Cassia Drive Stream Restoration
STREAM DESIGN REPORT

Prepared For:

Arundel Rivers Federation
P.O. Box 760
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June 2026

Prepared By:

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Table of Contents

Appendices

1.0 INTRODUCTION

1.1 Project Background and Goals

Arundel Rivers Federation (ARF) selected ESA, Inc. to provide design and permitting services for the restoration of a tributary stream in the Gingerville community in Edgewater, Maryland. The project will restore approximately 700 linear feet of an unnamed tributary to Church Creek, a tributary of the South River, part of the West Chesapeake Bay Watershed (MDE 8 Digit Watershed 02131003, HUA 11 Digit 02060004010). The channel is deeply incised with widespread vertical instability and is disconnected from its floodplain. The goals of the project are to stabilize and restore the stream and increase habitat.

The restoration design approach is regenerative step pools, which will arrest and resist channel erosion, reduce sediment loads to downstream areas, enhance hyporheic exchange, and improve riparian habitat. Deliverables for this project include preliminary and final designs, cost estimates and all permits necessary for implementation. This design report documents the methodology and results of the assessment of existing conditions and provides a description and justification of the proposed design.

1.2 Site Description

The project area is an ephemeral/intermittent stream located on three private properties in Gingerville, accessed from the cul-de-sac of Cassia Drive. The stream originates from two corrugated metal pipe (CMP) storm drain outfalls and it flows east through a forested valley to a concrete arch culvert under Admiral Cochrane Drive. A vicinity map is provided in Attachment 1.

The total drainage area to the downstream limit of the project is approximately 27.8 acres. The drainage area consists of the Gingerville and Admirals View residential communities and has approximately 23.05% impervious area, 78.3% developed land, and 8.85 % forest coverage (USGS StreamStats, 2026). A drainage area map of the site is shown in **Figure 1.** The project area consists of mature upland forests and no wetlands are present.

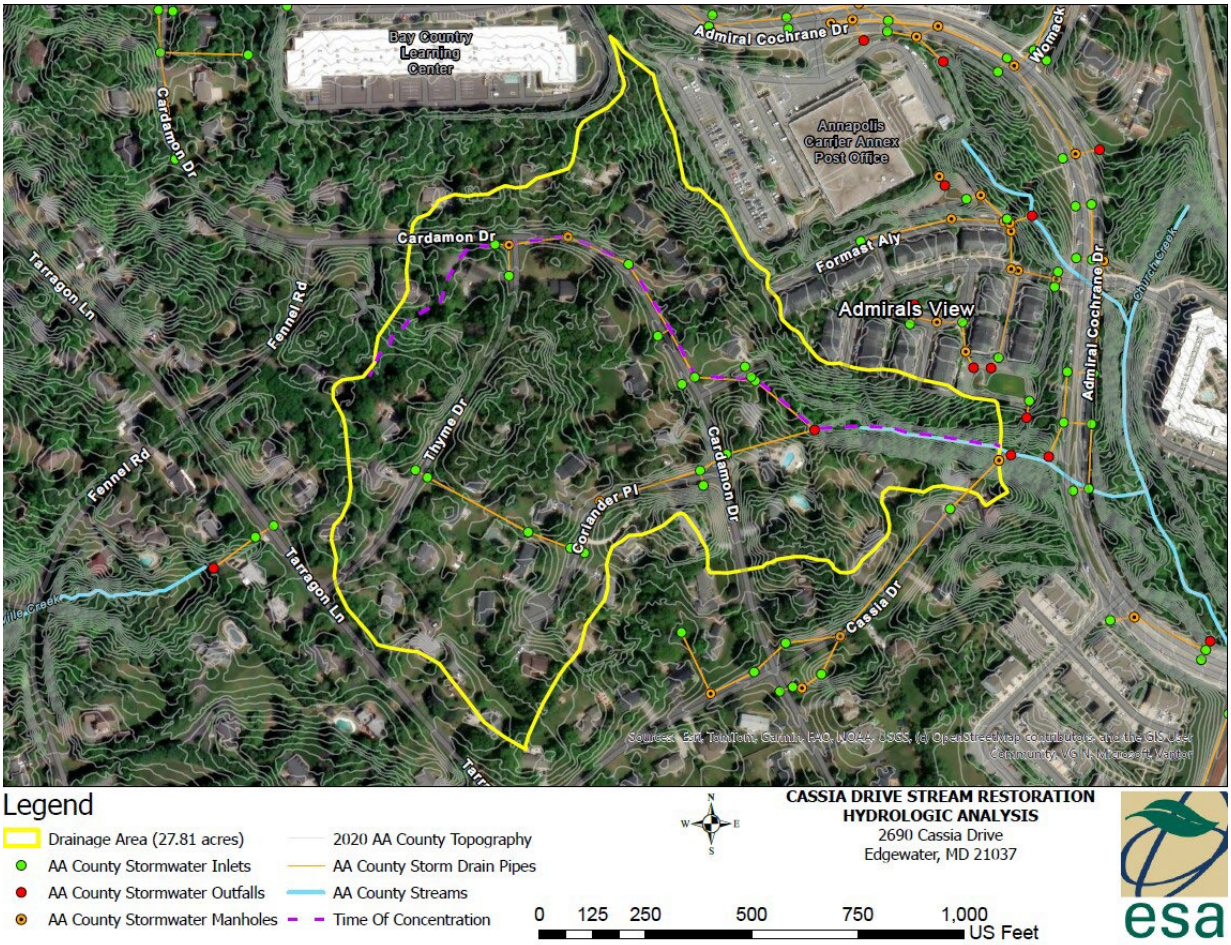

Figure 1: Stream Drainage Area Map

2.0 ASSESSMENT

Field work was conducted by ESA in the fall of 2025 to document site conditions and collect data required for permitting and design. Work included a geomorphological assessment of the stream, BANCS assessment, delineation of wetlands and waters of the United States, and forest stand delineation. Prior to field work, data collected via a desktop analysis was reviewed to assess soils, topography, mapped streams, stormwater infrastructure, land use, and general site conditions. Field run topography and locations of flagged environmental features such as specimen trees were collected by a licensed surveyor in the fall of 2025. Specific methodology of the data collection is described below. An existing conditions site map is in **Appendix A.**

2.1 Geomorphic Stream Assessment

A geomorphic stream assessment was conducted by collecting stream data, including representative cross-sections and pebble counts to determine stream classification using methodologies described in *Applied Fluvial Morphology* (Rosgen, 1996). Cross sections were

surveyed using a level and stadia rod. Bankfull discharge (Q_{BKF}) was determined by examining field estimated bankfull elevations at riffle cross-sections and regional curve regressions.

Pebble counts were conducted using the random step toe procedure at evenly spaced intervals across ten transects. For each count, the intermediate axes of 100 particles were measured by sampling ten particles in ten transects (Wolman, 1954). Bedform features and vertical stability were evaluated, and channel slope was determined from field run topography. All data were processed using RIVERMorph to calculate channel dimensions and classifications.

The Cassia Drive stream is designated as Use Class I – Water Contact Recreation and Protection of Nontidal Warmwater Aquatic Life. The entire 638-ft. stream channel area was assessed. A longitudinal profile and four stream channel cross-sections were surveyed at representative riffles. Cross-sectional geomorphic parameters and plots are provided in **Table 1** and **Appendix B**. The cross-sections are shown on the existing condition site map in **Appendix A.** Photographs of the project area are provided in **Appendix C**.

The channel is deeply incised and classifies as a narrow, unstable B5, gully morphology with sand as the dominant substrate. It has widespread vertical and lateral instability and lacks floodplain connection. The entrenchment ratios range from 1.43 to 1.78, and width-depth ratios range from 3.62 to 9.18. The overall channel slope is 0.0282. The channel is unstable and will likely continue to degrade without restoration work.

Bank material contains sand and other fine particles, such as silt and clay. Gravel was rarely detected and cobble was absent. The median particle size (D50) was 0.2 mm and the D84 was 0.25 mm, which is sand. The bedload is from the bed and banks.

Bedform features within the reach are poorly defined and few riffles and pools were observed. Existing riffles consist of poorly established transient features primarily composed of sand and small gravel. Pools are generally associated with headcuts and debris jams.

Three headcuts were observed. The largest occurs just below two 19-inch trees. Bank heights below the headcut are 5 to 6 feet for about 100 feet in the downstream direction before gradually decreasing. Below this headcut the stream transitions from ephemeral to riverine intermittent due to the significant gradient drop. Bankfull discharge (Q_{BKF}) and geomorphic channel parameters were determined and are shown in **Table 1**.

At the downstream end of the project site a stormwater pond on the north side of the stream valley discharges to the stream. Below the outfall, the 55-foot-long flow path to the stream is eroded. The pond is owned by Admirals View residential community. Discharge from the pond was determined from the pond's as-built plan (Admiral View Road, Storm Drain and Storm Water Management Plans, dated January 27, 2012) to be: Q_{10} = 8.82 cfs and Q_{100}=26.15 cfs.

Table 1: Existing Channel Dimensions and Classifications

Bankfull Channel Dimension Parameter	Cross-Section			
	1	2	3	4
Bankfull Width (W_{bkf}) (ft)	4.81	4.52	4.05	6.15
Mean Depth (d_{bkf}) (ft)	1.08	1.0	1.12	0.67
Bankfull Cross-section Area (A_{bkf}) (ft^2)	5.2	4.51	4.52	4.1
Width-Depth Ratio (W_{bkf}/d_{bkf})	4.45 (Low)	4.52 (Low)	3.62 (Low)	9.18 (Low)
Maximum Depth (d_{mbkf}) (ft)	1.3	1.33	1.48	0.8
Width of Flood-prone Area (W_{fpa}) (ft)	7.44	8.06	5.96	8.8
[1]Bankfull Discharge (Q_{bkf}) (ft^3/s)	18.9	18.9	18.9	18.9
Entrenchment Ratio (ER) (ft/ft)	1.55 (Moderately Entrenched)	1.78 (Moderately Entrenched)	1.47 (Moderately Entrenched)	1.43 (Moderately Entrenched)
Stream Classification	B5	B5	B5	B5

2.2 BANCS and Pollutant Load Reduction

Protocol 1

Protocol 1 for Prevented Sediment uses the *Bank Assessment for Non-Point Source Consequences of Sediment* (BANCS) method to calculate bank erosion estimates to determine sediment and nutrient loadings from the stream restoration project area. These loadings are used to calculate sediment and nutrient reduction credits using Protocol 1 Prevented Sediment as described by the *Consensus Recommendations for Improving the Application of the Prevented Sediment Protocol for Urban Stream Restoration Projects Built for Pollutant Removal* (Wood, 2020). This protocol was used to determine pollutant load reductions for the stream restoration.

BANCS uses two bank erodibility estimation tools to predict stream bank erosion -- the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). BEHI evaluates bank height, bankfull height, root depth, root density, bank angle, surface protection, bank material, and bank stratification to determine bank susceptibly to erosion. NBS assesses the erosion forces acting on the bank based on water surface slope, water depths, radius of curvature, stream velocities, and direction of velocity vectors.

BEHI/NBS adjective ratings were recorded along each bank, along with bank length and height. The BEHI/NBS adjectives were paired with erosion rates from the Center for Watershed Protection's Modified Washinton, D.C. bank erosion curve and multiplied by bank lengths and heights to determine annual erosion loads. Soil samples were collected from the site to determine sediment

mass and nutrient amounts in the stream banks soil. The reduction in pollutants from stream restoration was then calculated according to Protocol 1 as described in the Expert Panel document. Soil bulk density, Total Nitrogen (TN), and Total Phosphorus (TP) values were measured by soil samples collected within each stratum of bank at the site and were analyzed by the Waypoint Analytical laboratory in Richmond, Virginia. Soil bulk density samples were collected following methods described by *International Organization for Standards (ISO) 11272-2017, Soil Quality-Determination of Dry Bulk Density*. This method involves collecting an undisturbed soil core by pressing a cylinder of known volume into the soil, which is then excavated and extracted without loss of sample material. The soil is then oven-dried and weighed. Additional paired samples were collected for nutrient analysis.

Using the BANCS assessment and Protocol 1, the pollutant load reductions are 55.8 tons per year of sediment, 68.7 pounds per year of TN, and 45.7 pounds per year of TP. The calculations are shown in **Appendix D**.

2.3 Wetlands and Waters of the United States

Wetlands are included within the definition of 'waters of the United States' in the federal Clean Water Act and are defined by the U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA) as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." The identification of wetlands was based upon the routine method as described in the 1987 *Corps of Engineers Wetlands Delineation Manual* (referred to hereafter as the Manual) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (*Version 2.0), November 2010. The identification of stream channels was based on methodologies in the USACE Jurisdictional Determination Form Instructional Guidebook (USACE, 2007), a regulatory guidance letter (USACE, 2005), and the Navigable Waters Protection Rule (EPA, 2020).

According to the Manual, an area is identified as a wetland if it meets all three wetland parameters: hydric soils, hydrophytic vegetation, and wetland hydrology. The field investigation includes identifying vegetation, soils, and hydrology of possible wetlands, and marking any wetland boundaries with labeled pink and black striped flagging. Wetland Determination Data Stations (WDS) were used to document conditions within potential wetlands and uplands, as well as to provide justification for the delineation.

There are no wetlands within the project area. As documentation, data was collected at a wetland determination plot in the lowest part of the site, near the stream. The data form is provided in **Appendix A**. The project stream was identified as an ephemeral channel in the upper portion of the site. It transitions to an intermittent stream below the large headcut about 340 feet downstream of the two CMP storm drain outfalls.

2.4 Forest Stand Delineation

Methods and protocols described within the *Maryland State Forest Conservation Technical Manual* were used to perform an assessment of the forest within the project area. Data was used to identify, delineate and characterize forest stands based on species composition, density, size, condition, and successional stage. Based on the site size and minimum sampling requirements, a total of three fixed plot forest sampling data stations were established for analysis. Plots were one-tenth (1/10) acre in size. Information gathered at each sampling plot included:

- Tree species observed including relative dominance and percent of canopy coverage,
- Shrub / understory species and the percent of understory coverage,
- Herbaceous species and percent of forest floor herbaceous coverage,
- Percent and coverage of downed woody debris, and
- The presence or absence of exotic or invasive species and percent coverage.

Forest Stands were given a Priority Rating of 1-3 based on the following criteria as listed in the Manual:

- Priority 1 – Stands that contain Priority Retention Areas as defined by the Manual (DNR, 1997; pg. 2-10, and Natural Resources Article 5-1607(c)), which include factors such as the 100-year floodplain, intermittent and perennial streams and their buffers, coastal bays and their buffers, steep slopes, critical habitats, wetlands, specimen trees, as well as rare, threatened, and endangered species.
- Priority 2 – Stands that contain priority areas identified by a local land use plan, local forest conservation program, or other criteria adopted by a local forest conservation program.
- Priority 3 – All other stands. Priority 3 stands are further ranked in order of functional value in terms of wildlife habitat, water quality protection, and at least one other objective, such as aesthetics or recreation.

