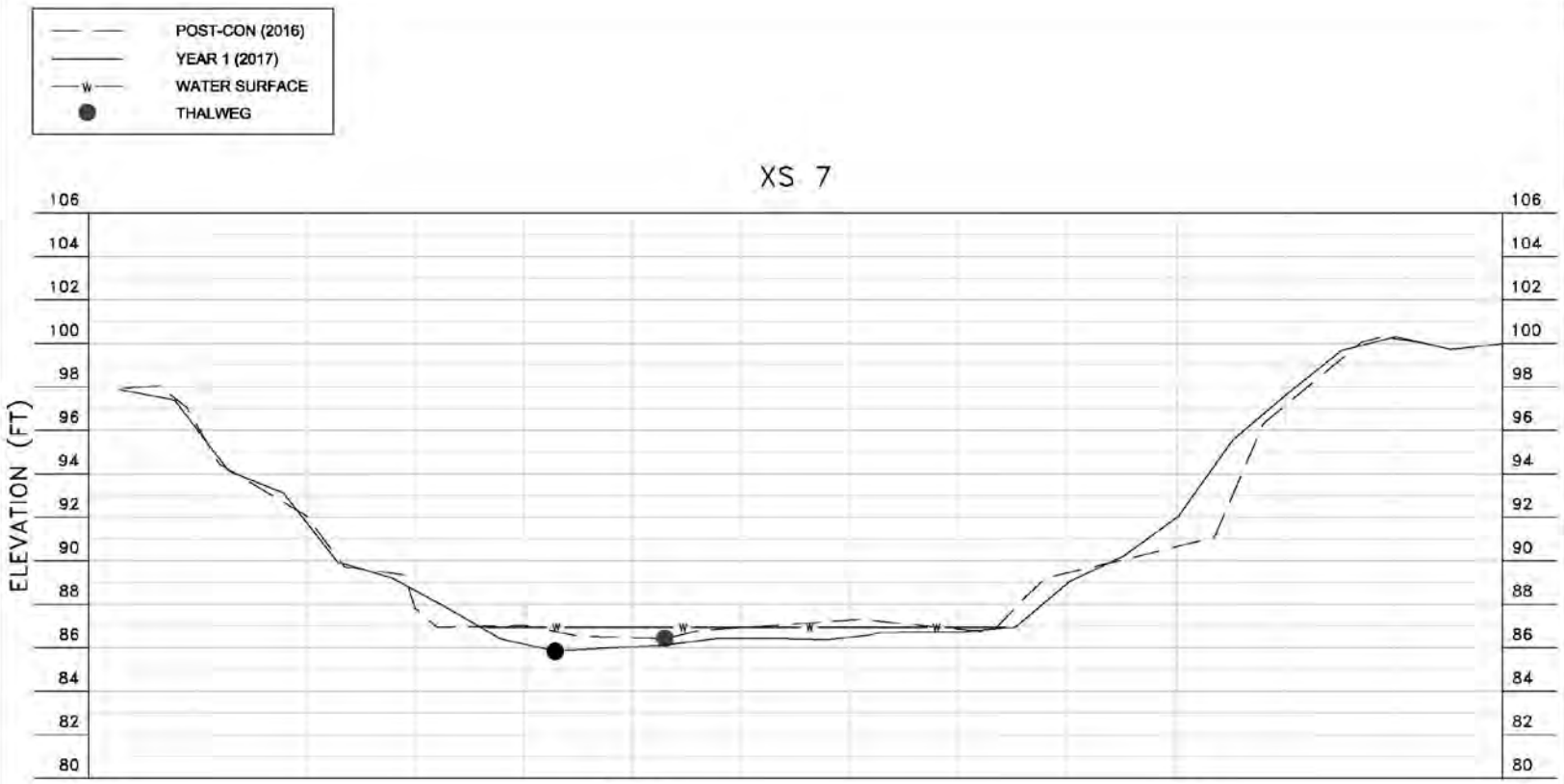

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Wetland

Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 7

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