Centreville Dam Removal Project

Site Characterization Report

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Prepared For:

American Rivers
Rivers Connect Us

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Engineers & Planners Since 1946

Executive Summary

The following report describes the work that has been completed to date in order to examine the potential for removing the Centreville Dam in Centreville, MD. The site characterization involves investigating factors critical to the design of the dam removal including a determination of the quantity of impounded sediments, investigation of potential contaminants, the presence of nearby infrastructure, impacts to natural resources and others. Constraints that will impact design, construction and costs will also be discussed. This report is considered preliminary to the more involved design phases which may be completed at a later time. The potential to remove the dam will be evaluated based on the ability to achieve project goals.

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1. Introduction

The Centreville Dam consists of a concrete and stone structure approximately five feet tall, ten feet wide, and thirty feet long. An approximately 18 inch diameter steel pipe passes through the dam such that, at baseflow conditions, flow does not overtop the dam. The dam is located on Gravel Run in Centreville, Maryland within town property and is owned by the Town of Centreville (**Figure 1**). Several pieces of infrastructure including a 15 inch diameter sewer line and an 8 inch diameter water supply line exist in close proximity to the dam in the downstream direction. Both of these pipes are encased on concrete. State Highway Administration Bridge #170200 over SR 213 is also just downstream.

Goals for the dam removal include providing fish passage to species including perch, herring and American eels, improving fisheries, benthic macro-invertebrate and wildlife habitat, restoring fish habitat, restoring/stabilizing stream channel and banks, and establishing native riparian vegetation consisting of trees, shrubs, and grasses. The setting of the dam is unique as it lies within the Corsica River Watershed, targeted by MD DNR for the comprehensive restoration of a significant Chesapeake Bay watershed (Corsica River WRAS, 2004). The dam ranks in the top two tiers for the Chesapeake Bay Fish Passage Prioritization and is considered a priority barrier in need of addressing. Impairments to the watershed include excessive nutrients (nitrogen and phosphorous) and sediment. These factors led to including the goal of minimizing impacts to downstream water bodies due to the removal of the dam including mobilization of excessive sediment, pollutants, and nutrients.