Specimen trees, which are defined as any tree with a Diameter at Breast Height (DBH) of 30 inches or larger, were identified, numbered and flagged. The species, height, crown width, and condition of each specimen tree was recorded, and all specimen tree locations were field-located.

One forest stand was documented within the project area, a 2.76-acre mid-successional hardwood stand, dominated by black gum (*Nyssa sylvatica*), red map (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*) in the 12-inch diameter size class. There are approximately 193 trees per acre in this stand and canopy coverage is 60-75 percent. Common understory species include American holly (*Ilex opaca*), European privet (*Ligustrum vulgare*), pawpaw (*Asimina triloba*), and flowering dogwood (*Cornus florida*). Common groundcover species include Japanese honeysuckle (*Lonicera japonica*), common greenbrier (*Smilax rotundifolia*), multiflora rose (*Rosa multifora*), and English ivy (*Hedera helix*). The forest contains environmentally sensitive resources, including the

stream and five specimen trees, which makes it high priority for retention. However, coverage by invasive, non-native plants is relatively significant at 10-40%. These species include privet, bittersweet (*Celastrus orbiculatus*), Japanese honeysuckle, multiflora rose, and English ivy. Forest sampling plot data and the FSD plan are in **Appendix A**.

Other significant plant species in the project area include northern red oak (*Quercus rubra*), black cherry (*Prunus serotina*), tuliptree (*Liriodendron tulipifera*), possumhaw (*Viburnum nudum*), and strawberry bush (*Euonymus americanus*).

3.0 HYDROLOGIC ANALYSIS

3.1 Bankfull Discharge

Bankfull discharges was determined using field data and the following regional regression equations:

- Powell, 2007, for urban Coastal Plain region of Maryland, developed using data from streams with watersheds with greater than 15 percent impervious area.
- Western Coastal Plain Region of Maryland (Thomas and Sanchez-Claros, 2019b), which used annual peak data through the 2017 water year. Fixed Region Regression Equations for MD (from Application of Hydrologic Methods in Maryland, Sixth Edition, July 2023)

A summary of the bankfull data is provided in **Table 2**.

Table 2: Bankfull Summary

Bankfull Area (sq ft)	Bankfull Velocity (ft/s)	Bankfull Discharge (cfs)
4.5	4.2	18.9

3.2 Peak Discharges

The U.S. Department of Agriculture's (USDA) Technical Release 55 (TR-55) was used to determine peak discharges for the 1-, 2-, 10-, and 100-year storm events for the stream.

The hydrologic parameters used in the analysis are:

- Drainage Area = 27.81 acres
- Runoff Curve Number (RCN) = 81, and
- Time of Concentration (Tc) = 0.275 hour.

A summary of the estimated peak discharges for the stream is provided in **Table 3**. TR-55 model outputs are included in **Appendix E**.

Table 3: Peak Discharge Results (TR-55)

Peak Discharge (cubic feet per second, cfs)			
1-Year	**2-Year**	**10-Year**	**100-Year**
27.25	38.54	77.40	160.46

4.0 RESTORATION DESIGN APPROACH

The proposed design is to install a regenerative step-pool storm conveyance (RSC) as the most desirable restoration approach to address the relatively high slope of the stream, and its position within a narrow stream valley. The RSC will dissipate flow velocities, provide grade control, and allow for subsurface filtration of surface water. The upper portion of the watershed lacks stormwater quality management, and RSCs are designed to convey the 100-year storm discharge. This will help mitigate storm flows, thereby reducing erosion. The proposed riffle weirs and adjacent berms are placed to avoid impacts to larger trees and to take advantage of existing low areas of the stream valley to increase floodplain connectivity, like near station 1+00.

We also propose a step-pool storm conveyance (SPSC), a variation of an RSC, near the downstream limit of the project area. Near the western end of the stream where the water enters the culvert under Admiral Cochrane Drive, there is an outfall directed into the stream valley from a stormwater management pond on the Admirals View property. The outfall's flow path to the stream is steep and eroding. An SPSC will stabilize the outfall, prevent erosion, and convey the flow to the stream. These restoration measures are the preferred restoration approaches of Anne Arundel County's Department of Public Works, Bureau of Watershed Restoration and Protection and have been used successfully throughout the county and surrounding areas. Design computations are in **Appendix F**.

Access to the project site is proposed from Admiral Cochrane Drive, using the maintenance entrance for the Admirals View stormwater pond. There is also a flat area nearby that is suitable for a staging area. Accessing the site from this location minimizes disturbance to the forested riparian valley since it makes use of an existing entrance pathway. The limit of disturbance (LOD) is limited to a narrow corridor along the stream valley, and the contractor shall use the stream channel itself for the temporary construction haul road as much as possible to minimize disturbance to the riparian forest. The haul road will include a 6-inch minimum layer of shredded wood mulch to minimize soil compaction and prevent erosion. Trees within the LOD will be protected with tree trunk protection planking, including a specimen tree near the outfall channel from the Admirals View stormwater pond. The limit-of-clearing and larger trees to be removed are shown on the plans.

The LOD will be stabilized and planted with native vegetation. Coconut fiber soil stabilization matting will be installed on graded stream banks greater than 3 feet in height to provide protection while seed and native plantings become established. Proposed shrub and tree plantings include

winterberry, spicebush, highbush blueberry, American holly, black gum, flowering dogwood, American beech, mockernut hickory, white oak, and northern red oak. Co-benefits of the project include carbon sequestration by the planted trees and shrubs and the restoration of the riparian areas and the creation of varied wildlife habitat in the stream's pools. The stabilization of the channel with the riffle weirs and their non-erosive conveyance of storm flows will provide climate change resilience by protecting the stream from potentially more intense rainstorms.

5.0 FUNCTION-BASED RAPID ASSESSMENT

A function-based rapid stream assessment was conducted using the USFWS *Final Draft Function-Based Rapid Stream Assessment Methodology* (Starr, et al. 2015) to assess the current condition of the site and to compare results to conditions that would be achieved through proposed stream restoration. This method involves evaluation of overall watershed condition, as well as five levels of the stream functions pyramid: Hydrology (Level 1), Hydraulics (Level 2), Geomorphology (Level 3), Physiochemical (Level 4), and Biology (Level 5). Each level is composed of several parameters that are individually rated as *Functioning, Functioning-At-Risk,* or *Not Functioning*. Uplift is achieved when a parameter's rating is improved because of proposed stream restoration activities. Rapid watershed assessment and existing and proposed reach level stream function-based rapid assessment data sheets are provided in **Appendix G**. Results of the watershed and functional stream assessment are summarized below.

Watershed Assessment

Watershed Impoundments and Riparian Vegetation are rated as *Good*. Concentrated Flow, Land Use Change, and Sediment Supply were rated as *Fair*. Distance to Roads, Physiochemical /Water Quality, Flashiness, and Biology/Landscape Connectivity are rated as *Poor*. The overall watershed assessment score is *Fair/Poor*. The watershed assessment criteria are summarized in **Table 4**.

Table 4. Watershed Assessment Summary

	Category/Parameter/Measurement	Rating
1	Hydrology / Runoff / Watershed Impoundments	Good
2	Hydrology / Runoff / Concentrated Flow	Fair
3	Hydrology / Runoff / Land Use Change	Fair
4	Hydrology / Runoff / Distance to Roads	Poor
5	Hydrology / Runoff / Flashiness	Poor
6	Geomorphology / Riparian Vegetation	Good
7	Geomorphology / Sediment Supply	Fair
8	Physiochemical / Water Quality / 303 (d) List	Poor
9	Biology / Landscape connectivity	Poor
Overall Watershed Condition Score		**Poor**

Stream Assessment

Existing and proposed Hydrology (Level 1) were both rated as *Not Functioning* due to the presence of concentrated flows from outfalls, a flashy flow regime, and high impervious cover. Hydrology is not expected to improve with stream restoration practices because the hydrology conditions are a

result of watershed conditions. Hydraulics (Level 2) will improve from *Not Functioning* to *Functioning* by decreasing the bank height ratio and entrenchment and improving vertical stability, likely with riffle grade controls. Geomorphology (Level 3) will improve from *Functioning-at-Risk* to *Functioning*. Proposed stream restoration will reduce bank erosion, increase lateral stability, and improve bedform diversity and shelter for fish and macroinvertebrates. Pool frequency and depth will improve. Physiochemical (Level 4) was rated as *Functioning-At-Risk* and is not expected to improve with stream restoration. Increased bank stability though restoration will reduce bank erosion, but during storm events the water will likely be cloudy due to development in the upper watershed. Biology (Level 5) was rated as *Functioning-At-Risk* and is not expected to improve with stream restoration. The site is expected to continue to be inhabited primarily by pollution tolerant macroinvertebrates due to the high level of impervious cover in the watershed.

Overall, the existing stream is rated as *Not Functioning* due to vertical and lateral instability and floodplain disconnection. It is classified as an unstable B channel, an entrenched gully with a low width-depth ratio. The highest functional level that can be improved through stream restoration is Level 2, Hydraulics. It can be improved from *Not Functioning* to *Functioning* by decreasing the bank height ratio and entrenchment and improving vertical stability. This will be done through stream restoration by creating a stable B channel. The B channel type is a reliable option that is favored for use in more developed watersheds due to its ability to effectively withstand flashy flow regimes.

Resource Improvement and Resource Trade-offs

Resource trade-offs associated with this project include a restored and stable stream channel and tree loss. The restored stream will convey storm flows with minimal bank erosion which will reduce sediment loads to downstream areas. In addition, the stream functions of hydraulics and geomorphology will be improved from *Not Functioning* to *Functioning*. Habitat will be improved as the riparian area will be restored with native trees and shrubs and the stream's pools will create more varied wildlife habitat. However, to accomplish these improvements some trees will be cleared to construct the project. This trade-off has been mitigated as much as possible by several means, such as placing the riffle weirs to avoid larger trees and limiting the extent of the LOD. Other measures include locating the construction entrance at an existing maintenance entrance, using the stream channel as the construction haul road as possible, and protecting trees to remain with trunk plank protection.

6.0 REFERENCES

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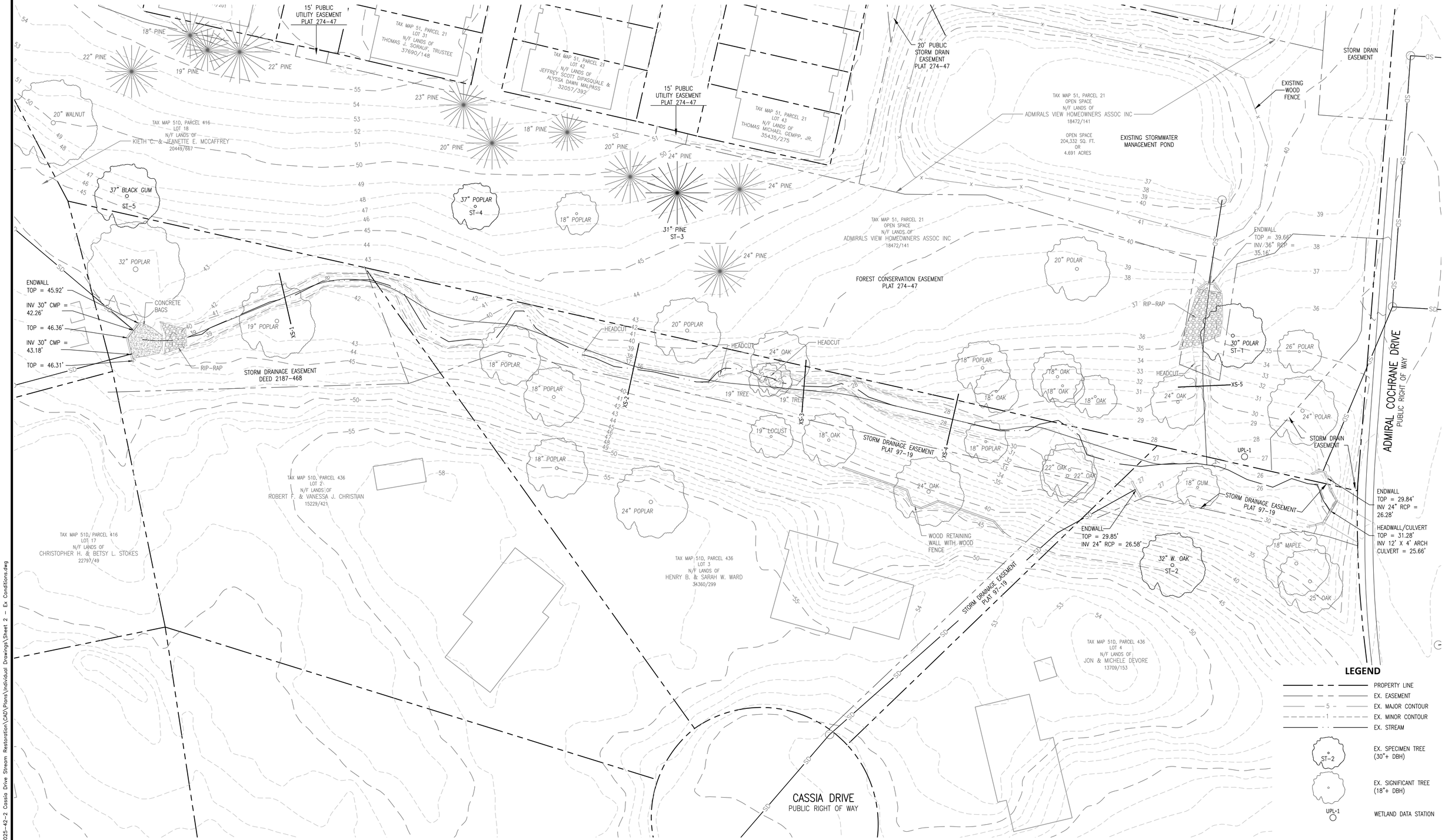
Appendix A:

Existing Conditions:
Site Map, Forest Stand Delineation Plan and Data Forms, Wetland Determination Data Sheet



Professional Certification.