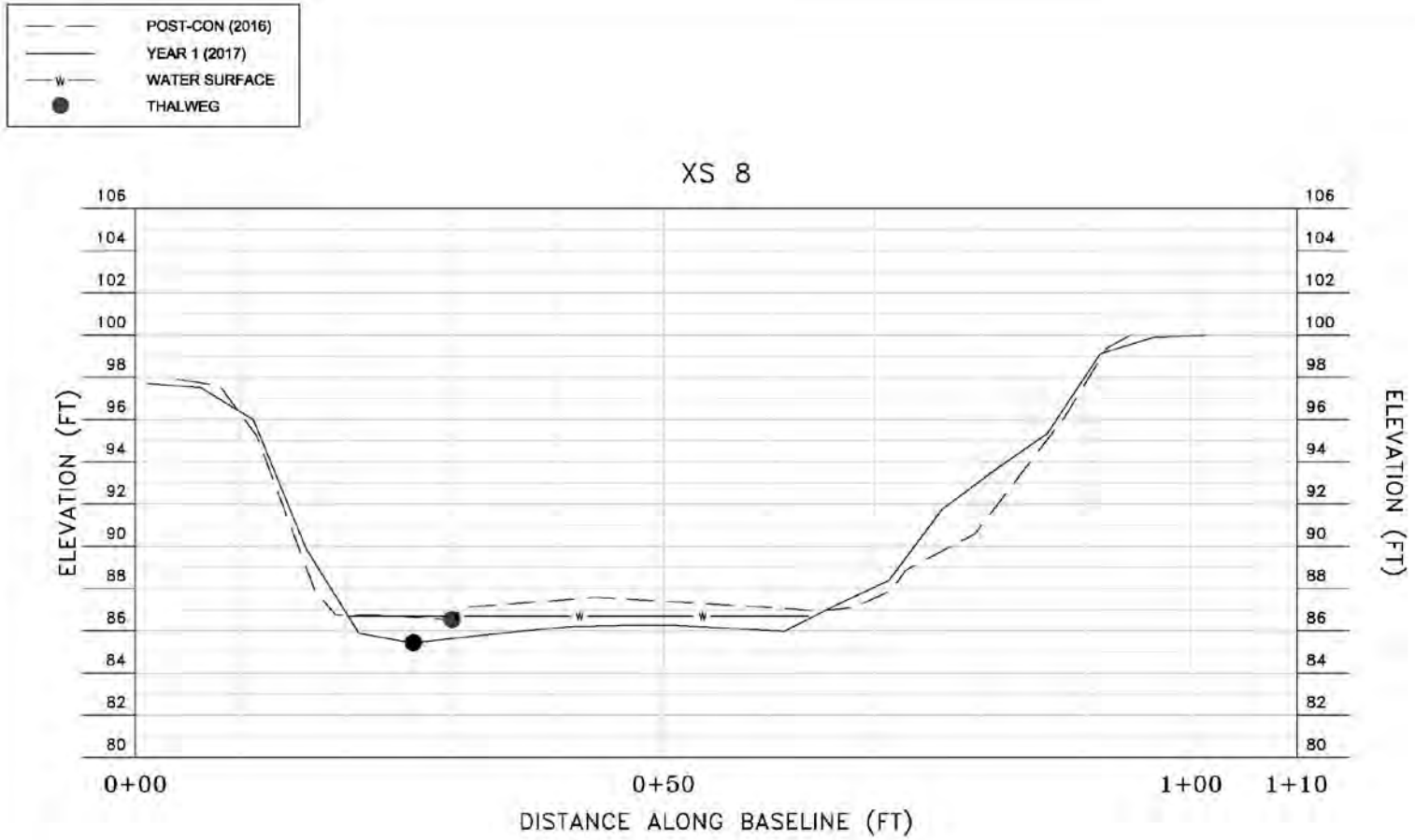

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 8

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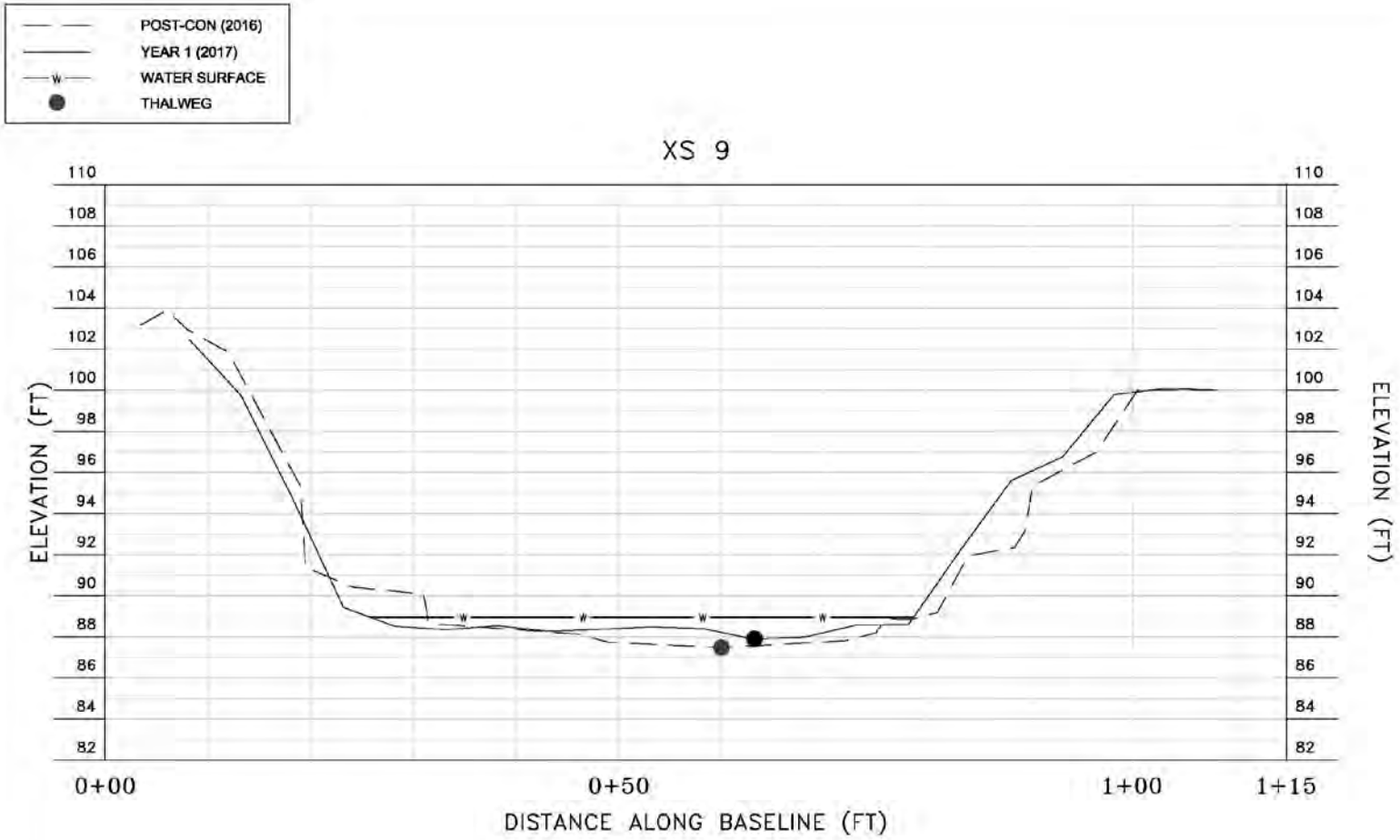