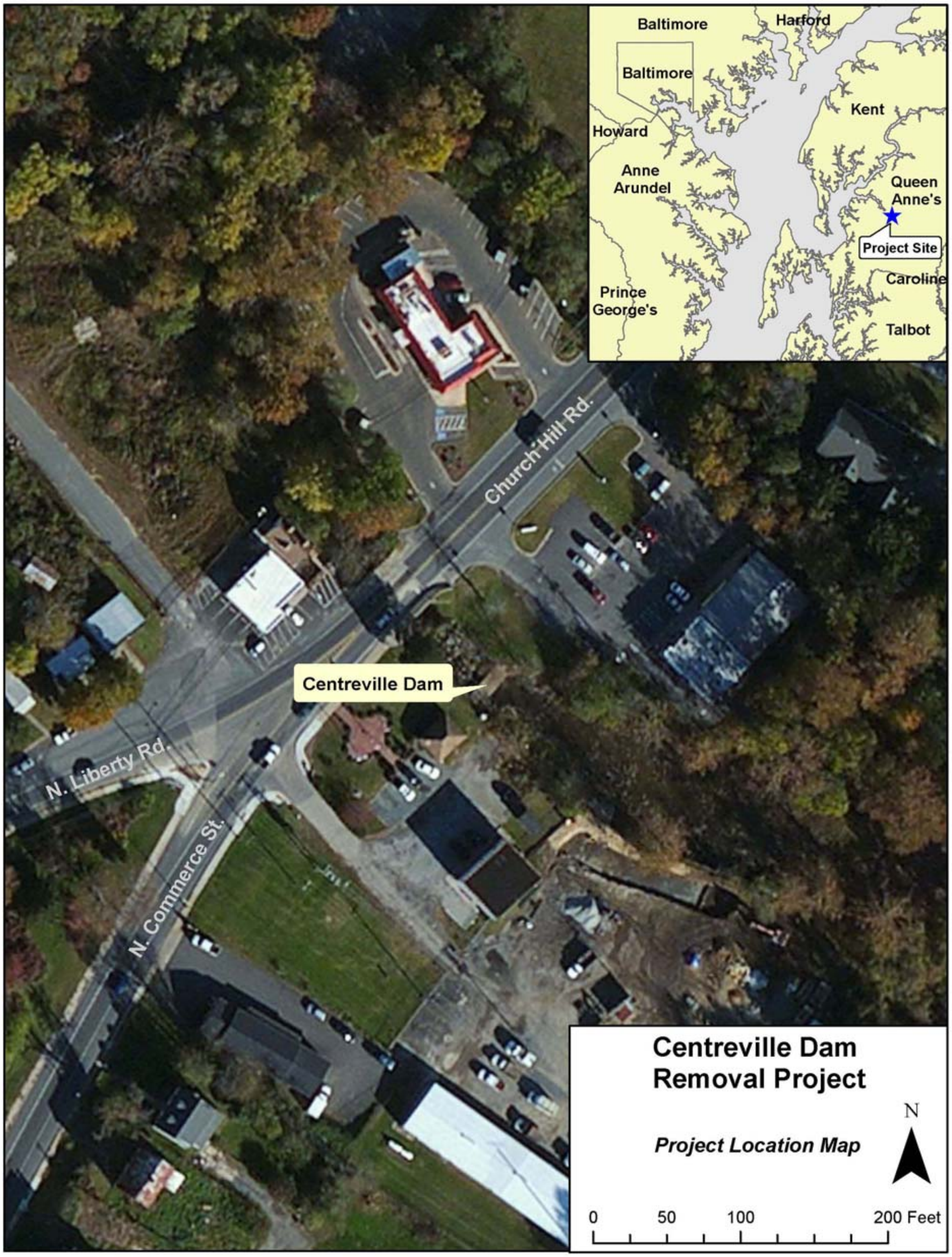

Figure 1. Project Location Map

2. Background Information

2.1. Literature and Historical Information Review

Requests were made of the Town of Centreville and the State Highway Administration for information on the area surrounding the dam and the local infrastructure. The intent was to determine when the dam was constructed, potential construction techniques, the physical characteristics of the downstream crossing, and other relevant information.

The Centreville town historian provided information indicating that a survey was completed of the area around Gravel Run in 1924, an area at the time that was known as Turpin Meadows. It was also indicated that the foundations for the now defunct electrical plant were built around 1949 by the Sheetz Construction Company suggesting that a dam was constructed at about the same time (Personal Communication, 2012).

However, plans provided by the Maryland State Highway Administration for the construction of MD 213 and the bridge downstream of the existing dam indicate the presence of a dam at this location in 1933. The plans also show a “Brick and Concrete Power House” of a larger and significantly different footprint than existing structures at the site. While the dam appears in the same location as the contemporary structure, it is somewhat different in configuration. This suggests that the dam and powerhouse that were in place in 1933 were destroyed and rebuilt. Remnants of the former dam may exist beneath the existing dam.

The plans provided from MD SHA indicated that the existing MD 213 Bridge was built to replace a single lane bridge in 1933 and was to be known as Bridge #170200. Plans state that the span of the bridge shall be 20-feet and that the stream bed shall be paved with an 8 inch thick concrete slab with approximately 14-foot wingwalls. The distance between the bridge seat and the concrete slab below is 7-feet. Repaving and sidewalk modifications were made at a later date; however these changes did not modify the bridge span.

A search was made for relevant historic aerial photographs of the subject area, but limited resources were found to be available. An aerial photograph from 1937 was located which showed the likely presence of a dam at the site, however lack of resolution prevents assessment of existing site conditions.

2.2 Site Information

Gravel Run is located in Maryland watershed 02-13-05 (Chester River Area) and is a tributary to the Corsica River. The stream is designated as a Use I- Waterway (Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life) by COMAR 26.08.02.

The property is located within Critical Zone Area IDA (Intensely Developed Area) as well as within FEMA FIRM Zone A6 (EL. 7), a zone that is characterized by a 1% chance of annual flooding.

The existing dam at this location represents a blockage for fish passage due to the height of the dam, water velocity, and depth. At baseflow conditions all flow occurs through the dam via an 18 inch diameter steel pipe. The concrete encased 15 inch diameter sewer line and 8 inch diameter water line crossing just downstream of the MD 213 bridge may also represent a fish blockage and will be addressed as part of this project.

2.3 Watershed Characteristics - Land Use and Drainage Area Information

The drainage area and land use information of the study site were developed from GISHydro 2000, topographic mapping, aerial photos, and USGS information. Present land use consists of residential areas (low, medium, and high density), Cropland, Pasture, Forest, Commercial and Institutional Space. (***Table 2.1***). Impervious surface occupies approximately 35% of the project watershed. Figures showing drainage area and land use information area provided in ***Appendix A.***

Table 2.1 Study Site Land Use Characteristics

Land Use	***Percent of Watershed***
Low Density Residential (2ac.)	4
Medium Density Residential (1/4 ac.)	6
High Density Residential (1/8 ac.)	1
Commercial	3
Cropland	50
Forest	13
Pasture	9
Institutional	13
Other	1

Soils information for the project was obtained from GISHydro 2000. The soil database used for the curve number computations is the SSURGO Soils. The predominant hydrologic soil groups within the project limits are B, C, and D soils. ***Table 2.2*** displays the percent of each hydrologic soil group within the drainage area. Refer to the Hydrologic Soils Group Map in ***Appendix A*** *for* the watershed's soil boundaries.