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional landscape architect under the laws of the State of Maryland, License No. 3752, Expiration Date: 11/18/2025

REVISIONS			
NO.	BY	DATE	DESCRIPTION

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EXISTING CONDITIONS

CASSIA DRIVE STREAM RESTORATION

MAP 051D, GRID 0015, PARCEL 0436, SUBDIVISION 280

SECOND ELECTION DISTRICT, ANNE ARUNDEL COUNTY, MD

NORTH

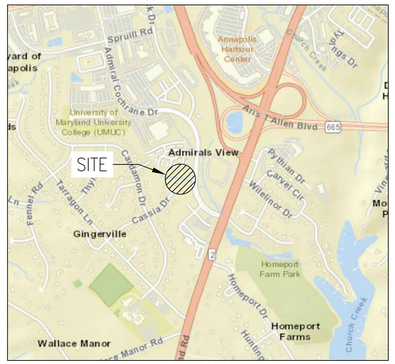
0' 10' 20' 40'
SCALE: 1"=20'

SCALE: 1" = 20'
DATE: JANUARY, 2026
ESA PROJECT NO.: 2025-45-2
SHEET: 1 of 2

February 2026 FILE: T:\NEWPROJ\2025\2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings\Sheet 2 - Ex Conditions.dwg

STAND SUMMARY	
	STAND A
	2.76 ACRES
NUMBER OF PLOTS	3
PRIORITY FOR RETENTION AND PROTECTION	HIGH
DOMINANT SPECIES	BLACK GUM
CO-DOMINATE AND ASSOCIATE SPECIES	RED MAPLE, SWEETGUM
FOREST ASSOCIATION	MIXED HARDWOOD FORESTS
SUCCESSIONAL STAGE	MID-LATE
MEAN SIZE CLASS	12"
% CANOPY COVERAGE	60-75%
% UNDERSTORY COVERAGE	50-70%
% HERBACEOUS COVER	20-30%
% INVASIVE COVERAGE	10-40%
# OF CANOPY LAYERS	3
# OF TREES PER ACRE	193
COMMON UNDERSTORY SPECIES	AMERICAN HOLLY, EUROPEAN PRIVET, PAW PAW, SASSAFRAS, FLOWERING DOGWOOD
NUMBER OF UNDERSTORY SPECIES	8
COMMON HERBACEOUS SPECIES	JAPANESE HONEYSUCKLE, COMMON GREENBRIAR, MULTIFLORA ROSE, ENGLISH IVY
LIST OF MAJOR INVASIVE PLANT SPECIES	MULTIFLORA ROSE, BITTERSWEET, JAPANESE HONEYSUCKLE, EUROPEAN PRIVET
% WOODY DEBRIS	5-7%
COMMENTS	MID-LATE, MIXED HARDWOODS ALONG SLOPES OF STREAM VALLEY

ID #	SPECIES	SCIENTIFIC NAME	DBH (INCHES)	HEIGHT (FT)	CROWN (FT)	OBSERVATIONS
1	TULIP TREE	*LIRIODENDRON TULIPIFERA*	30	85	30	FAIR, CROWN DIEBACK
2	WHITE OAK	*QUERCUS ALBA*	32	90	50	GOOD, TWIN STEMS AT ABOUT 10 FT
3	LOBLOLLY PINE	*PINUS TAEDA*	31	120	50	GOOD
4	TULIP TREE	*LIRIODENDRON TULIPIFERA*	37	120	50	GOOD, INVASIVE VINE BURDEN
5	BLACK GUM	*NYSSA SYLVATICA*	37	100	70	GOOD



VICINITY MAP
SCALE: 1"=1,000'

LEGEND

- PARCEL BOUNDARIES
- LIMIT OF STUDY AREA
- EX. MAJOR CONTOUR
- EX. MINOR CONTOUR
- EX. STREAM FLOW PATH
- EX. SOILS
- EX. TREE LINE
- EX. SPECIMEN TREE (30"+ DBH)
- EX. SIGNIFICANT TREE (18"+ DBH)
- FOREST STAND DATA STATION
- UPLAND DATA STATION
- SLOPES 15–24.99%
- SLOPES 25% +

FOREST STAND LEGEND		
STAND NO.	DESCRIPTION	SIZE (ACRES)
STAND A	MID–LATE SERAL HARDWOOD	2.76

SOILS LEGEND				
MAP UNIT	DESCRIPTION	HYDROLOGIC SOIL GROUP	DRAINAGE CLASS	HYDRIC
AoC	Annapolis loamy sand, 5-10% slopes	C	Well Drained	No
AuB	Annapolis -Urban land complex, 0-5% lopes	C	Well Drained	No
AuD	Annapolis-Urban land complex, 5-15% slopes	C	Well Drained	No
CkA	Colemantown fine sandy loam,0-2% slopes.	C/D	Poorly Drained	Yes
CRD	Collington and Annapolis soils, 10-15% slopes.	B	Well drained	No
DuB	Donlonton-Urban land complex, 0-5% slopes.	D	Moderately well drained	No
WBA	Widewater and Issue soils, 0-2% slopes.	C/D	Poorly Drained	Yes
Uz	Urban Land.	D	N/A	N/A

NOTES

1. THE STUDY AREA IS LOCATED IN THE COMMUNITY OF GINGERVILLE, IN EDGEWATER, MARYLAND 21037.
2. THE STUDY AREA IS WITHIN FOUR PRIVATE PROPERTIES: 2690, 2691 AND 2694 CASSIA DRIVE. THE FOURTH PROPERTY IS THE OPEN SPACE LOT FOR THE ADMIRALS VIEW TOWNHOME COMMUNITY.
3. TOTAL STUDY AREA COVERS 3.25 ACRES.
4. THE SITE DRAINS TO CHURCH CREEK AND IS IN THE SOUTH RIVER WATERSHED (DNR 021310030991; HUA 02060004010).
5. THE SITE IS WITHIN THE ATLANTIC AND GULF COASTAL PLAIN REGION (MLRA 149A).
6. A NATURAL RESOURCES INVENTORY, FOREST STAND DELINEATION, AND WETLAND DELINEATION WERE PERFORMED BY ENVIRONMENTAL SYSTEMS ANALYSIS INC. ON NOVEMBER 18 AND 21, 2025, WHICH IS DOCUMENTED IN THE *CASSIA DRIVE STREAM SURVEY REPORT MARCH 2026*.
7. UNNAMED TRIBUTARY TO CHURCH CREEK IS A USE CLASS I STREAM.
8. NO 100-YR FEMA FLOODPLAINS OCCUR ON SITE (MAP 24003C0213F AND 24003C0233F).
9. THERE ARE NO NONTIDAL WETLANDS AND BUFFERS THAT OCCUR WITHIN THE PROJECT.
10. ONE FOREST STAND WAS DELINEATED. STAND A IS A MID TO LATE SERAL HARDWOOD FOREST COVERING 2.76 ACRES. A TOTAL OF 5 SPECIMEN TREES (>= 30-INCH DBH) WERE DOCUMENTED.
11. NO TREES ON SITE WERE FOUND TO BE NATIONAL, STATE, OR COUNTY CHAMPION TREES, OR WITHIN 75% OF THE CURRENT STATE CHAMPION.
12. HIGHLY ERODIBLE SOILS ARE ABSENT.
13. STEEP SLOPES OCCUR.

William Saffell — April 9, 2026
William Saffell — Date

Qualified Professional
as per the 1991 Maryland
Forest Conservation Act
Issued February 6, 2017

2141 Priest Bridge Drive, Suite 1
Crofton MD, 21114

REVISIONS			
NO.	BY	DATE	DESCRIPTION

Prepared for:

Arundel Rivers Federation

P.O. Box 760
Edgewater, MD 21037

Prepared by:

Environmental Systems Analysis, Inc.
Natural Resources Management
Ecological Restoration
2141 Priest Bridge Drive, Suite 1
Crofton, Maryland 21114

FOREST STAND DELINEATION

CASSIA DRIVE STREAM RESTORATION

MAP 051D, GRID 0015, PARCEL 0436, SUBDIVISION 280

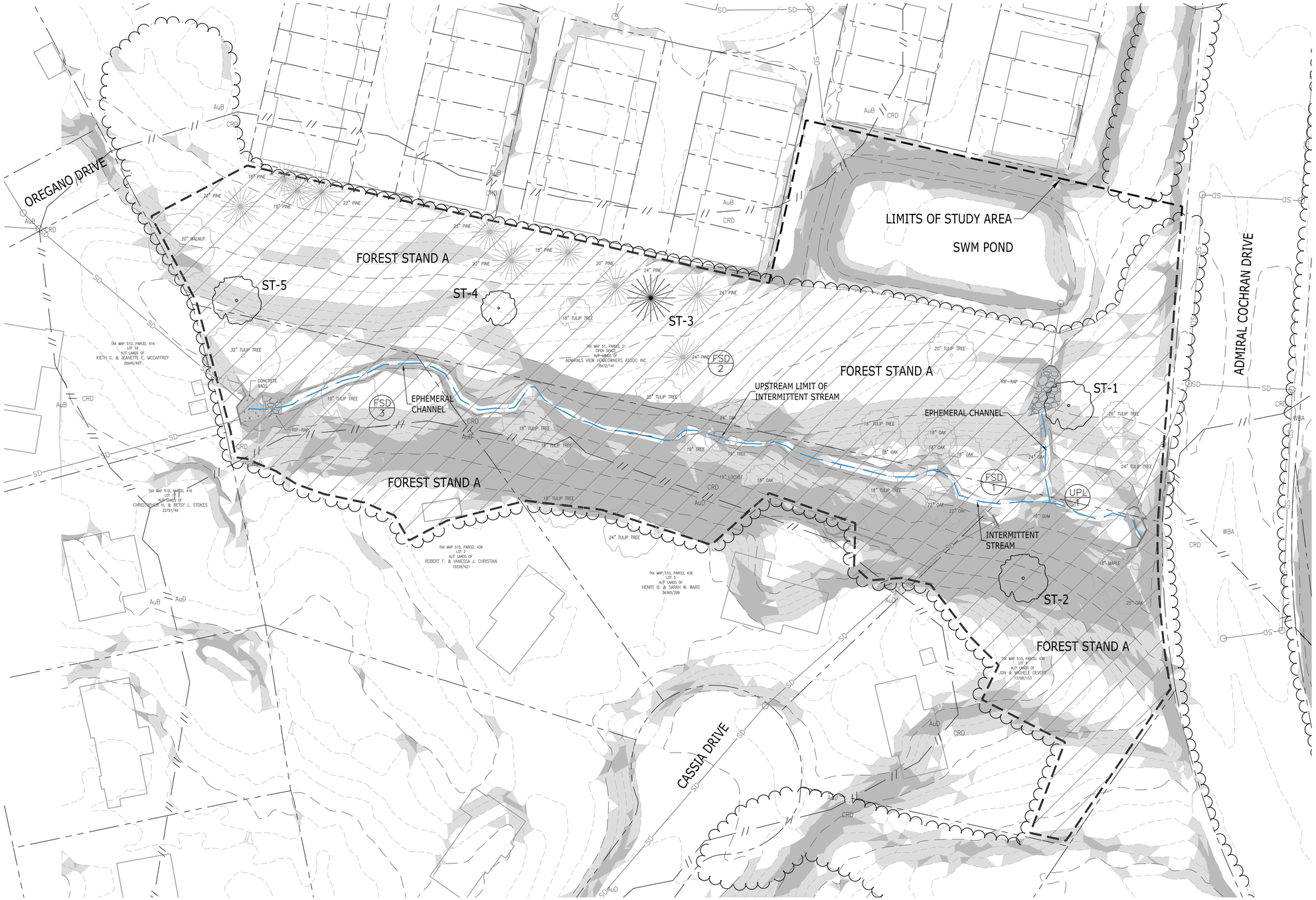
SECOND ELECTION DISTRICT, ANNE ARUNDEL COUNTY, MD

SCALE: 1"=100'
DATE: APRIL 2026
ESA PROJECT NO.: 2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings
SHEET: 1 of 2

0 100 200 Feet

April 2026 FILE: T:\NEWPROJ\2025\2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings\Graphics\Forest Stand Delineation Cover Sheet.dwg 4/16/2026 12:39:24 PM, DWG To PDF.pc3

T:\NEWPROJ\2025\2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings\Graphics\Forest Stand Delineation Cover Sheet.dwg



April 2026 FILE: T:\NEWPROJ\2025\2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings\Graphics\Forest Stand Delineation.dwg

William Saffell April 9, 2026
William Saffell Date

Qualified Professional
as per the 1991 Maryland
Forest Conservation Act
Issued February 6, 2017

2141 Priest Bridge Drive, Suite 1
Crofton MD, 21114

REVISIONS			
NO.	BY	DATE	DESCRIPTION

Prepared for:

Arundel Rivers FEDERATION

P.O. Box 760
Edgewater, MD 21037

Prepared by:

esa **Environmental Systems Analysis, Inc.**
Natural Resources Management
Ecological Restoration
2141 Priest Bridge Drive, Suite 1
Crofton, Maryland 21114

FOREST STAND DELINEATION

CASSIA DRIVE STREAM RESTORATION

MAP 051D, GRID 0015, PARCEL 0436, SUBDIVISION 280

SECOND ELECTION DISTRICT, ANNE ARUNDEL COUNTY, MD

SCALE: 1"=30'
DATE: APRIL 2026
ESA PROJECT NO.: 2025-42-2 Cassia Drive Stream Restoration\CAD\Plans\Individual Drawings
SHEET: 2 of 2

Forest Sample Plot Field Data

Property: Cassia Dr. **Prepared by:** WS

Stand #: A **Plot#:** 1 **Plot Size: 1/10 acre (37' radius)**/variable **Date:** 11/21/2025

	Size Class of Trees >20' height within sample plot															
Tree Species	# of Trees			# of Trees			# of Trees			# of Trees			# of Trees			Total
	2-5.9" dbh			6-9.9" dbh			10-17.9" dbh			18-29.9" dbh			>30" dbh			
Crown Position	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	
Black gum			1			3			3							7
Red Maple									1							1
American holly			6			1			1							8
Sweetgum			1						1	4						6
Black cherry			1													1
Tulip poplar									1							1
Total			9			4			7	4						24
Total # of Trees per Size Class	9			4			7			4			0			24
# of standing dead trees ≥ 6" dbh	0			0			0			0			0			0

List of Common Understory Species 3'-20'	% Canopy Coverage						% Invasive Cover					
American holly, european privet, multiflora rose, Viburnum nudum, sapling sweetgum	C	N	E	S	W	Total	C	N	E	S	W	Total
						75%						10%
List of Herbaceous Species 0'-3'	% Understory Cover 3'-20'						% Herbaceous Woody Cover 0'-3'					
Japanese honeysuckle, multiflora rose, American strawberrybush	C	N	E	S	W	Total	C	N	E	S	W	Total
						40%						5%
List of Invasive Species							Plot Successional Stage					
Japanese honeysuckle, multiflora rose, european privet							mid-late					
Comments: Mixed hardwoods along slopes. Located at downstream end of projected. Higher density or large trees, but similar age forest structure.												
Total number of tree species >6"dbh: 5							% Woody Debris: 7					

Forest Sample Plot Field Data

Property: Cassia Dr. **Prepared by:** WS

Stand #: A **Plot#:** 2 **Plot Size: 1/10 acre (37' radius)**/variable **Date:** 11/21/2025