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 9

REVISIONS

No.	Date	Description	Appr. By

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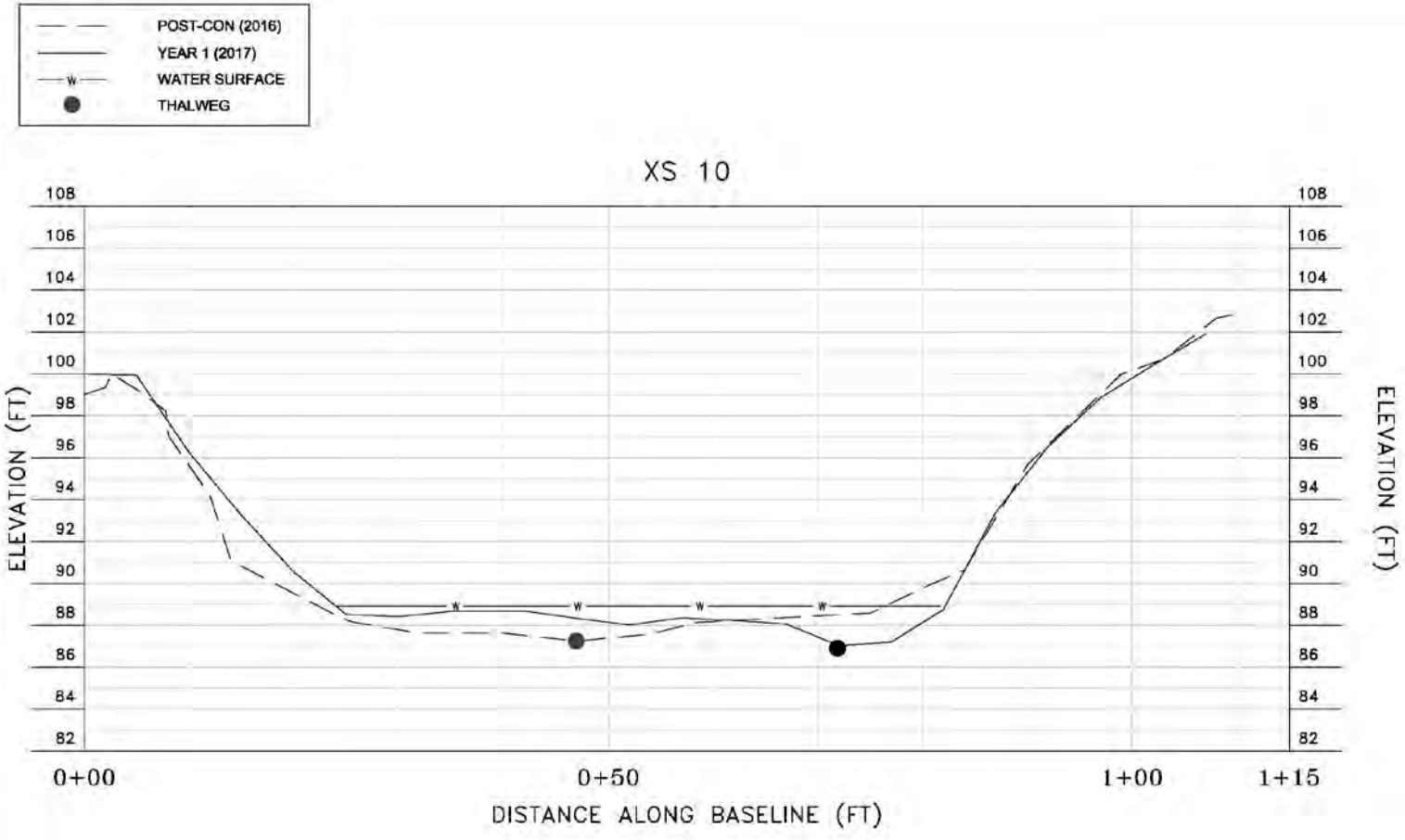