Table 2.2 Study Site Hydraulic Soils Distribution

Hydrologic Soil Group	***% of Drainage Area***
A	0%
B	68%
C	25%
D	7%

2.4 Property Owner Information

Property maps of the subject area were provided by The Town of Centreville and compared with a list of records provided by Queen Anne's County. Much of the land adjacent to the site is owned by the Town of Centreville, however private landowners do own some of the area that may be impacted (**Figure 2**). While some of the area along the right bank is owned by the Town, the areas further up the bank are owned by Z&B Brodie Family Limited, currently occupied by Dunkin' Donuts and Subway Restaurants. Further upstream and to the southeast of this property is the property of Ralph and Rebecca Marquardt bordered by Catherine Downes and Vachela Downes III. The area along the left bank is owned by the Town of Centreville and comprises the town garage to an area approximately 330 feet upstream of the dam. At this point the land, including some of the wetted portion of the stream is owned by John K. and WM. Turpin IV. The wetted area on the right bank upstream of this is owned by the Centreville United Methodist Church followed by several additional property owners upstream.

The Town of Centreville recently completed three retrofit projects in the vicinity of the town dam: a coastal plain outfall and re-graded swale with earthen berms was constructed in a tributary adjacent to Gravel Run which included portions of Turpins Farm, a bio swale was built at the Town public works yard and a rain garden was built at the Town police department, both of which directly abut Gravel Run.