	Size Class of Trees >20' height within sample plot															
Tree Species	# of Trees			# of Trees			# of Trees			# of Trees			# of Trees			Total
	2-5.9" dbh			6-9.9" dbh			10-17.9" dbh			18-29.9" dbh			>30" dbh			
Crown Position	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	
Loblolly pine										1						1
Sassafras			2			2										4
Hickory			7			1		2								10
American beech			1													1
Northern red oak								1								1
Tulip poplar								1								1
Total			10			3		4		1						18
Total # of Trees per Size Class	10			3			4			1			0			18
# of standing dead trees ≥ 6" dbh	0			0			1			0			0			1

List of Common Understory Species 3'-20'	% Canopy Coverage						% Invasive Cover					
	C	N	E	S	W	Total	C	N	E	S	W	Total
Flowering dogwood, European dogwood, sassafras, pawpaw						60%						20%
List of Herbaceous Species 0'-3'	% Understory Cover 3'-20'						% Herbaceous Woody Cover 0'-3'					
	C	N	E	S	W	Total	C	N	E	S	W	Total
Japanese honeysuckle, multiflora rose,English ivy						30%						5%

List of Invasive Species	Plot Successional Stage
Japanese honeysuckle, multiflora rose, european privet, English ivy	mid-late
Comments: Mixed hardwoods along slopes. Located along middle of projected. Localized regeneration due to treefall gap.	
Total number of tree species >6"dbh: 5	% Woody Debris: 5

Forest Sample Plot Field Data

Property: Cassia Dr. **Prepared by:** WS

Stand #: A **Plot#:** 3 **Plot Size: 1/10 acre (37' radius)**/variable **Date:** 11/21/2025

	Size Class of Trees >20' height within sample plot															
Tree Species	# of Trees			# of Trees			# of Trees			# of Trees			# of Trees			Total
	2-5.9" dbh			6-9.9" dbh			10-17.9" dbh			18-29.9" dbh			>30" dbh			
Crown Position	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	DOM	COD	OTH	
Red maple								1		1						2
Blackgum								2		1						3
American holly			5			2										7
Hickory									1							1
Black cherry						1										1
Box elder			1			1										2
Total			6			4		3	1	2						16
Total # of Trees per Size Class	6			4			4			2			0			16
# of standing dead trees ≥ 6" dbh	0			0			1			0			0			1

List of Common Understory Species 3'-20'	% Canopy Coverage						% Invasive Cover					
	C	N	E	S	W	Total	C	N	E	S	W	Total
American holly, european privet, pawpaw, Japanese bush honeysuckle						60%						50%
List of Herbaceous Species 0'-3'	% Understory Cover 3'-20'						% Herbaceous Woody Cover 0'-3'					
	C	N	E	S	W	Total	C	N	E	S	W	Total
Japanese honeysuckle, English ivy						40%						40%

List of Invasive Species	Plot Successional Stage
Japanese bush honeysuckle, Japanese honeysuckle, european privet, bittersweet.	mid-late
Comments: Mixed hardwoods along slopes. Located at upstream end of projected. Higher invasive cover. Bamboo stands upslope of plot.	
Total number of tree species >6"dbh: 6	% Woody Debris: 7

U.S. Army Corps of Engineers
WETLAND DETERMINATION DATA SHEET – Atlantic and Gulf Coastal Plain Region
See ERDC/EL TR-10-20; the proponent agency is CECW-COR

OMB Control #: 0710-0024, Exp: 09/30/2027
Requirement Control Symbol EXEMPT:
(Authority: AR 335-15, paragraph 5-2a)

Project/Site: Cassia Drive City/County: Anne Arundel County Sampling Date: 11/21/2025
Applicant/Owner: Arundel Rivers Federation State: MD Sampling Point: 1
Investigator(s): WS, JC Section, Township, Range:
Landform (hillside, terrace, etc.): valley Local relief (concave, convex, none): None Slope (%): 1
Subregion (LRR or MLRA): 149A Lat: -76.5473 Long: 38.9694 Datum:
Soil Map Unit Name: CRD NWI classification: none
Are climatic / hydrologic conditions on the site typical for this time of year? Yes x No (If no, explain in Remarks.)
Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes x No
Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area**
Hydric Soil Present?	Yes	No X	**within a Wetland?** **Yes** **No** X
Wetland Hydrology Present?	Yes	No x	

Remarks:

Bench along channel upstream of culvert. Lowest point of project.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- Inundation Visible on Aerial Imagery (B7)
- Water-Stained Leaves (B9)
- Aquatic Fauna (B13)
- Marl Deposits (B15) **(LRR U)**
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- Surface Soil Cracks (B6)
- Sparsely Vegetated Concave Surface (B8)
- x Drainage Patterns (B10)
- Moss Trim Lines (B16)
- Dry-Season Water Table (C2)
- Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- FAC-Neutral Test (D5)
- Sphagnum Moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes	No x	Depth (inches):
Water Table Present?	Yes	No x	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	No x	Depth (inches):

Wetland Hydrology Present? **Yes** **No** x

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants. Sampling Point: 1

Tree Stratum (Plot size: 30 ft)	Absolute % Cover	Dominant Species?	Indicator Status
1. Liriodendron tulipifera	50	x	FACU
2. Acer rubrum	5		FAC
3. Quercus rubra	10		FACU
4. Nyssa sylvatica	15		FAC
5.			
6.			
	80	=Total Cover	
50% of total cover: 40		20% of total cover:	16

Sapling Stratum (Plot size: 30 ft)			
1. N/A			
2.			
3.			
4.			
5.			
6.			
		=Total Cover	
50% of total cover: --		20% of total cover:	--

Shrub Stratum (Plot size: 30 ft)			
1. Acer rubrum	20	x	FAC
2. Carya sp.	5		
3. Liquidambar styraciflua	5		
4. Ilex opaca	10	X	FAC
5. Viburnum nudum	1		
6. Rosa multiflora	2		
	43	=Total Cover	
50% of total cover: 21.5		20% of total cover:	8.6

Herb Stratum (Plot size: 30 ft)			
1. Onoclea sensibilis	1	x	FACW
2. Lonicera japonica	2	x	FACU
3. Rosa multiflora	1	x	FACU
4. Smilax rotundifolia	1	x	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	5	=Total Cover	
50% of total cover: 2.5		20% of total cover:	1

Woody Vine Stratum (Plot size: 30 ft)			
1. Glechoma hederacea	2	x	FACU
2. Vitis sp.	3	x	FAC
3.			
4.			
5.			
	5	=Total Cover	
50% of total cover: 2.5		20% of total cover:	1

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 9 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 55 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub - Woody Plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody Vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? **Yes** X **No** ___

Remarks: (If observed, list morphological adaptations below.)

SOIL

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 2/1	100	N/A				sandy loam	topsoil
3-6	10YR 4/2	40	N/A				loam	
	10YR 2/2	60	N/A				silty loam	
6-10	10YR 2/2	100	N/A				silty loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Organic Bodies (A6) **(LRR P, T, U)**
- ___ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ___ Muck Presence (A8) **(LRR U)**
- ___ 1 cm Muck (A9) **(LRR P, T)**
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Coast Prairie Redox (A16) **(MLRA 150A)**
- ___ Iron Monosulfide (A18)
- ___ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) **(LRR P, S, T, U)**
- ___ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ___ Thin Dark Surface (S9) **(LRR S, T, U)**
- ___ Barrier Islands 1 cm Muck (S12) **(MLRA 153B, 153D)**
- ___ Loamy Mucky Mineral (F1) **(LRR O)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)
- ___ Marl (F10) **(LRR U)**
- ___ Depleted Ochric (F11) **(MLRA 151)**
- ___ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ___ Umbric Surface (F13) **(LRR P, T, U)**
- ___ Delta Ochric (F17) **(MLRA 151)**
- ___ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ___ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ___ Anomalous Bright Floodplain Soils (F20) **(MLRA 149A, 153C, 153D)**
- ___ Very Shallow Dark Surface (F22) **(MLRA 138, 152A in FL, 154)**

Indicators for Problematic Hydric Soils[3]:

- ___ 1 cm Muck (A9) **(LRR O)**
- ___ 2 cm Muck (A10) **(LRR S)**
- ___ Coast Prairie Redox (A16) **(outside MLRA 150A)**
- ___ Reduced Vertic (F18) **(outside MLRA 150A, 150B)**
- ___ Piedmont Floodplain Soils (F19) **(LRR P, T)**
- ___ Anomalous Bright Floodplain Soils (F20) **(MLRA 153B)**
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (F22) **(outside MLRA 138, 152A in FL, 154)**
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

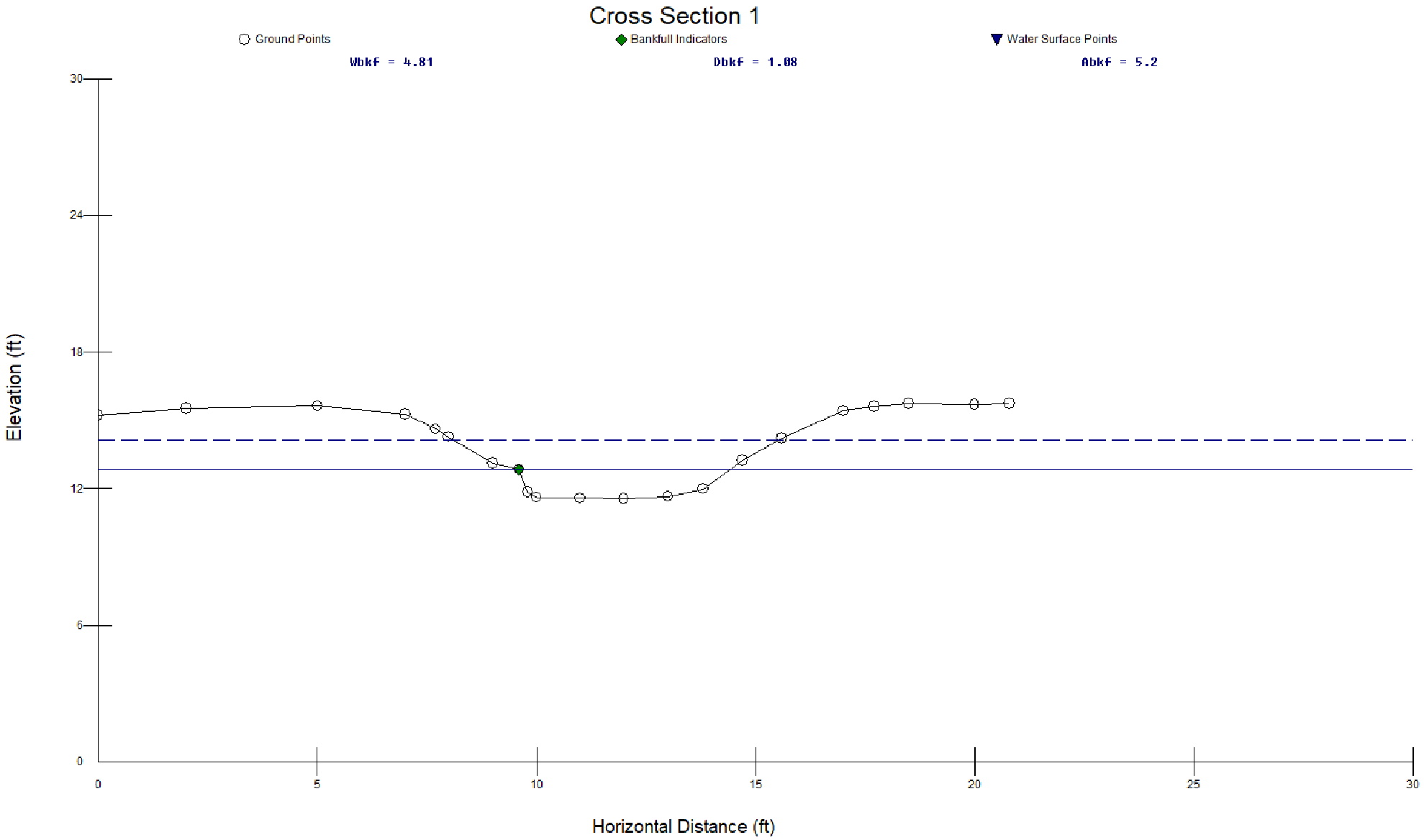
Hydric Soil Present? **Yes** ___ **No** X

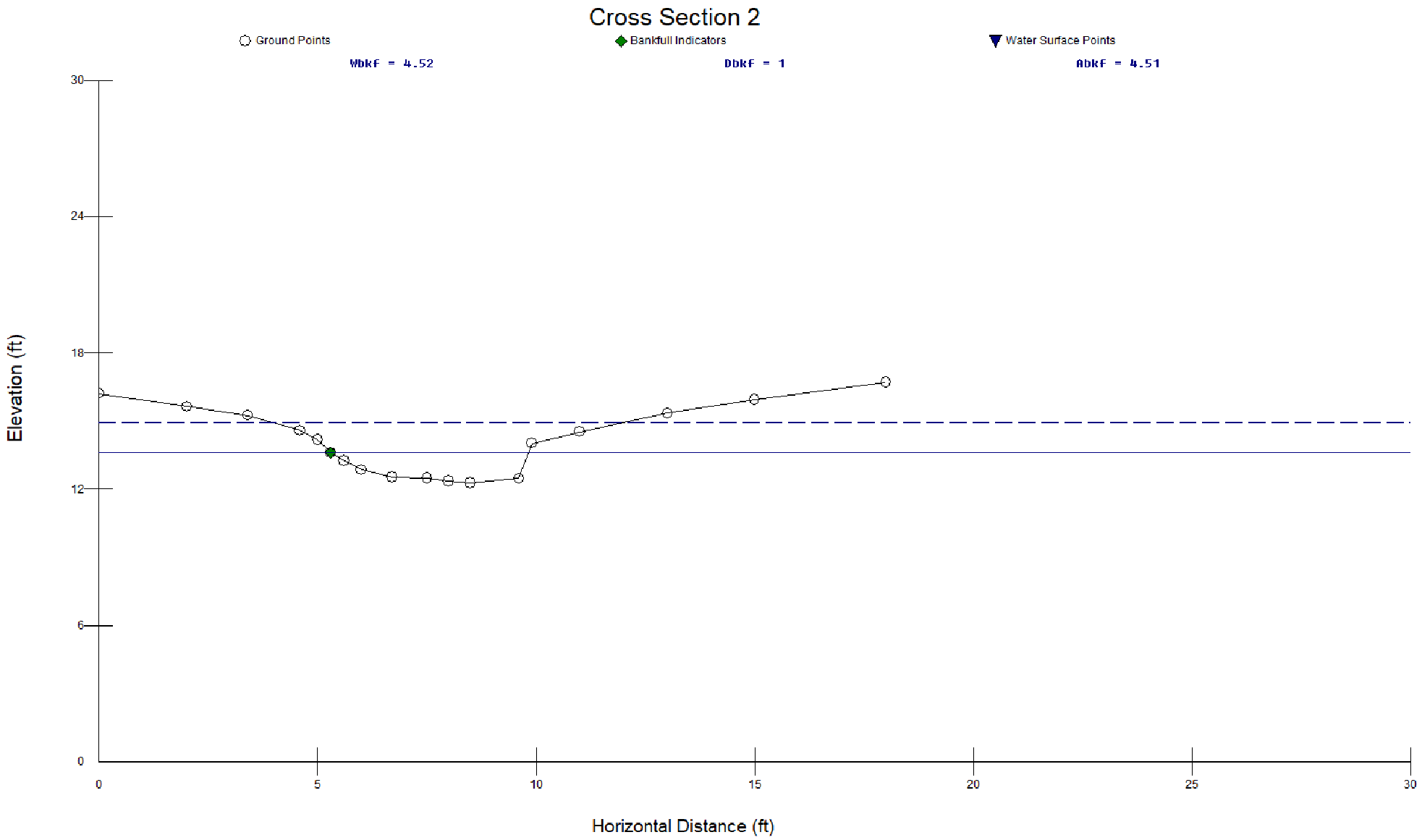
Remarks:

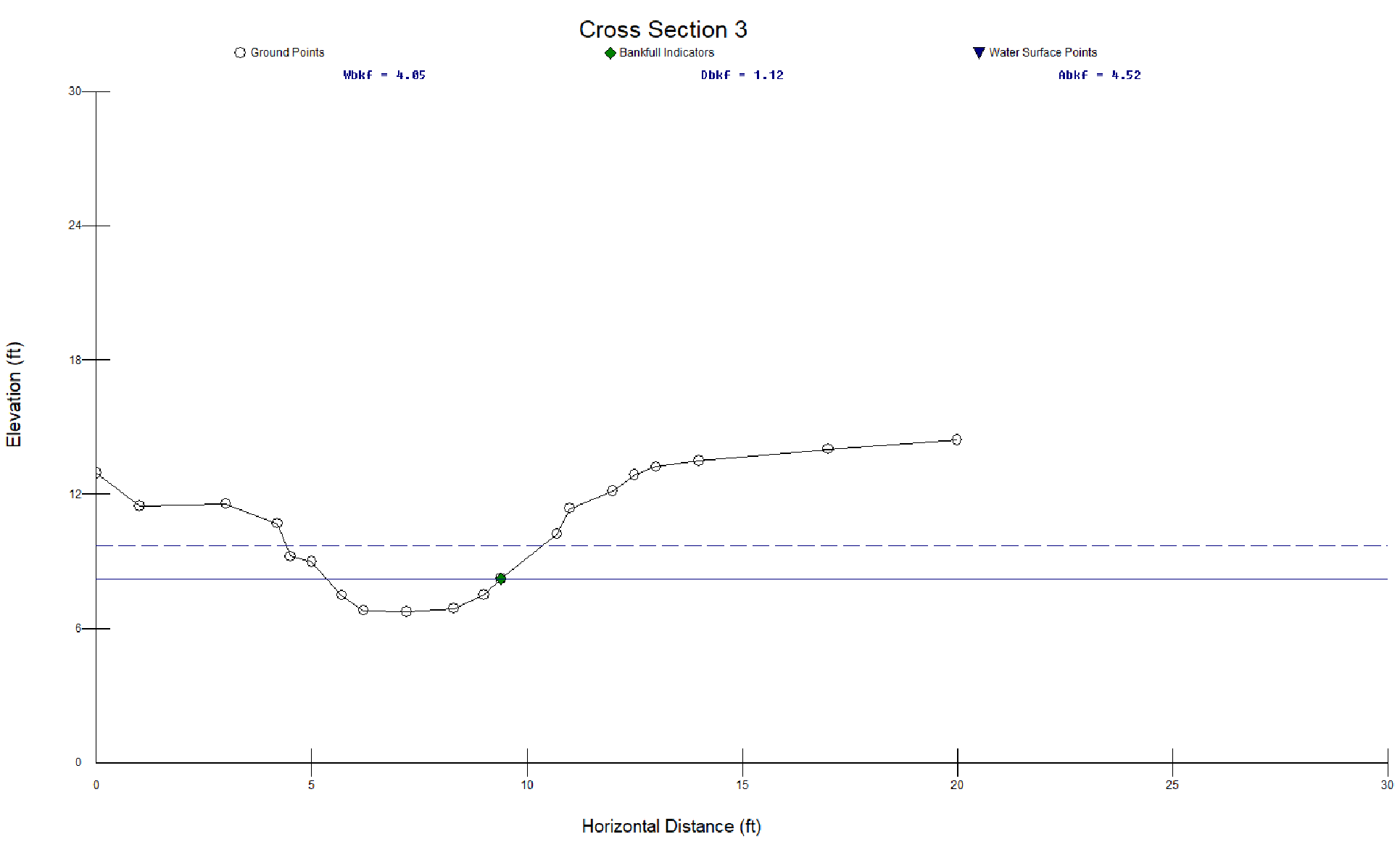
Alluvial deposition along stream, no redox concentrations.

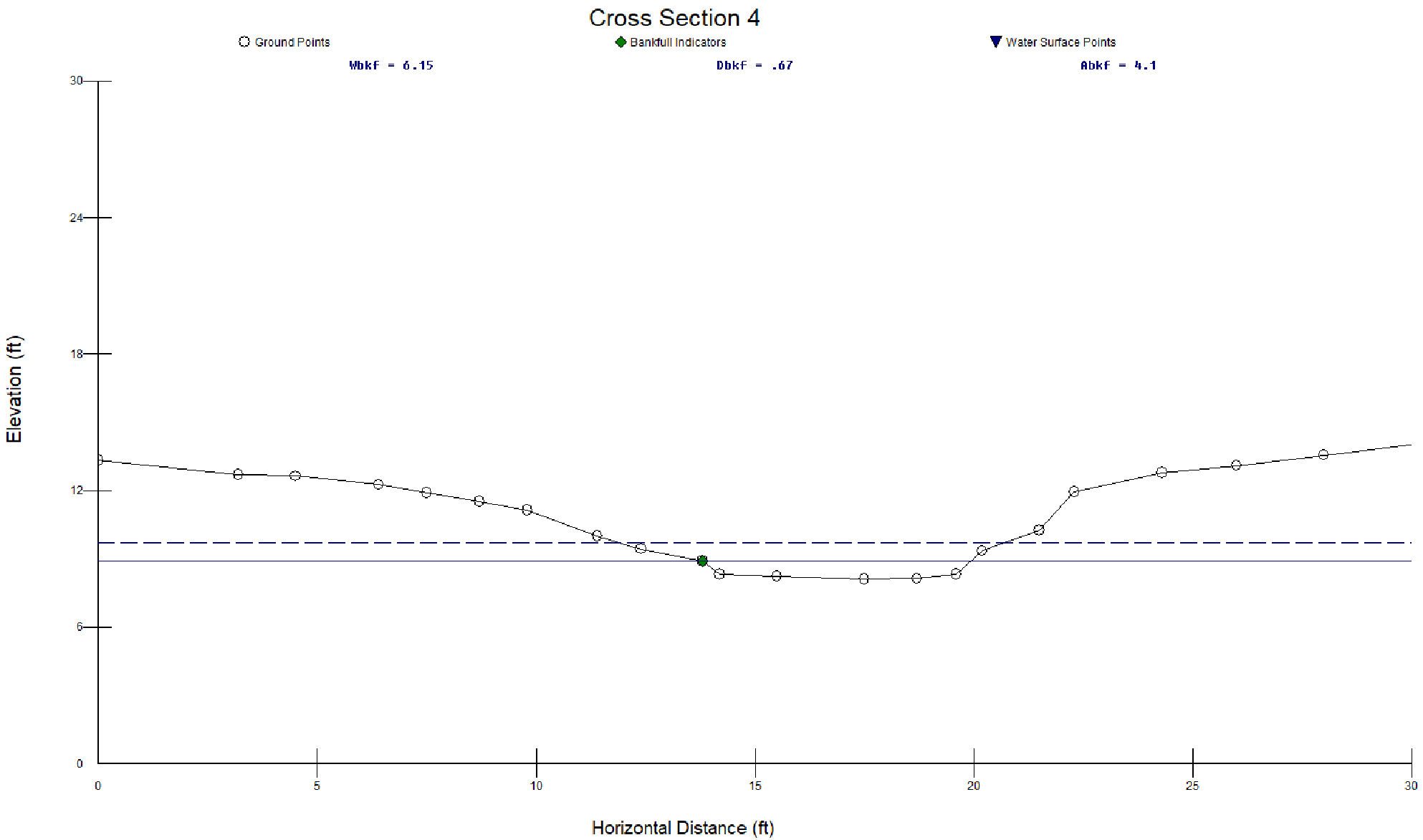
Appendix B:

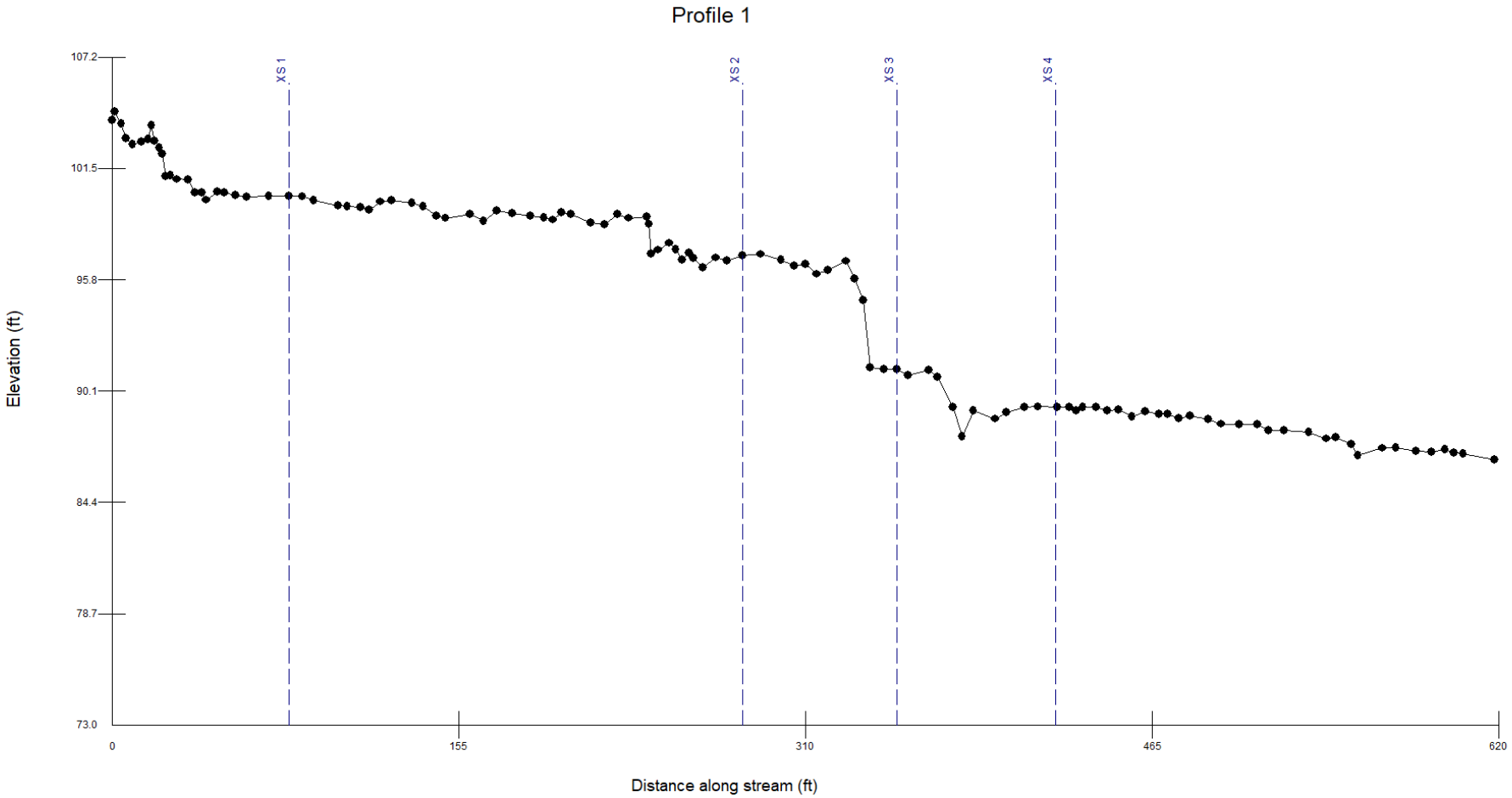
Cross-section and Longitudinal Profile Plots


Cross Section 1
Ground Points
Bankfull Indicators
Water Surface Points
WbkF = 4.81
DbkF = 1.08
AbkF = 5.2
Elevation (ft)
30
24
18
12
6
0
0
5
10
15
20
25
30
Horizontal Distance (ft)


Cross Section 2
Ground Points
Bankfull Indicators
Water Surface Points
WbkF = 4.52
DbkF = 1
AbkF = 4.51
Elevation (ft)
30
24
18
12
6
0
0
5
10
15
20
25
30
Horizontal Distance (ft)


Cross Section 3
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 4.85
Dbkf = 1.12
Abkf = 4.52
Elevation (ft)
30
24
18
12
6
0
0
5
10
15
20
25
30
Horizontal Distance (ft)


Cross Section 4
Ground Points
Bankfull Indicators
Water Surface Points
WbkF = 6.15
DbkF = .67
AbkF = 4.1
Elevation (ft)
30
24
18
12
6
0
0
5
10
15
20
25
30
Horizontal Distance (ft)


Profile 1
XS 1
XS 2
XS 3
XS 4
107.2
101.5
95.8
90.1
84.4
78.7
73.0
Elevation (ft)
0
155
310
465
620
Distance along stream (ft)

Appendix C:

Site Photographs

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 1: Outfalls at upstream end of project.

PHOTO 2: View looking downstream from the outfalls.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 3: Upper end of site looking downstream.

PHOTO 4: Upper end of site looking upstream.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 5: Middle of site looking downstream.

PHOTO 6: Middle of site looking upstream.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 7: Middle of site looking downstream at two tulip trees in the channel at a 5-foot headcut.

PHOTO 8: Middle of site looking upstream at incised channel below the head-cut.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 9: Storm drain outfall on right (south) bank at lower end of site.

PHOTO 10: Lower end of site looking downstream at stable section towards culvert under Admiral Cochrane Drive.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 11: Eroded flow path below outfall from SWM pond on left (north) bank.

PHOTO 12: SWM pond outfall and rock apron.

Photos Taken January 2026

CASSIA DRIVE STREAM RESTORATION

Site Photographs

PHOTO 13: Proposed construction access from Admiral Cochrane Drive.

PHOTO 14: Proposed construction access and stockpile area near existing SWM pond.