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 10

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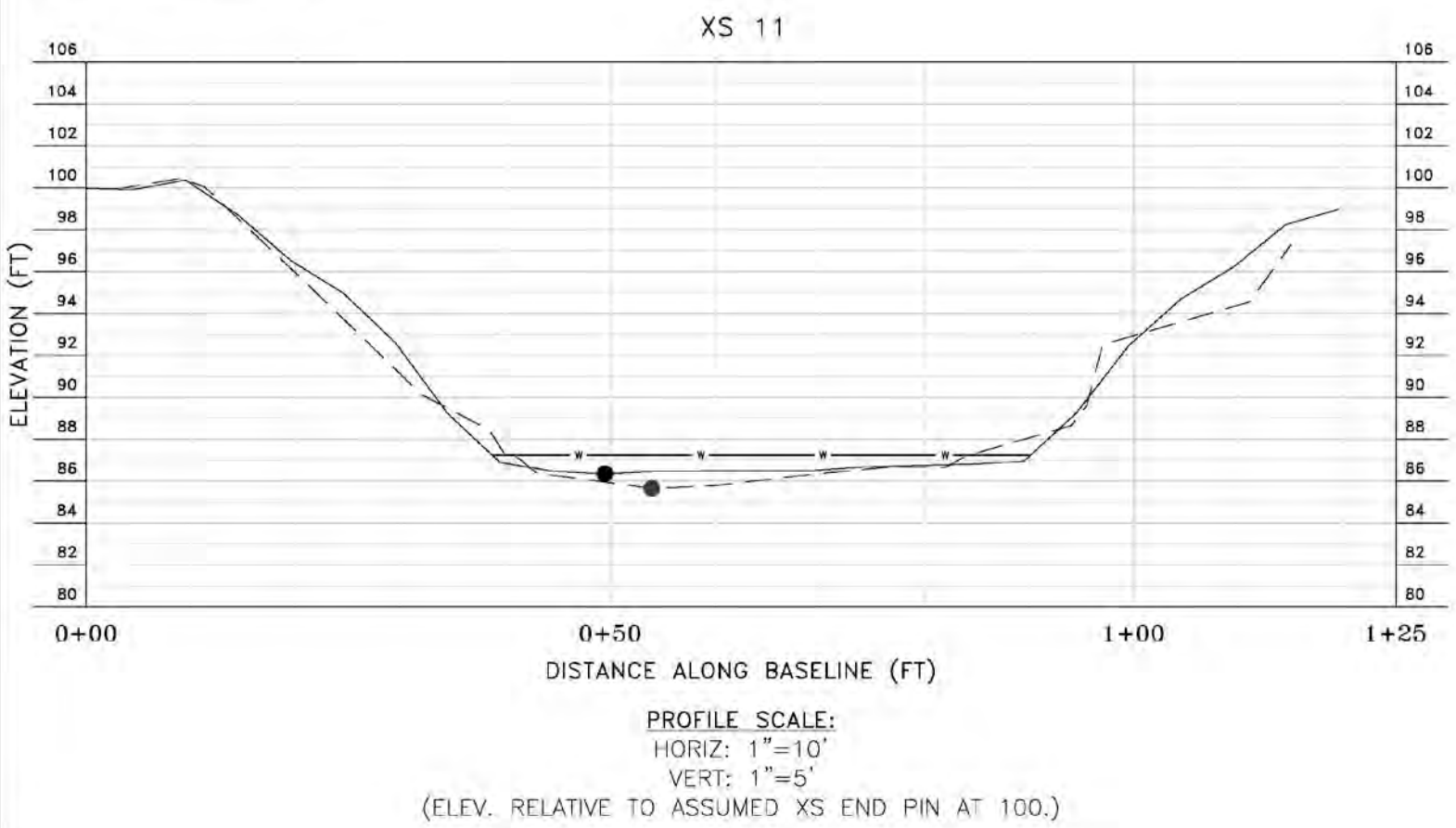