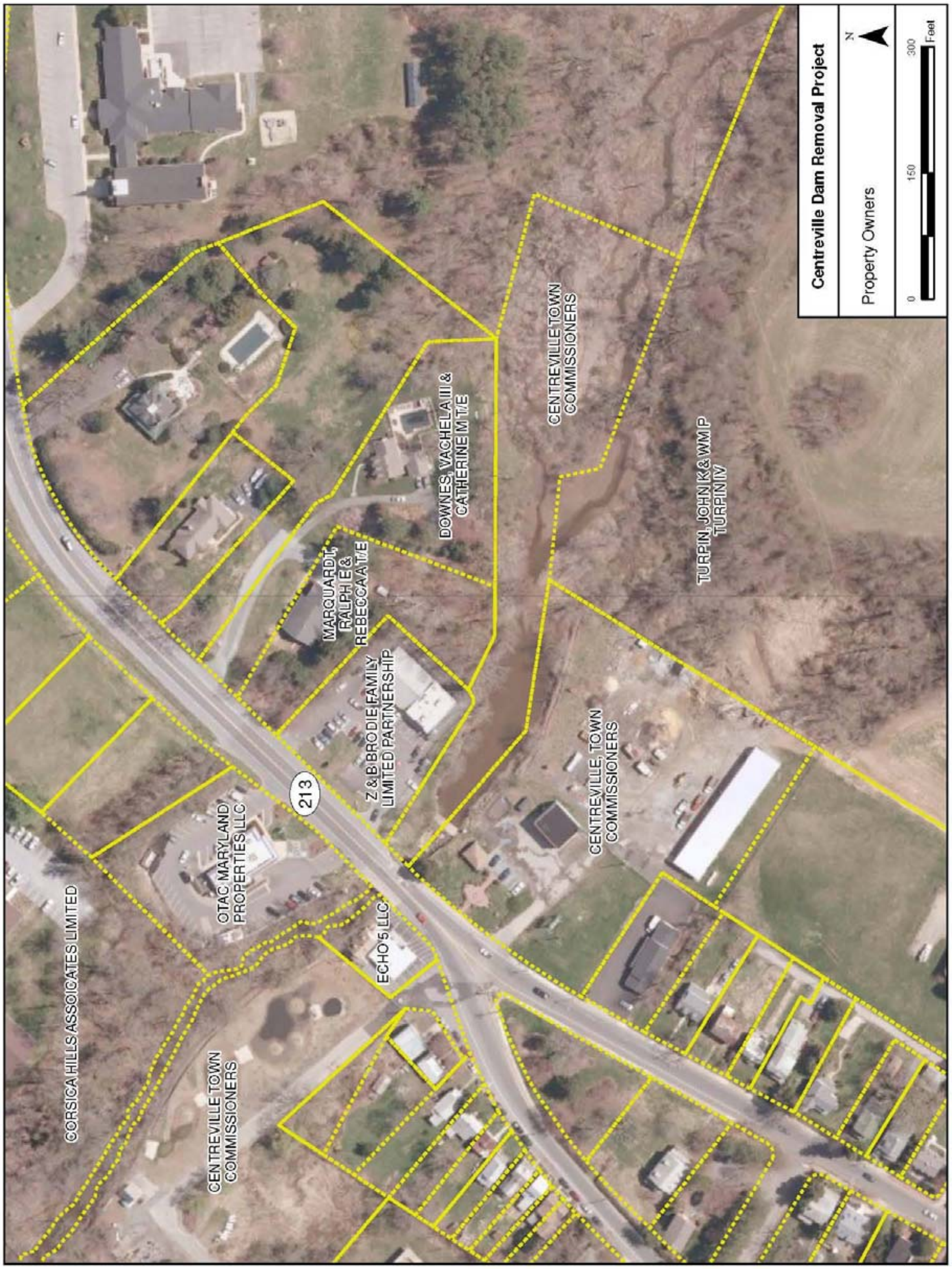

Figure 2. Property Owners Surrounding the Dam Removal Site

3. Methods

3.1. Topographic Survey

Topographic survey was performed in May, 2012 using a Trimble S-3 robotic Total Station capable of 2 mm +-2 ppm (0.0065ft +-2 ppm) accuracy. Vertical control was provided by NGS Benchmark G122 in the concrete around the MD 213 Bridge. Horizontal control was developed by georeferencing points collected in the field with points easily observed on aerial photographs such as building corners, bridge abutments, etc. A total of 534 points were collected within an area from 75 feet downstream of the MD 213 Bridge to 600 feet upstream of the bridge, including the dam structure.

3.2. Geomorphic Survey

To supplement data collected using the Total Station, a longitudinal profile was collected using rod and level to highlight geomorphic features. This profile extends from approximately 3 feet upstream of the existing dam to a point 235.9 feet downstream. The longitudinal profile survey includes bed surface and water surface elevation as well as the invert elevation of the pipe bisecting the dam in both upstream and downstream locations. The longitudinal profile also includes the water line crossing, bridge area, and sewer line crossing. At the completion of the field surveys, the data were input into *The Reference Reach Spreadsheet v.4.3L* (Mecklenburg 2006).

3.3. Bathymetric Survey

Bathymetric survey was completed using the push pole method. A small diameter pole is used to penetrate impounded materials until the depth of refusal. A canoe was used to access the wetted area of the impoundment as, despite generally shallow depths, unconsolidated materials prevented easy access to this wetted area. The push pole was implemented at 25 locations within the impoundment.

3.4 Hydrologic Analysis

Hydrologic modeling was used to generate recurrence interval discharges for the Centreville Dam Removal project site based on existing conditions. USDA Soil Conservation Service (SCS) TR-55 and TR-20 computer programs were used to determine runoff from the surrounding watershed area. Based on homogeneity within the drainage area, the watershed was not subdivided for the TR-20 analysis.

Discharges were calculated for the 1-, 2-, 10-, 50- and 100-year recurrence intervals. Land use and soils data together were used to determine curve number values for each study point using TR-55 methodology. See ***Appendix A*** for curve number computations, hydrologic soils maps as well as land use and drainage area maps.

TR-55 methodology was also used for time of concentration calculations. An analysis of the overall drainage area indicated a total time of concentration of 2.078 hours, or 124.7 minutes, to the downstream study point. See ***Appendix A*** for time of concentration computations.

The rainfall depths for the 6 and 24 hour duration storm were calculated by GISHydro 2000 software, which obtained data from the Precipitation Frequency Data Server, maintained by the

Hydrometeorological Design Studies Center (HDSC) of NOAA's National Weather Service (http://www.nws.noaa.qov/ohd/hdsc/) ***(Table 3.1)***.

Table 3.1: Area Reduction Rainfall Data

Return Period (years)	***Rainfall Depth w/ area reduction (inches)***
1	1.88
2	2.28
10	3.37
50	7.35
100	8.60

3.5 HEC-RAS Hydraulic Analysis

The hydraulic analysis was performed using the Army Corp of Engineers HEC-RAS (Hydrologic Engineering Center River Analysis System) computer program, Version 4.1.0. HEC-RAS is designed to compute one-dimensional flow profiles in natural and constructed stream channels by applying the energy equation between cross sections.

A hydraulic model was generated for the existing condition using a subcritical flow regime. Data used to develop the model included cross sections, Manning's n values, loss coefficients and boundary conditions. The model was run in the subcritical flow regime. Normal depth was selected as the downstream boundary condition used to approximate the downstream energy slope.

3.5.1 Cross Section Data

Cross section information was provided by topographic survey and supplemented by digital topography provided by Queen Anne's County. The existing condition model consists of twelve (12) cross sections. The cross sections begin 365 feet upstream of MD 213 (River Station 12) and extend 335 feet downstream of MD 213 (River Station 1). The sections are coded from left to right looking downstream.