Photos Taken January 2026

Appendix D:

Pollutant Load Reduction Computations – Protocol 1

Cassia Drive BANCS Computations 2025 And Nutrient Pollutant Load												
Station Begin (ft)	Station End (ft)	Bank		Bank Length (ft)	Bank Height (ft)	BEHI	NBS	Bank Erosion Rate (ft/yr) [1]	Bank Erosion Rate (ft^3/year) [1]	Sediment Load (tons/year) [1, 2]	Nitrogen Load (pounds/year) [3]	Phosphorous Load (pounds/year) [4]
		L	R									
0	18	☑		18	2.1	V. Low	High	1.00	37.80	1.62	1.99	1.32
18	84	☑		66	5	High	Mod.	0.04	13.20	0.57	0.70	0.46
84	98	☑		14	4.1	High	Mod.	1.00	57.40	2.46	3.02	2.01
98	152	☑		54	4.7	High	High	0.64	162.43	6.96	8.56	5.69
152	182	☑		30	5.2	Mod.	Mod.	1.00	156.00	6.68	8.22	5.47
182	205	☑		23	3.4	Mod.	Mod.	0.64	50.05	2.14	2.64	1.75
205	215	☑		10	5.2	High	High	1.00	52.00	2.23	2.74	1.82
215	240	☑		25	3	Mod.	Mod.	0.64	48.00	2.06	2.53	1.68
240	280	☑		40	3.9	High	Mod.	1.00	156.00	6.68	8.22	5.47
280	306	☑		26	3.3	High	Mod.	0.64	54.91	2.35	2.89	1.92
306	320	☑		14	2.9	High	High	1.00	40.60	1.74	2.14	1.42
320	338	☑		18	1.8	Mod.	Mod.	0.64	20.74	0.89	1.09	0.73
338	350	☑		12	6.1	High	V. High	1.00	73.20	3.14	3.86	2.56
350	377	☑		27	6	High	High	0.64	103.68	4.44	5.46	3.63
377	412	☑		35	5.8	High	Mod.	1.00	203.00	8.70	10.70	7.11
412	443	☑		31	3.5	High	Mod.	0.64	69.44	2.97	3.66	2.43
443	471	☑		28	2.6	Mod.	Low	1.00	72.80	3.12	3.84	2.55
471	484	☑		13	2.6	High	High	0.64	21.63	0.93	1.14	0.76
484	515	☑		31	2.5	High	High	1.00	77.50	3.32	4.08	2.72
515	554	☑		39	1.7	Mod.	Mod.	0.64	42.43	1.82	2.24	1.49
554	578	☑		24	1.5	Mod.	Mod.	1.00	36.00	1.54	1.90	1.26
578	600	☑		22	1.3	Low	Mod.	0.64	18.30	0.78	0.96	0.64
600	618	☑		18	2	Low	Mod.	1.00	36.00	1.54	1.90	1.26
0	18		☑	18	4.8	Low	High	0.64	55.30	2.37	2.91	1.94
18	33		☑	15	4.3	High	Mod.	0.64	41.28	1.77	2.17	1.45
33	84		☑	51	5.5	High	High	1.75	490.88	21.03	25.86	17.20
84	126		☑	42	4.5	High	Mod.	0.15	28.35	1.21	1.49	0.99
126	156		☑	30	4.2	High	Mod.	0.07	8.82	0.38	0.46	0.31
156	198		☑	42	4.7	High	High	0.07	13.82	0.59	0.73	0.48
198	214		☑	16	1.5	Mod.	Low	0.07	1.68	0.07	0.09	0.06
214	240		☑	26	2.1	Mod.	Mod.	0.07	3.82	0.16	0.20	0.13
240	296		☑	56	3.4	High	High	0.13	24.75	1.06	1.30	0.87
296	318		☑	22	2.4	High	Mod.	0.13	6.86	0.29	0.36	0.24
318	335		☑	17	2.2	Mod.	V. High	0.13	4.86	0.21	0.26	0.17
335	344		☑	9	7.6	High	High	0.30	20.52	0.88	1.08	0.72

Cassia Drive BANCS Computations 2025 And Nutrient Pollutant Load												
Station Begin (ft)	**Station End (ft)**	**Bank**		**Bank Length (ft)**	**Bank Height (ft)**	**BEHI**	**NBS**	**Bank Erosion Rate (ft/yr) [1]**	**Bank Erosion Rate (ft^3/year) [1]**	**Sediment Load (tons/year) [1, 2]**	**Nitrogen Load (pounds/year) [3]**	**Phosphorous Load (pounds/year) [4]**
		L	**R**									
344	375		☑	31	7.6	High	High	0.30	70.68	3.03	3.72	2.48
375	407		☑	32	6.2	High	Mod.	0.30	59.52	2.55	3.14	2.09
407	441		☑	34	4.4	High	Mod.	0.30	44.88	1.92	2.36	1.57
441	476		☑	35	2.9	High	High	0.30	30.45	1.30	1.60	1.07
476	492		☑	16	2.5	Mod.	Low	0.30	12.00	0.51	0.63	0.42
492	511		☑	19	3	Mod.	Mod.	0.30	17.10	0.73	0.90	0.60
511	554		☑	43	1.6	Low	Mod.	0.30	20.64	0.88	1.09	0.72
554	600		☑	46	1.7	Mod.	Mod.	0.30	23.46	1.00	1.24	0.82
600	618		☑	18	1.3	Low	Mod.	1.00	23.40	1.00	1.23	0.82
Total				***1236***					***2606.19***	***111.64***	***137.31***	***91.32***

Notes:

[1] Bank erosion rates calculated using bank length, bank height, BEHI/NBS scores, and erosion rate values compiled by the Center for Watershed Protection, which include values from the USFWS Washington DC Bank Erosion Curve, Rosgen Colorado Bank Erosion Rate Curve, and interpolated points from the Rosgen Colorado Bank Erosion Rate curve.

[2] Predicted Sediment Load: $S=\Sigma(cAR)2{,}000$ where: S = sediment load (ton/year) for reach or stream.

c = bulk density of soil (lbs/cf). Soils types were dominated by CRD, which had a soil bulk density of 85.67 lbs/cf.

R = bank erosion rate (ft/year)

A = eroding bank area (ft^2)

2,000 = conversion from pounds to tons

[3] Nitrogen Load: S*1.23 (lbs/ton)

[4] Phosphorus Load: S*0.818 (lbs/ton)

Reduction of sediment and nutrient pollutants - 50%

TSS Load Reduced (tons/year):	55.8
TSS Load Reduced (lbs/year):	111,635.93
TN Load Reduced lbs/year) :	68.7
TP Load Reduced (lbs/year):	45.7

Notes: Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects

Appendix E:

TR-55 Model Outputs Calculations

WinTR-55 Current Data Description

--- Identification Data ---

User: M. Ratz
Project: Cassia Dr. Stream Restoration
SubTitle: Sub Area A
State: Maryland
County: Anne Arundel NOAA-C
Filename: T:\NEWPROJ\2025\2025-42-2 Cassia Drive Stream Restoration\Data\Hydrology\Cassia Drive 1.w55

Date: 5/1/2026
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Sub Aea A	Gingerville community	Outlet	27.81	81	.275

Total area: 27.81 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
2.65	3.2	4.13	4.95	6.19	7.3	8.54

Storm Data Source: Anne Arundel NOAA-C County, Maryland (NRCS)
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Storm Data

Rainfall Depth by Rainfall Return Period

1-Yr (in)	2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)
2.65	3.2	4.13	4.95	6.19	7.3	8.54

Storm Data Source: Anne Arundel NOAA-C County, Maryland (NRCS)
Rainfall Distribution Type: NOAA_C
Dimensionless Unit Hydrograph: <standard>

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 1-Yr (cfs)	2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS							
Sub Aea A	27.25	38.54	58.82	77.40	106.00	131.59	160.46
REACHES							
OUTLET	27.25	38.54	58.82	77.40	106.00	131.59	160.46

M. Ratz

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 1-Yr (cfs)	(hr)	2-Yr (cfs)	(hr)	5-Yr (cfs)	(hr)	10-Yr (cfs)	(hr)	25-Yr (cfs)	(hr)	50-Yr (cfs)	(hr)	100-Yr (cfs)	(hr)
SUBAREAS														
Sub Aea A	27.25	12.22	38.54	12.21	58.82	12.22	77.40	12.21	106.00	12.21	131.59	12.22	160.46	12.22
REACHES														
OUTLET	27.25		38.54		58.82		77.40		106.00		131.59		160.46	

M. Ratz

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Sub Aea A	27.81	0.275	81	Outlet	Gingerville community

Total Area: 27.81 (ac)

M. Ratz

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Sub Aea A							
SHEET	100	0.0200	0.150				0.163
SHALLOW	393	0.0102	0.050				0.067
CHANNEL	776	0.0129	0.016	3.98	7.07	7.185	0.030
CHANNEL	537	0.0311	0.035	20.00	13.00	9.944	0.015
					Time of Concentration		.275

Cassia Dr. Stream Restoration
Sub Area A
Anne Arundel NOAA-C County, Maryland

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Sub Aea A	Paved; open ditches (w/right-of-way)		B	.031	89
	Paved; open ditches (w/right-of-way)		C	3.197	92
	Paved; open ditches (w/right-of-way)		D	.32	93
	Residential districts (1/8 acre)		B	.164	85
	Residential districts (1/8 acre)		C	.01	90
	Residential districts (1/2 acre)		B	1.022	70
	Residential districts (1/2 acre)		C	16.778	80
	Residential districts (1/2 acre)		D	3.915	85
	Woods	(fair)	B	1.06	60
	Woods	(fair)	C	.977	73
	Woods	(fair)	D	.331	79
	Total Area / Weighted Curve Number			27.81	81

Appendix F:

Design Computations

SPSC Sizing Spreadsheet **Cassia**

(Based on Anne Arundel County SPSC Guidelines, 2021) **L = 15'; H = 1'**

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Riffle Weir Sizing			
	Q_{100}	Q_{10}	Q_2
Design Flow (cfs)	161.0	77.4	38.5
Width (ft)	15.0	15.0	15.0
L, Length (ft)	15.0	15.0	15.0
H, Height (ft)	1.0	1.0	1.0
Design Depth of flow (ft)	2.00	1.50	1.20
D50 (in)	12	12	12
P_D, Parabolic Depth (ft)	2.00	2.00	2.00
Width Depth Ratio (W/P_D)	7.5	7.5	7.5
Manning's n Value	0.055	0.060	0.066
Slope (ft/ft)	6.67%	6.67%	6.67%
Rock Unit Weight (lbs/cf)	165.0	165.0	165.0
Top Width at Depth	15.0	13.0	11.6
Flow area (sf)	20.0	13.0	9.3
Hydraulic Radius	1.27	0.97	0.78
Froude	1.03	0.90	0.80
Isbash Maximum Velocity (ft/s)	8.85	12.35	12.35
Depth ("A") at TW/4 offset from centerline	1.50	1.50	1.50
Calculated Flow at Design Depth (cfs)	165.1	81.2	46.1
Calculated Velocity (ft/s)	8.25	6.25	4.96
Does the proposed section provide adequate conveyance?	YES	YES	YES
Is the proposed velocity less than the maximum allowable velocity?	YES	YES	YES

SPSC Sizing Spreadsheet **Cassia**
(Based on Anne Arundel County SPSC Guidelines, 2022) **H= 3'**

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Cascade Weir Sizing			
	Q_{100}	Q_{10}	Q_2
Design Flow (cfs)	161.0	77.4	38.5
Width (ft)	15.0	15.0	15.0
L, Length (ft)	12.0	12.0	12.0
H, Height (ft)	3.0	3.0	3.0
Design Depth of flow (ft)	1.40	1.40	0.80
D50 (in)	30	30	30
P_D, Parabolic Depth (ft)	2.00	2.00	2.00
Manning's n Value	0.050	0.050	0.050
Slope (ft/ft)	25.00%	25.00%	25.00%
Rock Unit Weight (lbs/cf)	165.0	165.0	165.0
Top Width at Depth	12.5	12.5	9.5
Flow area (sf)	11.7	11.7	5.1
Hydraulic Radius	0.90	0.90	0.52
Froude	2.07	2.07	1.91
Isbash Maximum Velocity (ft/s)	13.99	13.99	13.99
Depth ("A") at TW/4 offset from centerline	1.50	1.50	1.50
Calculated Flow at Design Depth (cfs)	163.1	163.1	49.0
Calculated Velocity (ft/s)	13.9	13.9	9.7
Does the proposed section provide adequate conveyance?	YES	YES	YES
Is the proposed velocity less than the maximum allowable velocity?	YES	YES	YES
Does the proposed cascade have a slope of <= 0.5 ft/ft?	YES		

Scour Depth - pools downstream of cascades	
Q_{100}, cfs	161.0
Pool Max Depth, ft	1.0
H, Height of upstream grade control structure, ft	3.0
TW, Top width of the upstream grade control structure, ft	15.0
y, depth of Q_{100} in downstream/receiving structure	2
K, coefficient	1.32

p_d, Calculated scour depth, ft	4.1
Potential depth of scour below design pool bottom, ft	3.1
Minimum footer boulder depth below pool bottom, ft	4.1

SPSC Sizing Spreadsheet **Cassia**

(Based on Anne Arundel County SPSC Guidelines, 2022) **H= 3.5**

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Cascade Weir Sizing			
	Q_{100}	Q_{10}	Q_2
Design Flow (cfs)	161.0	77.4	38.5
Width (ft)	15.0	15.0	15.0
L, Length (ft)	14.0	14.0	14.0
H, Height (ft)	3.5	3.5	3.5
Design Depth of flow (ft)	1.40	1.40	0.80
D50 (in)	30	30	30
P_D, Parabolic Depth (ft)	2.00	2.00	2.00
Manning's n Value	0.050	0.050	0.050
Slope (ft/ft)	25.00%	25.00%	25.00%
Rock Unit Weight (lbs/cf)	165.0	165.0	165.0
Top Width at Depth	12.5	12.5	9.5
Flow area (sf)	11.7	11.7	5.1
Hydraulic Radius	0.90	0.90	0.52
Froude	2.07	2.07	1.91
Isbash Maximum Velocity (ft/s)	13.99	13.99	13.99
Depth ("A") at TW/4 offset from centerline	1.50	1.50	1.50
Calculated Flow at Design Depth (cfs)	163.1	163.1	49.0
Calculated Velocity (ft/s)	13.9	13.9	9.7
Does the proposed section provide adequate conveyance?	YES	YES	YES
Is the proposed velocity less than the maximum allowable velocity?	YES	YES	YES
Does the proposed cascade have a slope of <= 0.5 ft/ft?	YES		

Scour Depth - pools downstream of cascades	
Q_{100}, cfs	161.0
Pool Max Depth, ft	1.0
H, Height of upstream grade control structure, ft	3.5
TW, Top width of the upstream grade control structure, ft	15.0
y, depth of Q_{100} in downstream/receiving structure	2
K, coefficient	1.32

p_d, Calculated scour depth, ft	4.3
Potential depth of scour below design pool bottom, ft	3.3
Minimum footer boulder depth below pool bottom, ft	4.3