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 11

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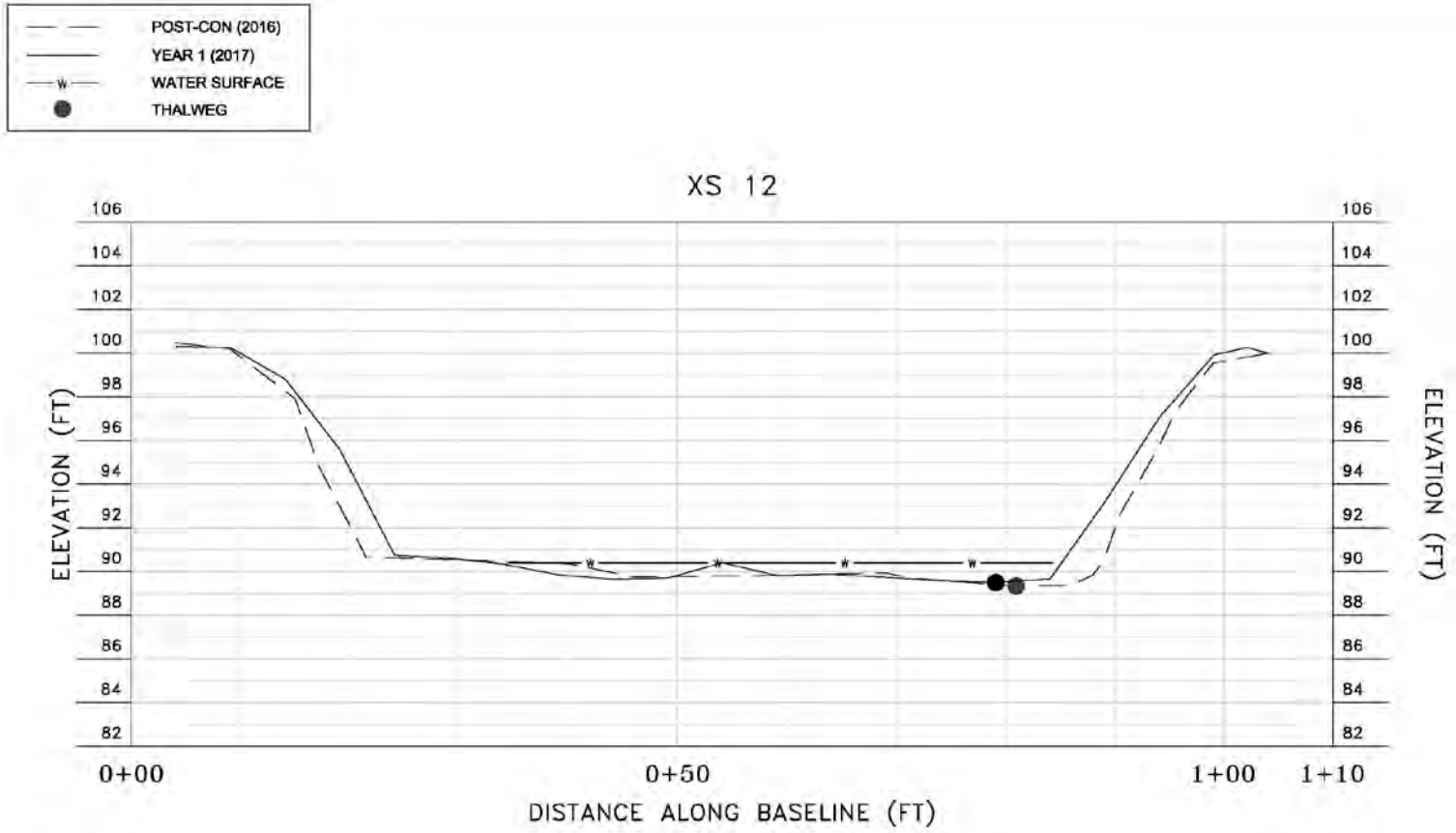

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Pigg River Dam Removal Restoration - Monitoring
Rocky Mount, Virginia

Year 1 - XS 12

REVISIONS

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APPENDIX C: List of Species classified as rare, threatened, endangered or of special concern in the Dan and Mayo River Basins. *Source: U.S. Fish and Wildlife Service Information, Planning and Conservation System (IPaC) and the North Carolina Natural Heritage Program.*