3.5.2 Starting Water Surface Elevations

Boundary conditions are required for the HEC-RAS models to compute the flow profiles. For the subcritical flow regime, a starting water surface elevation needed to be specified at the downstream bounding cross section (RS 1). The normal depth method was used as the downstream boundary condition. The downstream channel slope (0.002 ft/ft) was used to approximate the energy slope.

3.5.3 Manning's "n" Values

The Manning's roughness coefficient, 'n', is an estimate of the resistance to flow in a given channel. Factors which may affect the roughness include bed material, vegetation, channel irregularities, obstructions and channel alignment. The Manning's 'n' values were assigned based on field investigations and tables provided in Chow's "Open Channel Hydraulics" Manual. The 'n' values used in this study range from 0.03 to 0.045 in the channel and 0.024 to 0.065 in the overbanks.

3.5.4 Contraction and Expansion Coefficients

Contraction and expansion of flow, due to changes in cross section, is one form of energy loss within a reach. Where the change in river cross section is small and the flow is subcritical, coefficients of contraction and expansion are typically on the order of 0.1 and 0.3 respectively. For this project the contraction and expansion values of 0.1 and 0.3 were used throughout the entire reach since there was not an abrupt contraction of flow prior to the bridge.

3.5.5 Structure Modeling

The HEC-RAS program calculates energy losses caused by structures in three parts; losses that occur in the reach immediately downstream and upstream of the structure and losses at the structure itself. The HEC-RAS bridge routines utilize four cross sections in the computations of energy losses due to a structure.

The existing bridge over Gravel Run was modeled using HEC-RAS bridge routines. The structure is a single span concrete slab bridge. The clear span is 20 feet and the bridge width is 42.5 feet. Structural drawings for Bridge #1702000 were used to verify the dimensions of the bridge. The bridge is aligned to be perpendicular to channel flow and the opening is considered entirely effective. The energy method was chosen as the bridge modeling approach.

A downstream toe wall of the bridge was modeled as an inline structure. The toe wall acts a grade control structure and the obstruction was included in the model.

The existing Centreville Dam was modeled as an inline structure. The width of the dam is 10.7 feet. An 18 inch diameter steel pipe conveys baseflow through the dam. The area of the opening was modeled as fully open sluice gate in the program to demonstrate the distribution of flow through the pipe and over the weir for different flow conditions.

A sensitivity analysis was run by varying the tailwater condition by 0.5’ to check if the model converges prior to reaching the structures. The water surfaces converged downstream of the toe wall to demonstrate a reliable tailwater condition.

3.6 Wetland Analysis

McCormick Taylor conducted a qualitative wetland assessment immediately upstream of the dam. The project site was field investigated on July 12, 2012 to identify an approximate wetland boundary line, assess functions and values of the system and discuss potential impacts resulting from dam modifications.

Wetlands were identified in accordance with the *Interim Regional Supplement to the Corps of Engineers wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region* (USACE 2008). This approach is based on three parameters including hydrology, hydric soils and hydrophytic vegetation. Soil color was identified using a Munsell color chart (Munsell 1975). Multiple plots were sampled surrounding the impounded area of Gravel Run to identify an approximate wetland boundary line.

A functions/values assessment, using the USACE New England Method as presented in The Highway Methodology Workbook Supplement – Wetland Functions and Values; A Descriptive Approach (USACE 1999), was completed for the wetland area. This method provides a framework for assessment that relies on the presence of certain physical characteristics broadly understood to indicate the presence of related functions, along with the best professional judgment of an experienced wetland scientist.

3.7 Subsurface Exploration

In order to determine the nature of the subsurface conditions at the site, five borings were performed by John D. Hynes and Associates on June 7, 2012 within the impoundment. Locations of the borings are shown in ***Figure 3***. Boring B-1 was drilled to the depth of 12 feet with the use of a tripod drill assembly by driving drill casing and using chopping and jetting techniques to clear the inside of the casing. Borings B-2 to B-5 were completed with the use of hand auger equipment to a depth of 4 feet. Samples were collected at each soil type encountered. The ground surface is considered to be the mudline of Gravel Run and water depths were between 1 to 2 feet deep at the boring locations. Samples of subsurface samples were examined and visually classified in accordance with Unified Soil Classification System (USCS) and ASTM Specification D-2488.

3.8 Stream Bed Sediment Testing

Field exploration was supplemented with laboratory testing data including Gradation Analysis Tests (Sieve and Hydrometer Testing) in order to determine grain size. Samples were also tested for Priority Pollutant Metals, Nitrogen, Potassium, and Total Petroleum Hydrocarbons (Diesel Range Organics and Gas Range Organics). Testing was completed by Phase Separation Science. Samples consisted of a composite of soils in each boring though soils were not combined from each unique boring. The complete report provided by John D. Hynes and Associates including boring and testing results is included in **Appendix B**.