SPSC Sizing Spreadsheet **Cassia SWM Pond Outfall**
(Based on Anne Arundel County SPSC Guidelines, 2022) **H= 6.0**

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Cascade Weir Sizing			
	Q_{100}	Q_{10}	Q_2
Design Flow (cfs)	26.0	8.8	
Width (ft)	8.0	8.0	8.0
L, Length (ft)	15.0	15.0	15.0
H, Height (ft)	6.0	6.0	6.0
Design Depth of flow (ft)	1.00	0.50	
D50 (in)	30	30	30
P_D, Parabolic Depth (ft)	2.00	2.00	2.00
Manning's n Value	0.050	0.050	0.050
Slope (ft/ft)	40.00%	40.00%	40.00%
Rock Unit Weight (lbs/cf)	165.0	165.0	165.0
Top Width at Depth	5.7	4.0	#DIV/0!
Flow area (sf)	3.8	1.3	#DIV/0!
Hydraulic Radius	0.62	0.32	#DIV/0!
Froude	2.40	2.20	#DIV/0!
Isbash Maximum Velocity (ft/s)	13.99	13.99	#DIV/0!
Depth ("A") at TW/4 offset from centerline	1.50	1.50	1.50
Calculated Flow at Design Depth (cfs)	51.4	11.8	#DIV/0!
Calculated Velocity (ft/s)	13.6	8.8	#DIV/0!
Does the proposed section provide adequate conveyance?	YES	YES	#DIV/0!
Is the proposed velocity less than the maximum allowable velocity?	YES	YES	#DIV/0!
Does the proposed cascade have a slope of <= 0.5 ft/ft?	YES		

Scour Depth - pools downstream of cascades	
Q_{100}, cfs	26.0
Pool Max Depth, ft	1.0
H, Height of upstream grade control structure, ft	6.0
TW, Top width of the upstream grade control structure, ft	8.0
y, depth of Q_{100} in downstream/receiving structure	1
K, coefficient	1.32

p_d, Calculated scour depth, ft	2.7
Potential depth of scour below design pool bottom, ft	1.7
Minimum footer boulder depth below pool bottom, ft	2.0

SPSC Sizing Spreadsheet
(Based on Anne Arundel County SPSC Guidelines, 2021)

Cassia SWM Pond Outfall
L = 10'; H = 1'

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Riffle Weir Sizing			
	Q_{100}	Q_{10}	Q_2
Design Flow (cfs)	26.0		
Width (ft)	8.0	8.0	8.0
L, Length (ft)	10.0	10.0	10.0
H, Height (ft)	1.0	1.0	1.0
Design Depth of flow (ft)	1.00		
D50 (in)	9	9	9
P_D, Parabolic Depth (ft)	1.00	1.00	1.00
Width Depth Ratio (W/P_D)	8.0	8.0	8.0
Manning's n Value	0.060	#NUM!	#NUM!
Slope (ft/ft)	10.00%	10.00%	10.00%
Rock Unit Weight (lbs/cf)	165.0	165.0	165.0
Top Width at Depth	8.0	#DIV/0!	#DIV/0!
Flow area (sf)	5.3	#DIV/0!	#DIV/0!
Hydraulic Radius	0.64	#DIV/0!	#DIV/0!
Froude	1.03	#NUM!	#NUM!
Isbash Maximum Velocity (ft/s)	7.66	#NUM!	#NUM!
Depth ("A") at TW/4 offset from centerline	0.75	0.75	0.75
Calculated Flow at Design Depth (cfs)	31.2	#NUM!	#NUM!
Calculated Velocity (ft/s)	5.84	#NUM!	#NUM!
Does the proposed section provide adequate conveyance?	YES	#NUM!	#NUM!
Is the proposed velocity less than the maximum allowable velocity?	YES	#NUM!	#NUM!

Appendix G:

Function-Based Rapid Stream Assessment Data Sheets

RAPID WATERSHED ASSESSMENT DATA SHEET

Watershed: Lower Western Shore

Rater(s): ESA

Stream: Cassia Drive

Date: 11/21/25

Photo(s): See Report

Overall Watershed Condition: **Fair/Poor**

WATERSHED ASSESSMENT

	Category / Parameter / Measurement	Description of Watershed Condition			Rating (G/F/P)
		Good	Fair	Poor	
1	Hydrology / Runoff / Watershed Impoundments	No impoundment upstream of project area	No impoundment within 1 mile upstream of project area OR impoundment does not adversely affect hydrology or fish passage	Impoundment(s) located within 1 mile upstream of project area and/or has an adverse effect on hydrology and/or fish passage	**Good**
2	Hydrology / Runoff / Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place	**Fair**
3	Hydrology / Runoff / Land Use Change	Rural communities/slow growth or primarily forested (>70%)	Single family homes/suburban development occurring or active agricultural practices occurring, or commercial and/or industrial development starting, forested area 20 - 70%	Rapidly urbanizing/urban or primarily active agricultural practices (> 70%), forested area <20%	**Fair**
4	Hydrology / Runoff / Distance to Roads	No roads in or adjacent to site. No proposed major roads in or adjacent to site in 10 year DOT plans	No roads in or adjacent to site. No more than one major road proposed in 10 year DOT plans	Roads located in or adjacent to site boundary and/or major roads proposed in 10 year DOT plans	**Poor**
5	Hydrology / Runoff / Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7%- 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%	**Poor**
6	Geomorphology / Riparian Vegetation	>80% of contributing stream length has >25 ft corridor width	50 - 80% of contributing stream length has >25 ft corridor width	<50% of contributing stream length has >25 ft corridor width	**Good**
7	Geomorphology / Sediment Supply	Low sediment supply. Upstream bank erosion and bed load supply is minimal. There are few bars present in the channel	Moderate sediment supply from upstream bank erosion and bed load supply. There are some point bars and small lateral bars	High sediment supply from upstream bank erosion and bed load supply. There are numerous alternating point bars, transverse bars and/or mid-channel bars	**Fair**
8	Physicochemical / Water Quality / 303(d) List	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present. Not on 303d list	Considerable cloudiness most of the time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with green or olive-green film; or moderate odor of ammonia or rotten eggs. Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months. On or downstream of 303d list and TMDL/WS Mgmt plan addressing deficiencies	Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream. On or downstream of 303d list and no TMDL/WS mgmt plan to address deficiencies	**Poor**
9	Biology / Landscape Connectivity	Channel upstream and downstream of project area has native bed and bank materials and is not impaired	Channel upstream and downstream of project area has native bed and bank materials but is impaired	Channel upstream and downstream of project area is concrete piped, or hardened	**Poor**

EXISTING and PROPOSED REACH LEVEL STREAM FUNCTION-BASED RAPID ASSESSMENT FIELD DATA SHEET

Watershed:	Lower Western Shore	Rater(s):	ESA
Stream:	Cassia Drive, Tributary of Church Creek, Ephemeral	Date:	11/21/25
Reach Length:	396	Latitude:	38.969697961535026
Photo(s):	See Report	Longitude:	-76.54813800027709

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Runoff	**Stream Function Pyramid Level 1 Hydrology**			
	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place
	Existing Condition		X	
	Proposed Condition		X	
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%
	Existing Condition			X
	Proposed Condition			X
	If existing runoff is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Impervious area is approximately 39% and contains flows from culverts. These conditions will not change through stream restoration and uplift of Level 1 is not anticipated.		
	Runoff Overall EXISTING Condition **NF**			
	Runoff Overall PROPOSED Condition **NF**			
	Stream Function Pyramid Level 1 Hydrology Overall EXISTING Condition NF			
	Stream Function Pyramid Level 1 Hydrology Overall PROPOSED Condition NF			
	Stream Function Pyramid Level 2 Hydraulics			
	3. Bank Height Ratio (BHR)	<1.10	1.11 - 1.50	>1.50
	Existing Condition			X
	Proposed Condition	X		
	4a. Entrenchment (Meandering streams in alluvial valleys or Rosgen C, E, DA Streams)	>2.2	2.1 - 1.4	<1.4
	Existing Condition			X
	Proposed Condition	X		
	4b. Entrenchment (Non meandering streams in colluvial valleys or Rosgen B Streams)	>1.4	1.3 - 1.1	<1.1
	Existing Condition			
	Proposed Condition			
	5. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10 - 40%; hillslopes 50 - 200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent
	Existing Condition			X
	Proposed Condition		X	

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
	6. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability
	Existing Condition		X	
	Proposed Condition	X		
	If existing floodplain connectivity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Headcuts and adjacent to steep slopes.		
	Floodplain Connectivity Overall EXISTING Condition	**NF**		
	Floodplain Connectivity Overall PROPOSED Condition	**F**		
	Stream Function Pyramid Level 2 Hydraulics Overall EXISTING Condition	**NF**		
	Stream Function Pyramid Level 2 Hydraulics Overall PROPOSED Condition	**F**		
	Stream Function Pyramid Level 3 Geomorphology			
Riparian Vegetation	7. Riparian Vegetation Zone (EPA, 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive
	Left Bank Existing	X		
	Left Bank Proposed	X		
	Right Bank Existing	X		
	Right Bank Proposed	X		
	If existing riparian vegetation is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	A forested buffer exceeding 100 feet is located along both sides of the stream.		
	Riparian Vegetation Overall EXISTING Condition	**F**		
	Riparian Vegetation Overall PROPOSED Condition	**F**		
Lateral Stability	8. Dominant Bank Erosion Rate Potential	Dominant bank erosion rate potential is low or BEHI/NBS Rating: L/VL, L/L, L/M, L/H, L/VH, M/VL	Dominant bank erosion rate potential is moderate or BEHI/NBS Rating: M/L, M/M, M/H, L/Ex, H/L, M/VH, M/Ex, H/L, H/M, VH/VL, Ex/VL	Dominant bank erosion rate potential is high or BEHI/NBS Rating: H/H, H/Ex, VH/H, Ex/M, Ex/H, Ex/VH, VH/VH, Ex/Ex
	Existing Condition (Right bank)			X
	Proposed Condition (Right Bank)	X		
	Existing Condition (Left bank)			X
	Proposed Condition (Left Bank)	X		
	9. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability
	Existing Condition			X
	Proposed Condition	X		

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
	If existing lateral stability is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	BEHI ratings along both banks were primarily rated as High, Very High, and Extreme. Typical conditions included actively eroding vertical banks with an average height of 4-8 feet. Banks were primarily comprised of sandy substrates.		
	Lateral Stability Overall EXISTING Condition	**NF**		
	Lateral Stability Overall PROPOSED Condition	**F**		
Bedform Diversity (Do not complete if stream is ephemeral)	10. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking
	Existing Condition			
	Proposed Condition			
	11a. Pool-to-Pool Spacing Ratio (Watersheds < 10 mi^2)	4.0 - 5.0	3.0 - 4.0 ***or*** 5.0 - 7.0	< 3.0 ***or*** >7.0
	Existing Condition			
	Proposed Condition			
	11b. Pool-to-Pool Spacing Ratio (Watersheds > 10 mi^2)	5.0 - 7.0	3.5 - 5.0 ***or*** 7.0 - 8.0	<3.5 ***or*** >8.0
	Existing Condition			
	Proposed Condition			
	12a. Pool Max Depth Ratio/Depth Variability (Gravel Bed Streams)	>1.5	1.2 - 1.5	<1.2
	Existing Condition			
	Proposed Condition			
	12b. Pool Max Depth Ratio/Depth Variability (Sand Bed Streams)	>1.2	1.1 - 1.2	<1.1
	Existing Condition			
	Proposed Condition			
	Moderate Gradient Perennial Streams in Colluvial Valleys			
	11. Pool-to-Pool Spacing Ratio (3-5% Slope)	2.0 - 4.0	4.0 - 6.0	>6.0
	Existing Condition			
	Proposed Condition			
	12. Pool Max Depth Ratio/Depth Variability	>1.5	1.2 - 1.5	<1.2
	Existing Condition			
	Proposed Condition			
	If existing bedform diversity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason			
	Bedform Diversity Overall EXISTING Condition			
	Bedform Diversity Overall PROPOSED Condition			

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Stream Function Pyramid Level 3 Geomorphology Overall EXISTING Condition				**FAR**
Stream Function Pyramid Level 3 Geomorphology Overall PROPOSED Condition				**F**
Stream Function Pyramid Level 4 Physiochemical				
Water Quality and Nutrients (Do not complete if stream is ephemeral)	13. Water Appearance and Nutrient Enrichment (USDA 1999)	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present	Frequent cloudiness especially after storm events; objects visible to depth 0.5 to 3.0 ft; may have slight green color; no oil sheen on water surface. Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate	Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream
	Existing Condition			
	Proposed Condition			
	14. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent
	Existing Condition			
	Proposed Condition			
	If existing water quality is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason			
Stream Function Pyramid Level 4 Physicochemical Overall EXISTING Condition				**N/A (ephemeral)**
Stream Function Pyramid Level 4 Physicochemical Overall PROPOSED Condition				**N/A (ephemeral)**
Stream Function Pyramid Level 5 Biology				
Biology (Do not complete if stream is ephemeral)	15. Macroinvertebrate	Abundant	Rare	Not present
	Existing Condition			
	Proposed Condition			
	16. Macroinvertebrate Tolerance	Abundant intolerant species	Limited intolerant species	Only tolerant species
	Existing Condition			
	Proposed Condition			
	17. Fish Presence	Abundant	Rare	Not present
	Existing Condition			
	Proposed Condition			
	If existing biology is FAR or NF, provide description of cause (s) and stability trend and if F can not be potentially achieved, provide reason	No flow during assessment, water isolated to pools. Macroinvertebrates and fish rare to not present. Only limited colonization of intolerant species is anticipated due to the high impervious cover within the watershed. Intermittent flow additionally limits colonization.		
Stream Function Pyramid Level 5 Biology Overall EXISTING Condition				**N/A (ephemeral)**
Stream Function Pyramid Level 5 Biology Overall PROPOSED Condition				**N/A (ephemeral)**

Reach ID:	Cassia

Rapid Assessment Summary

Overall Watershed Condition Poor

Overall EXISTING Reach Level Stream Condition NF

LEVEL 1 - NF	LEVEL 2 - NF	LEVEL 3 - FAR	LEVEL 4 - N/A	LEVEL 5 - N/A
If existing overall condition is FAR or NF, provide description of cause(s)	Stream contains widespread instability. Banks are actively eroding. Sandy composition of banks adds to instability. Headcuts noted.			