TAXONOMIC GROUP	SCIENTIFIC NAME	COMMON NAME	STATUS	COUNTY
Amphibian	*Ambystoma talpoideum*	Mole Salamander	Special Concern	Rockingham
Amphibian	*Hemidactylium scutatum*	Fouroed Salamander	Special Concern	Stokes
Amphibian	*Plethodon wehrlei*	Wehrle's Salamander	Threatened	Stokes
Bird	*Ammodramus savannarum*	Grasshopper Sparrow	Watch List, Rare	Rockingham
Bird	*Corvus corax*	Common Raven	Watch List, Rare	Stokes
Bird	*Empidonax traillii*	Willow Flycatcher	Watch List, Rare	Stokes
Bird	*Falco peregrinus anatum*	American Peregrine Falcon	Endangered	Stokes
Bird	*Lanius ludovicianus*	Loggerhead Shrike	Special Concern	Rockingham
Butterfly	*Speyeria diana*	Diana Fritillary	Watch List, Rare	Stokes
Caddisfly	*Diplectrona metaqui*	a diplectronan caddisfly	Rare	Stokes
Crustacean	*Cambarus davidi*	Carolina Ladle Crayfish	Rare	Stokes
Crustacean	*Orconectes carolinensis*	North Carolina Spiny Crayfish	Special Concern	Stokes
Dragonfly or Damselfly	*Arigomphus villosipes*	Unicorn Clubtail	Watch List, Rare	Rockingham
Dragonfly or Damselfly	*Lestes eurinus*	Amber-winged Spreadwing	Watch List, Rare	Rockingham
Dragonfly or Damselfly	*Macromia margarita*	Mountain River Cruiser	Rare	Rockingham
Dragonfly or Damselfly	*Ophiogomphus edmundo*	Edmund's Snaketail	Rare	Stokes
Dragonfly or Damselfly	*Ophiogomphus incurvatus*	Appalachian Snaketail	Watch List, Rare	Stokes
Dragonfly or Damselfly	*Somatochlora georgiana*	Coppery Emerald	Rare	Rockingham
Dragonfly or Damselfly	*Stylurus amnicola*	Riverine Clubtail	Watch List, Rare	Rockingham
Freshwater Bivalve	*Elliptio fisheriana*	Northern Lance	Rare	Stokes
Freshwater Bivalve	*Lampsilis cariosa*	Yellow Lampmussel	Endangered	Rockingham
Freshwater Bivalve	*Lasmigona subviridis*	Green Floater	Endangered	Stokes

Freshwater Bivalve	*Pleurobema collina*	James Spinymussel	Endangered	Stokes
Freshwater Bivalve	*Strophitus undulatus*	Creeper	Threatened	Rockingham
Freshwater Bivalve	*Villosa constricta*	Notched Rainbow	Threatened	Stokes
Freshwater Bivalve	*Villosa delumbis*	Eastern Creekshell	Rare	Rockingham
Freshwater Fish	*Ambloplites cavifrons*	Roanoke Bass	Rare	Rockingham
Freshwater Fish	*Carpiodes cyprinus*	Quillback	Rare	Stokes
Freshwater Fish	*Cottus caeruleomentum*	Blue Ridge Sculpin	Special Concern	Stokes
Freshwater Fish	*Cyprinella labrosa*	Thicklip Chub	Watch List, Rare	Stokes
Freshwater Fish	*Etheostoma flabellare*	Fantail Darter	Watch List, Rare	Rockingham
Freshwater Fish	*Etheostoma podostemone*	Riverweed Darter	Rare	Stokes
Freshwater Fish	*Etheostoma vitreum*	Glassy Darter	Watch List, Rare	Stokes
Freshwater Fish	*Exoglossum maxillingua*	Cutlip Minnow	Special Concern	Stokes
Freshwater Fish	*Moxostoma ariommum*	Bigeye Jumprock	Threatened	Stokes
Freshwater Fish	*Noturus gilberti*	Orangefin Madtom	Endangered	Stokes
Freshwater Fish	*Percina rex*	Roanoke Logperch	Endangered	Rockingham
Freshwater Fish	*Thoburnia hamiltoni*	Rustyside Sucker	Endangered	Stokes
Grasshopper or Katydid	*Dendrotettix australis*	Scrub Pine Grasshopper	Watch List, Rare	Stokes
Lichen	*Ephebe lanata*	Rockshag Lichen	Rare	Stokes
Lichen	*Peltigera hydrothyria*	Waterfan Lichen	Watch List, Rare	Stokes
Liverwort	*Frullania plana*	A Liverwort	Watch List, Rare	Stokes
Liverwort	*Plagiochila ludoviciana*	A Liverwort	Rare	Stokes
Mammal	*Myotis lucifugus*	Little Brown Bat	Rare	Stokes
Mammal	*Perimyotis subflavus*	Tricolored Bat	Rare	Stokes
Mammal	*Sciurus niger*	Eastern Fox Squirrel	Watch List, Rare	Stokes
Mayfly	*Tsalia berneri*	a mayfly	Rare	Rockingham
Moss	*Anacamptodon splachnoides*	Knothole Moss	Watch List, Rare	Stokes
Moss	*Andreaea rothii var. rothii*	Black Falcate Split Moss	Watch List, Rare	Stokes