Figure 3. Boring Locations

4. Results

4.1 Geomorphic Assessment

Topographic, bathymetric, and geomorphic survey were all used to evaluate the geomorphic setting of the Centreville Dam and to determine design considerations. The channel around the dam is typical of the eastern shore of Maryland with fine grained bed composition, low slope, and sinuous pattern. The crest elevation of the dam is approximately 7 feet, the invert of slab that forms the base of the MD 213 Bridge is at an elevation of approximately 2.1 feet and the top of the utility crossing downstream of the bridge is at approximately 2.7 feet elevation. Results of this analysis can be found in **Appendix C**.

A fairly stable riffle was encountered approximately 263 feet upstream of the existing dam and is assumed to represent the upstream limits of the impoundment and the wetland attributed to the dam structure, though these limits are difficult to locate due to the low slopes encountered. Slopes upstream of this riffle are nearly flat (0.05%). Material has aggraded upstream of the dam to an elevation approximately 1.8 feet below the crest of the dam yielding a slope of 0.41% within the impoundment and 0.87% downstream of the dam to the upstream limit of the concrete paving beneath the MD 213 bridge. Downstream of the bridge a utility crosses the channel at an elevation of 2.7 feet, 0.65 feet higher than the surface of the slab beneath the bridge. Downstream of this utility crossing slope increases to approximately 1.04%.

Based on field observation, bed surface in the area upstream of the dam consists of fine grained silt/organics with some sand. Downstream of the dam the channel is dominated by placed riprap before transitioning onto the concrete slab of the bridge beneath MD 213. Bed material downstream of the MD 213 Bridge is comprised of sand/gravel.

4.2 Bathymetric Assessment

The impounded area upstream of the dam is characterized by deep deposits of loosely consolidated sand and silts within thick deposits. Probing using the push pole method yielded maximum depths of easily penetrable material of up to 6 feet and minimum depths of 0.5 feet. Borings at locations adjacent to push pole sample sites suggest that similar materials encountered at the surface of the impoundment extend to a depth of greater than 12 feet, significantly greater than was measured using the push pole. As such, the depths of impounded materials yielded by the push pole method may not accurately represent the existing conditions. Due to the geologic setting of the site, discussed further below, the presence of a relic channel with coarse grained fluvial deposits may not be present at this location.

4.3 Hydrologic Modeling

Peak discharges were calculated for the Gravel Run Watershed for the 1, 2, 10, 50, and 100 year return periods using the NRCS TR-20 program. These values are then compared to the peaks estimated by the Fixed Region Regression Equations to ensure the model was adequately calibrated. The Hydrology Panel recommends that the TR-20 peaks fall within one standard deviation of the Fixed Region Regression Peaks. These intervals are calculated and reported within the GIS-Hydro 2000 program. ***Table 4.1*** shows the results of the TR-20 model and the Fixed Region Regression Equations. Two different storm durations were used when running the TR-20 model. The 6 hour duration was used for the 1, 2, and 10 year return periods and the 24 hour duration was used for the 50 and 100 year return periods. See ***Appendix A*** for TR-20 Outputs for the Downstream Study Point.

The discharges from the TR-20 model fall within one standard deviation of the fixed region equation results and therefore the input parameters for the estimated TR-20 peaks are verified and consistent with Maryland Conditions. This TR-20 model is recommended to be used as the basis for the hydraulic analysis.

Table 4.1. Hydrologic Modeling Summary Table

Return Interval (yrs)	***1-Year Discharge (ft^3/s)***	***2-Year Discharge (ft^3/s***	***10-Year Discharge (ft^3/s***	***50-Year Discharge (ft^3/s***	***100-Year Discharge (ft^3/s***
Fixed Region Equations	-	117	380	877	1200
Lower Limit	-	75	246	569	780
Upper Limit	-	182	587	1350	1860
Existing Conditions TR-20 Model	108	177	406	1019	1226

4.4 Hydraulic Modeling

The Hydraulic analysis for the existing condition was conducted for the subcritical flow regime. The upstream reach limits begin immediately upstream of the impoundment. The model begins at River Station 12.

The velocities within the existing channel range from 0.86 fps to 6.48 fps for the 2-year storm and 1.49 fps to 7.98 fps for the 10-year event. The shear stresses range from 0.01 lb/ft^2 to 0.99 lb/ft^2 for the 2-year storm and 0.04 $lbft^2$ to 1.31 lb/ft^2 for the10-year storm. The highest velocities and largest shear stresses are observed at River Station 3, which is located where the stream channel narrows as it passes by a parking lot on the right overbank. River station 3 shows a reverse channel slope within the stream profile. The section is immediately downstream of the scour pool located below the toe wall in the channel. The increase in velocity computed is consistent with the results expected with this profile. The 1 and 2 year WSEL, based on the TR-20 hydrology noted above, remains within the stream banks except at River Station 12, where the flow is unconfined within the forested upland area. Cross section 11 also shows an increase in channel velocity due to the constriction of flow from a very broad upland area as well as the reverse channel profile. Above the 10 year storm, flows access the surrounding flood plain area in several sections.