	Functioning	Functioning-at-Risk		Not Functioning
		Trending Towards Functioning	Trending Towards Not Functioning	
Channel Evolution Trend (Rosgen, 1996)	Little or no presence of active vertical or lateral stream adjustment; floodplain and/or flood prone area well developed, vegetated, and hydrologically connected to stream. Simon Stage 1 & 6. Rosgen Stream type E, C, B, A, & DA	Presence of localized vertical or lateral stream adjustment; floodplain well developed, vegetated and hydrologically connected to stream (floodplain can be newly formed within a channel that shows past active vertical or lateral stream adjustments). Simon Stage 5. Rosgen Stream type F→C, D→C, F→Bc, & G→B	Channel shows past evidence of active vertical downcutting and lateral widening but is currently rebuilding a new floodplain; presence of moderately defined riffles and pools; moderate aggradation occurring; width/depth ratio 12-40. Rosgen Stream type C→F, C→D, Bc→F, E→Gc, B→G & C→Gc	Channel has widespread active vertical downcutting and lateral widening; floodplain not hydrologically connected (abandoned floodplain); lack of well defined riffles and pools; incision ratio > 2.1; and for laterally meandering stream a sinuosity ratio < 1.2; entrenchment < 1.4. Simon Stage 2, 3, 4, & 5. Rosgen Stream type F, D, Gc, & G
If existing channel evolution is FAR or NF, provide description of cause(s)	The stream was determined to be Not Functioning due to complete disconnection from the floodplain. Channel widening through active lateral erosion is widespread and headcuts are present.			

Restoration POTENTIAL Level 2 Functioning

Provide reason(s) for restoration potential prediction	Stream restoration at this site will result in Level 2 and Level 3 increasing to Functioning.

Overall PROPOSED Reach Level Stream Condition FAR

LEVEL 1 - NF	LEVEL 2 - F	LEVEL 3 - F	LEVEL 4 - N/A	LEVEL 5 - N/A
	The high Impervious cover within the drainage area limits the potential uplift of Level 1. Levels 2 and 3 will improve to Functioning.			

EXISTING and PROPOSED REACH LEVEL STREAM FUNCTION-BASED RAPID ASSESSMENT FIELD DATA SHEET

Watershed: Lower Western Shore
Stream: Cassia Drive, Tributary of Church Creek, Intermittent
Reach Length: 314 ft.
Photo(s): See Report

Rater(s): ESA
Date: 11/21/25
Latitude: 38.969393498274464
Longitude: -76.54698196822676

Reach ID: Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Runoff	**Stream Function Pyramid Level 1 Hydrology**			
	1. Concentrated Flow	No potential for concentrated flow/impairments from adjacent land use	Some potential for concentrated flow/impairments to reach restoration site, however, measures are in place to protect resources	Potential for concentrated flow/impairments to reach restoration site and no treatments are in place
	Existing Condition		X	
	Proposed Condition		X	
	2. Flashiness	Non-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover less than 6%	Semi-flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover 7 - 15%	Flashy flow regime as a result of rainfall patterns, geology, and soils, impervious cover greater than 15%
	Existing Condition			X
	Proposed Condition			X
	If existing runoff is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Impervious area is approximately 39% and contains flows from culverts. These conditions will not change through stream restoration and uplift of Level 1 is not anticipated.		
	Runoff Overall EXISTING Condition	**NF**		
	Runoff Overall PROPOSED Condition	**NF**		
	Stream Function Pyramid Level 1 Hydrology Overall EXISTING Condition	**NF**		
	Stream Function Pyramid Level 1 Hydrology Overall PROPOSED Condition	**NF**		
	Stream Function Pyramid Level 2 Hydraulics			
	3. Bank Height Ratio (BHR)	<1.10	1.11 - 1.50	>1.50
	Existing Condition			X
	Proposed Condition	X		
	4a. Entrenchment (Meandering streams in alluvial valleys or Rosgen C, E, DA Streams)	>2.2	2.1 - 1.4	<1.4
	Existing Condition			X
	Proposed Condition	X		
	4b. Entrenchment (Non meandering streams in colluvial valleys or Rosgen B Streams)	>1.4	1.3 - 1.1	<1.1
	Existing Condition			
	Proposed Condition			
	5. Floodplain Drainage	no concentrated flow; runoff is primarily sheet flow; hillslopes < 10%; hillslopes >200 ft from stream; ponding or wetland areas and litter or debris jams are well represented	runoff is equally sheet and concentrated flow (minor gully and rill erosion occurring); hillslopes 10 - 40%; hillslopes 50 - 200 ft from stream; ponding or wetland areas and litter or debris jams are minimally represented	concentrated flows present (extensive gully and rill erosion); hillslopes >40%; hillslopes <50 ft from stream; ponding or wetland areas and litter or debris jams are not well represented or absent
	Existing Condition			X
	Proposed Condition		X	

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
	6. Vertical Stability Extent	Stable	Localized Instability	Widespread Instability
	Existing Condition		X	
	Proposed Condition	X		
	If existing floodplain connectivity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Headcuts and adjacent to steep slopes.		
	Floodplain Connectivity Overall EXISTING Condition	**NF**		
	Floodplain Connectivity Overall PROPOSED Condition	**F**		
	Stream Function Pyramid Level 2 Hydraulics Overall EXISTING Condition	**NF**		
	Stream Function Pyramid Level 2 Hydraulics Overall PROPOSED Condition	**F**		
	Stream Function Pyramid Level 3 Geomorphology			
Riparian Vegetation	7. Riparian Vegetation Zone (EPA, 1999, modified)	Riparian zone extends to a width of >100 feet; good vegetation community diversity and density; human activities do not impact zone; invasive species not present or sparse	Riparian zone extends to a width of 25-100 feet; species composition is dominated by 2 or 3 species; human activities greatly impact zone; invasive species well represented and alter the community	Riparian zone extends to a width of <25 feet; little or no riparian vegetation due to human activities; majority of vegetation is invasive
	Left Bank Existing	X		
	Left Bank Proposed	X		
	Right Bank Existing	X		
	Right Bank Proposed	X		
	If existing riparian vegetation is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	A forested buffer exceeding 100 feet is located along both sides of the stream.		
	Riparian Vegetation Overall EXISTING Condition	**F**		
	Riparian Vegetation Overall PROPOSED Condition	**F**		
Lateral Stability	8. Dominant Bank Erosion Rate Potential	Dominant bank erosion rate potential is low or BEHI/NBS Rating: L/VL, L/L, L/M, L/H, L/VH, M/VL	Dominant bank erosion rate potential is moderate or BEHI/NBS Rating: M/L, M/M, M/H, L/Ex, H/L, M/VH, M/Ex, H/L, H/M, VH/VL, Ex/VL	Dominant bank erosion rate potential is high or BEHI/NBS Rating: H/H, H/Ex, VH/H, Ex/M, Ex/H, Ex/VH, VH/VH, Ex/Ex
	Existing Condition (Right bank)			X
	Proposed Condition (Right Bank)	X		
	Existing Condition (Left bank)			X
	Proposed Condition (Left Bank)	X		
	9. Lateral Stability Extent	Stable	Localized Instability	Widespread Instability
	Existing Condition			X
	Proposed Condition	X		

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
	If existing lateral stability is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	BEHI ratings along both banks were primarily rated as High, Very High, and Extreme. Typical conditions included actively eroding vertical banks with an average height of 8-11 feet. Banks were primarily comprised of sandy substrates.		
	Lateral Stability Overall EXISTING Condition	**NF**		
	Lateral Stability Overall PROPOSED Condition	**F**		
Bedform Diversity (Do not complete if stream is ephemeral)	10. Shelter for Fish and Macroinvertebrates (EPA 1999)	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, rubble, gravel, cobble and large rocks, or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	20-70% mix of stable habitat; suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale)	Less than 20% mix of stable habitat; lack of habitat availability less than desirables obvious; substrate unstable or lacking
	Existing Condition			X
	Proposed Condition	X		
	11a. Pool-to-Pool Spacing Ratio (Watersheds < 10 mi^2)	4.0 - 5.0	3.0 - 4.0 ***or*** 5.0 - 7.0	< 3.0 ***or*** >7.0
	Existing Condition			X
	Proposed Condition	X		
	11b. Pool-to-Pool Spacing Ratio (Watersheds > 10 mi^2)	5.0 - 7.0	3.5 - 5.0 ***or*** 7.0 - 8.0	<3.5 ***or*** >8.0
	Existing Condition			
	Proposed Condition			
	12a. Pool Max Depth Ratio/Depth Variability (Gravel Bed Streams)	>1.5	1.2 - 1.5	<1.2
	Existing Condition			
	Proposed Condition			
	12b. Pool Max Depth Ratio/Depth Variability (Sand Bed Streams)	>1.2	1.1 - 1.2	<1.1
	Existing Condition			X
	Proposed Condition	X		
	Moderate Gradient Perennial Streams in Colluvial Valleys			
Bedform Diversity (Do not complete if stream is ephemeral)	11. Pool-to-Pool Spacing Ratio (3-5% Slope)	2.0 - 4.0	4.0 - 6.0	>6.0
	Existing Condition			
	Proposed Condition			
	12. Pool Max Depth Ratio/Depth Variability	>1.5	1.2 - 1.5	<1.2
	Existing Condition			
	Proposed Condition			
	If existing bedform diversity is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Pools were primarily located at headcuts. Natural stable pools were lacking. Substrates were dominated by sand deposition, which likely originated from bank erosion.		
	Bedform Diversity Overall EXISTING Condition	**NF**		
	Bedform Diversity Overall PROPOSED Condition	**F**		

Reach ID:	Cassia

Function-based Rapid Reach Level Stream Assessment

Assessment Parameter	Measurement Method	Category		
		Functioning	Functioning-at-Risk	Not Functioning
Stream Function Pyramid Level 3 Geomorphology Overall EXISTING Condition				**FAR**
Stream Function Pyramid Level 3 Geomorphology Overall PROPOSED Condition				**F**
Water Quality and Nutrients (Do not complete if stream is ephemeral)	**Stream Function Pyramid Level 4 Physiochemical**			
	13. Water Appearance and Nutrient Enrichment (USDA 1999)	Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. Clear water along entire reach; diverse aquatic plant community includes low quantities of many species of macrophytes; little algal growth present	Frequent cloudiness especially after storm events; objects visible to depth 0.5 to 3.0 ft; may have slight green color; no oil sheen on water surface. Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrate	Very turbid or muddy appearance most of the time; objects visible at depth< 0.5 ft; slow moving water maybe bright green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface; or strong odor of chemicals, oil, sewage, or other pollutants. Pea-green, gray, or brown water along entire reach; dense stands of macrophytes clogging stream; severe algal blooms creating thick algal mats in stream
	Existing Condition		X	
	Proposed Condition		X	
	14. Detritus (Petersen, 1992)	Mainly consisting of leaves and wood without sediment covering it	Leaves and wood scarce; fine organic debris without sediment	Fine organic sediment - black in color and foul odor (anaerobic) or detritus absent
	Existing Condition		X	
	Proposed Condition	X		
	If existing water quality is FAR or NF, provide description of cause(s) and stability trend and if F can not be potentially achieved, provide reason	Site currently displays excessive sedimentation due to bank erosion; impacting turbidity. Stabilization of the channel and improvement to bed from will reduce sediment loads. However a categorical increase is not antcipated due to the small DA and intermittent flow.		
	Stream Function Pyramid Level 4 Physicochemical Overall EXISTING Condition			**FAR**
	Stream Function Pyramid Level 4 Physicochemical Overall PROPOSED Condition			**FAR**
Biology (Do not complete if stream is ephemeral)	**Stream Function Pyramid Level 5 Biology**			
	15. Macroinvertebrate	Abundant	Rare	Not present
	Existing Condition		X	
	Proposed Condition	X		
	16. Macroinvertebrate Tolerance	Abundant intolerant species	Limited intolerant species	Only tolerant species
	Existing Condition			X
	Proposed Condition			X
	17. Fish Presence	Abundant	Rare	Not present
	Existing Condition		X	
	Proposed Condition		X	
	If existing biology is FAR or NF, provide description of cause (s) and stability trend and if F can not be potentially achieved, provide reason	No flow during assessment, water isolated to pools. Macroinvertebrates and fish rare to not present. Only limited colonization of intolerant species is anticipated due to the high impervious cover within the watershed. Intermittent flow additionally limits colonization.		
	Stream Function Pyramid Level 5 Biology Overall EXISTING Condition			**FAR**
	Stream Function Pyramid Level 5 Biology Overall PROPOSED Condition			**FAR**

Reach ID:	Cassia

Rapid Assessment Summary

Overall Watershed Condition **Poor**

Overall EXISTING Reach Level Stream Condition NF				
LEVEL 1 - NF	**LEVEL 2 - NF**	**LEVEL 3 - FAR**	**LEVEL 4 - FAR**	**LEVEL 5 - FAR**
If existing overall condition is FAR or NF, provide description of cause(s)	Stream contains widespread instability. Banks are actively eroding. Sandy composition of banks adds to instability. Multiple headcuts noted.			

	Functioning	Functioning-at-Risk		Not Functioning
		Trending Towards Functioning	Trending Towards Not Functioning	
Channel Evolution Trend (Rosgen, 1996)	Little or no presence of active vertical or lateral stream adjustment; floodplain and/or flood prone area well developed, vegetated, and hydrologically connected to stream. Simon Stage 1 & 6. Rosgen Stream type E, C, B, A, & DA	Presence of localized vertical or lateral stream adjustment; floodplain well developed, vegetated and hydrologically connected to stream (floodplain can be newly formed within a channel that shows past active vertical or lateral stream adjustments). Simon Stage 5. Rosgen Stream type F→C, D→C, F→Bc, & G→B	Channel shows past evidence of active vertical downcutting and lateral widening but is currently rebuilding a new floodplain; presence of moderately defined riffles and pools; moderate aggradation occurring; width/depth ratio 12-40. Rosgen Stream type C→F, C→D, Bc→F, E→Gc, B→G & C→Gc	Channel has widespread active vertical downcutting and lateral widening; floodplain not hydrologically connected (abandoned floodplain); lack of well defined riffles and pools; incision ratio > 2.1; and for laterally meandering stream a sinuosity ratio < 1.2; entrenchment < 1.4. Simon Stage 2, 3, 4, & 5. Rosgen Stream type E, D, Gc, & G
If existing channel evolution is FAR or NF, provide description of cause(s)	The stream was determined to be Not Functioning due to complete disconnection from the floodplain. Channel widening through active lateral erosion is widespread and headcuts are present.			

Restoration POTENTIAL Level 2 Functioning	
Provide reason(s) for restoration potential prediction	Stream restoration at this site will result in Level 2 and Level 3 increasing to Functioning.

Overall PROPOSED Reach Level Stream Condition FAR				
LEVEL 1 - NF	**LEVEL 2 - F**	**LEVEL 3 - F**	**LEVEL 4 - FAR**	**LEVEL 5 - FAR**
	The high Impervious cover within the drainage area limits the potential uplift of Levels 1, 4, and 5. Levels 2 and 3 will be uplifted to Functioning.			