Moss	*Brothera leana*	Boar Moss	Watch List, Rare	Stokes
Moss	*Dicranum fuscescens*	Fuscous Moss	Watch List, Rare	Stokes
Moss	*Dicranum spurium*	Rusty Fork Moss	Watch List, Rare	Stokes
Moss	*Entodon compressus*	Flattened Entodon	Rare	Rockingham
Moss	*Fissidens asplenioides*	A Plume Moss	Rare	Stokes
Moss	*Fissidens elegans*	A Plume Moss	Watch List, Rare	Stokes
Moss	*Helodium paludosum*	Pond Fern Moss	Watch List, Rare	Stokes
Moss	*Orthodontium pellucens*	Translucent Orthodontium	Rare	Stokes
Moss	*Philonotis longiseta*	An Apple Moss	Watch List, Rare	Stokes
Moss	*Polytrichum appalachianum*	Appalachian Haircap Moss	Watch List, Rare	Stokes
Moth	*Apantesis carlotta*	Carlotta's Tiger Moth	Watch List, Rare	Stokes
Moth	*Argillophora furcilla*	Silver Fork Cane Moth	Watch List, Rare	Stokes
Moth	*Caripeta aretaria*	Southern Pine Looper	Watch List, Rare	Stokes
Moth	*Catocala herodias*	Herodias Underwing	Rare	Stokes
Moth	*Chytonix sensilis*	Barrens Marvel	Watch List, Rare	Stokes
Moth	*Heliomata infulata*	Rare Spring Moth	Watch List, Rare	Stokes
Moth	*Psamatodes abydata*	Dot-lined Angle	Watch List, Rare	Stokes
Moth	*Scopula aemulata*	Diminutive Wave	Watch List, Rare	Stokes
Moth	*Ulolonche modesta*	Modest Quaker Moth	Watch List, Rare	Stokes
Moth	*Zale sp. nr. squamularis*	a new Zale	Watch List, Rare	Stokes
Reptile	*Cemophora coccinea*	Scarlet Snake	Watch List, Rare	Rockingham
Reptile	*Crotalus horridus*	Timber Rattlesnake	Special Concern	Stokes
Vascular Plant	*Agastache nepetoides*	Yellow Giant-hyssop	Rare	Stokes
Vascular Plant	*Asplenium bradleyi*	Bradley's Spleenwort	Rare	Stokes
Vascular Plant	*Baptisia albescens*	Thinod White Wild Indigo	Watch List, Rare	Stokes
Vascular Plant	*Berberis canadensis*	American Barberry	Special Concern	Rockingham
Vascular Plant	*Bromus nottowayanus*	Nottoway Valley Brome	Watch List, Rare	Rockingham
Vascular Plant	*Cardamine micranthera*	Small-anthered Bittercress	Endangered	Stokes
Vascular Plant	*Cardamine rotundifolia*	Mountain Watercress	Threatened	Stokes
Vascular Plant	*Carex granularis*	Limestone Meadow Sedge	Watch List, Rare	Stokes
Vascular Plant	*Carex mitchelliana*	Mitchell's Sedge	Watch List, Rare	Stokes

Vascular Plant	*Cerastium nutans*	Nodding Chickweed	Watch List, Rare	Rockingham
Vascular Plant	*Chelone cuthbertii*	Cuthbert's Turtlehead	Special Concern	Stokes
Vascular Plant	*Corallorhiza odontorhiza*	Autumn Coral-root	Watch List, Rare	Stokes
Vascular Plant	*Crataegus succulenta*	Fleshy Hawthorn	Rare	Stokes
Vascular Plant	*Crocanthemum propinquum*	Creeping Sunrose	Threatened	Stokes
Vascular Plant	*Dichanthelium annulum*	Ringed Witch Grass	Rare	Stokes
Vascular Plant	*Dirca palustris*	Leatherwood	Watch List, Rare	Rockingham
Vascular Plant	*Echinacea laevigata*	Smooth Coneflower	Endangered	Rockingham
Vascular Plant	*Euonymus atropurpureus var. atropurpureus*	Eastern Wahoo	Watch List, Rare	Stokes
Vascular Plant	*Fallopia cristata*	Crested Climbing Buckwheat	Watch List, Rare	Stokes
Vascular Plant	*Fothergilla major*	Large Witch-alder	Rare	Stokes
Vascular Plant	*Gentiana austromontana*	Appalachian Gentian	Watch List, Rare	Stokes
Vascular Plant	*Gillenia stipulata*	Indian Physic	Threatened	Stokes
Vascular Plant	*Hackelia virginiana*	Virginia Stickseed	Rare	Rockingham
Vascular Plant	*Helianthus schweinitzii*	Schweinitz's Sunflower	Endangered	Stokes
Vascular Plant	*Heuchera caroliniana*	Carolina Alumroot	Watch List, Rare	Stokes
Vascular Plant	*Heuchera parviflora var. parviflora*	Grotto Alumroot	Watch List, Rare	Stokes
Vascular Plant	*Heuchera parviflora var. saurensis*	Sauratown Grotto Alumroot	Watch List, Rare	Stokes
Vascular Plant	*Heuchera pubescens*	Downy Alumroot	Rare	Stokes
Vascular Plant	*Humulus lupulus var. lupuloides*	Hops	Watch List, Rare	Stokes
Vascular Plant	*Humulus lupulus var. pubescens*	Hops	Watch List, Rare	Rockingham
Vascular Plant	*Hydrastis canadensis*	Goldenseal	Rare	Stokes
Vascular Plant	*Hydrophyllum virginianum*	John's Cabbage	Watch List, Rare	Rockingham
Vascular Plant	*Isotria verticillata*	Large Whorled Pogonia	Watch List, Rare	Stokes
Vascular Plant	*Juglans cinerea*	Butternut	Watch List, Rare	Stokes
Vascular Plant	*Juncus secundus*	Nodding Rush	Watch List, Rare	Rockingham
Vascular Plant	*Liatris aspera*	Rough Blazing-star	Threatened	Stokes
Vascular Plant	*Liatris squarrulosa*	Earle's Blazing-star	Rare	Stokes
Vascular Plant	*Lindernia monticola*	Flatrock Pimpernel	Watch List, Rare	Stokes
Vascular Plant	*Luzula multiflora var. multiflora*	Heath Woodrush	Watch List, Rare	Stokes
Vascular Plant	*Lysimachia tonsa*	Southern Loosestrife	Rare	Stokes