Tables 4.2 through 4.4 summarize the existing channel velocities, shear stresses, and 100-year water surface elevations at each HEC-RAS cross section:

Table 4.2. Existing Channel Velocities

River Station	***Existing Channel Velocity (ft/s)***	
	2-year	***10-year***
12	0.86	1.49
11	5.05	5.99
10	1.31	2.07
9	1.52	2.57
Dam		
8	2.02	3.12
7	2.93	4.51
Bridge		
6	3.28	4.57
Toe Wall		
5	3.09	4.17
4	1.60	2.65
3	6.48	7.98
2	3.24	4.21
1	3.29	4.37

Table 4.3. Existing Channel Shear Stresses

River Station	***Existing Channel Shear Stress (lbs/ft^2)***	
	2-year	***10-year***
12	0.01	0.04
11	0.71	0.89
10	0.04	0.08
9	0.04	0.12
Dam		
8	0.17	0.36
7	0.37	0.79
Bridge		
6	0.21	0.37
Toe Wall		
5	0.19	0.31
4	0.04	0.11
3	0.99	1.31
2	0.22	0.33
1	0.23	0.35

Table 4.4. Existing 100-Year Water Surface Elevations

River Station	***Existing 100-Year Water Surface Elevation (ft)***
12	11.93
11	11.07
10	10.66
9	10.45
Dam	
8	10.28
7	9.71
Bridge	
6	9.18
Toe Wall	
5	8.20
4	8.32
3	6.98
2	7.35
1	7.11

4.5. Wetland Analysis

Two wetland types were encountered at the site. The first wetland extended through the impoundment area from the dam upstream approximately 260 feet. This wetland is classified as L2UBHh (lacustral littoral unconsolidated bottom semi-permanently flooded system because of a dike/dam). This wetland can be directly attributed to the presence of the dam. At the time of investigation the wetland was inundated with a water depth of approximately five inches. Dam removal will likely transition this wetland into a single threaded channel system.

The portion of the wetland immediately upstream from the impoundment is classified as a palustrine emergent system (PEM) with both persistent and non-persistent vegetation (PEM1/2). Hydrology indicators included surface water, saturation, sediment deposits, inundation visible on aerial imagery, aquatic fauna and a hydrogen sulfide odor. Dominant vegetation within the wetland consists of *Leersia oryzoides* (rice cutgrass), *Typha latifolia* (broad-leaved cattail) *Peltandra virginica* (arrow arum) and *Ceratophyllum demersum* (coontail). All four of these species have an obligate wetland indicator status. This wetland was likely present before the installation of the dam. We don't anticipate that dam removal will affect the function of this wetland or reduce is size significantly. Should, based on further study, dam removal result in significant and unacceptable changes to this wetland, techniques utilized to protect the wetland may be implemented. These may include installation of grade control structures.

The wetland abuts Gravel Run along both banks. While fish were not observed in the stream at the time of investigation, it is initially determined that the stream provides habitat for the establishment of a healthy fish population. Low impervious surfaces and limited development appear to be present upstream. Submerged vegetation and gravel beds observed could provide spawning areas. Water velocities are not excessive for fish usage and the watercourse is a perennial system. Removal of the dam could be beneficial to the fish community below the dam by providing a contiguous system and access to the complex habitats upstream. A contiguous system would also allow anadromous fish to continue upstream.

As part of later design work the ability of both of the wetland systems upstream of the dam will be evaluated in more detail. This will include the ability of wetlands to trap sediments and flood flows as well as their ability to process nutrients and other toxins. We expect the reduction of wetland function to be minimal.

4.5.1 Subsurface Exploration

Boring B-1, located within the central portion of the impoundment, was completed to a depth of 12 feet. The boring yielded four feet of silt at the surface transitioning towards sand with some silt to ten feet. At this depth, a transition was observed to greenish brown silt with some fine to medium sand and some clay (**Table 4.5**).

Borings B-2 to B-5 were completed to a shallower depth of 4 feet. These borings consistently contained dark brown to brown silt with small amounts of sand and few organics. Boring B-2 contained some clay at depths between two and four feet.