Vascular Plant	*Mertensia virginica*	Virginia Bluebells	Watch List, Rare	Rockingham
Vascular Plant	*Micranthes micranthidifolia*	Lettuce-leaf Saxifrage	Watch List, Rare	Stokes
Vascular Plant	*Mononeuria groenlandica*	Greenland Sandwort	Threatened	Stokes
Vascular Plant	*Monotropsis odorata*	Sweet Pinesap	Special Concern	Stokes
Vascular Plant	*Panax quinquefolius*	Ginseng	Watch List, Rare	Stokes
Vascular Plant	*Panax trifolius*	Dwarf Ginseng	Watch List, Rare	Rockingham
Vascular Plant	*Paronychia argyrocoma*	Silverling	Watch List, Rare	Stokes
Vascular Plant	*Parthenium auriculatum*	Glade Wild Quinine	Rare	Rockingham
Vascular Plant	*Paspalum pubiflorum var. glabrum*	Hairy-seed Crown Grass	Watch List, Rare	Stokes
Vascular Plant	*Pieris floribunda*	Fetterbush	Watch List, Rare	Stokes
Vascular Plant	*Pinus strobus*	Eastern White Pine	Watch List, Rare	Rockingham
Vascular Plant	*Polemonium reptans var. reptans*	Jacob's Ladder	Threatened	Stokes
Vascular Plant	*Polygonum tenue*	Glade Knotweed	Watch List, Rare	Rockingham
Vascular Plant	*Pseudognaphalium micradenium*	Small Rabbitobacco	Rare	Stokes
Vascular Plant	*Ptelea trifoliata*	Wafer-ash	Watch List, Rare	Rockingham
Vascular Plant	*Pyrola americana*	American Shinleaf	Watch List, Rare	Rockingham
Vascular Plant	*Quercus bicolor*	Swamp White Oak	Watch List, Rare	Rockingham
Vascular Plant	*Quercus ilicifolia*	Bear Oak	Endangered	Stokes
Vascular Plant	*Quercus muehlenbergii*	Chinquapin Oak	Watch List, Rare	Rockingham
Vascular Plant	*Rhododendron catawbiense*	Catawba Rhododendron	Watch List, Rare	Stokes
Vascular Plant	*Sceptridium jenmanii*	Alabama Grape-fern	Special Concern	Stokes
Vascular Plant	*Scutellaria serrata*	Showy Skullcap	Watch List, Rare	Rockingham
Vascular Plant	*Sedum glaucophyllum*	Cliff Stonecrop	Rare	Stokes
Vascular Plant	*Silphium connatum*	Virginia Cuplant	Special Concern	Stokes
Vascular Plant	*Silphium connatum*	Virginia Cuplant	Special Concern	Rockingham
Vascular Plant	*Silphium perfoliatum*	Northern Cuplant	Threatened	Stokes
Vascular Plant	*Solidago rigida var. glabrata*	Southeastern Bold Goldenrod	Rare	Rockingham
Vascular Plant	*Solidago ulmifolia*	Elm-leaf Goldenrod	Rare	Rockingham
Vascular Plant	*Sphenopholis intermedia*	Prairie Wedgescale	Watch List, Rare	Stokes
Vascular Plant	*Spiraea corymbosa*	Shinyleaf Meadowsweet	Endangered	Stokes
Vascular Plant	*Stewartia ovata*	Mountain Camellia	Rare	Stokes
Vascular Plant	*Thermopsis fraxinifolia*	Ash-leaved Golden-banner	Special Concern	Stokes
Vascular Plant	*Thermopsis mollis*	Appalachian Golden-banner	Special Concern	Stokes

Vascular Plant	*Tradescantia virginiana*	Virginia Spiderwort	Threatened	Rockingham
Vascular Plant	*Trichostema brachiatum*	Glade Bluecurls	Endangered	Rockingham
Vascular Plant	*Tsuga canadensis*	Eastern Hemlock	Watch List, Rare	Stokes
Vascular Plant	*Tsuga caroliniana*	Carolina Hemlock	Watch List, Rare	Stokes
Vascular Plant	*Valerianella umbilicata*	Woodland Cornsalad	Watch List, Rare	Stokes
Vascular Plant	*Verbesina virginica var. virginica*	Frostweed	Watch List, Rare	Rockingham
Vascular Plant	*Viola tripartita*	Threearted Violet	Watch List, Rare	Stokes