Table 4.5. Grain size analysis of materials collected from within the impoundment

	D16	*D35*	*D50*	*D65*	*D84*	*D95*	*Mean*
B1/S1	0.0025	0.007	0.011	0.025	0.06	0.07	0.012247
B1/S3	0.055	0.11	0.175	0.2	0.3	0.4	0.128452
B2/S2	-	5	0.01	0.019	0.035	0.3	-
B4/S1	0.0025	0.007	0.0125	0.035	0.06	0.07	0.012247
B5/S1	0.00175	0.006	0.011	0.019	0.049	0.45	0.00926

4.5.2 Stream Bed Sediment Testing

Testing of sediment impounded by the dam for priority pollutants yielded elevated levels of arsenic and chromium based on cleanup levels established by MDE. Levels of arsenic ranged from 3.7 to 13 mg/kg while levels of chromium ranged from 22 to 47 mg/kg. For comparison, mg/kg units are often accepted as identical to parts per million (ppm). Minimum levels were encountered for both contaminants in B-1 and maximum levels encountered in B-5 (**Table 4.6**). Cleanup standards for arsenic provided by MDE included 0.43 mg/kg for residential settings, 1.9 mg/kg for non-residential settings and 0.026 mg/kg for the protection of groundwater. Cleanup standards for chromium are 310 mg/kg in a non-residential setting, significantly higher than the 47 mg/kg levels encountered. Cleanup standards are for the protection of human health and not necessarily ecological receptors. Land use requirements are based on the current or projected land use at the site or at potential disposal sites, indicating that this site may be required to conform to non-residential standards (MDE, 2009). Disposal would be required at non-residential sites. Preliminary coordination with MDE indicates that these levels are similar to those experienced locally but that further testing will likely be required. This will include collecting more samples subjected similar testing methods. This testing will be completed during later design phases of the project and will follow further coordination with regulatory agencies.

Aside from priority pollutants, potassium, nitrogen, nitrate, and nitrile were tested. No cleanup standards are provided for these materials. Full results are found in **Appendix B**.

Table 4.6 Results of Contaminant Testing

						MDE Cleanup Standards		
	B1/S6	***B2/S1***	***B3/S1***	***B4/S1***	***B5/S1***	***Residential***	***Non-Residential***	***Protection of Groundwater***
	mg/kg	***mg/kg***	***mg/kg***	***mg/kg***	***mg/kg***	***mg/kg***	***mg/kg***	***mg/kg***
TPH-DRO	ND	12	ND	ND	ND	230	320	
TPH-GRO	ND	ND	ND	ND	ND	230	620	
Antimony	ND	ND	ND	ND	ND	3.1	41	13
Arsenic	3.7	6.7	7	8.7	13	0.43	1.9	0.026
Beryllium	ND	ND	ND	ND	ND	1600	20000	6000
Cadmium	ND	ND	ND	ND	ND	3.9	51	27
Chromium	22	25	31	36	47	23	310	42
Copper	ND	17	17	25	32	310	4100	11000
Lead	ND	85	65	56	63	400	1000	
Mercury	ND	0.2	0.19	ND	ND	2.3	31	
Nickel	5.3	18	21	30	23	160	2000	
Selenium	ND	ND	ND	ND	ND	39	510	19
Silver	ND	ND	ND	ND	ND	39	510	31
Thallium	ND	ND	ND	ND	ND	0.55	7.2	3.6
Zinc	28	160	170	250	220	2300	31000	14000
						Cleanup Standards Not Provided		
Potassium	1000	1000	1400	1500	1500			
Percent Solids	72.9	71.5	45.1	43	42.7			
Ammonia Nitrogen	0.29	98.1	254	254	211			
Kjeldahl Nitrogen	256	1570	2720	2910	3200			
Nitrate	ND	ND	ND	ND	ND			
Nitrile	ND	ND	ND	ND	ND			

4.5.3 Target Species Analysis

In order to determine potential usage of habitat upstream of the site, Maryland Biological Stream Survey data were evaluated. This data is collected periodically by MBSS and includes evaluating the presence of fish species, collecting chemical data and assigning other metrics. The data on Gravel Run were collected both upstream and downstream of the existing dam in July, 2009 **(Table 4.7)**. A greater variety species of fish were observed at the sites downstream of the dam compared to upstream of the dam.

Table 4.7.- MBSS data related to fish collected at Gravel Run sampling locations.

Downstream of Dam		***Upstream of Dam***			
CORS-125-X-2009	***Percent of Total***	***CORS-109-X-2009***	***Percent of Total***	***CORS-124-X-2009***	***Percent of Total***
Tessellated darter	70	Tessellated darter	60.8	Tessellated darter	59.2
Mummichog	8.9	Eastern mudminnow	26.4	Eastern mudminnow	18
Eastern mosquitofish	4.7	Least brook lamprey	6.1	Least brook lamprey	10.7
American eel	3.9	American eel	5.2	American eel	5.3
Green sunfish	3.9	Pirate perch	1.4	Fallfish	3.4
Redbreast sunfish	2.8			Creek chubsucker	2.4
Banded killifish	2.6			Golden shiner	1
Creek chubsucker	1.4				
Eastern mudminnow	0.7				
Golden shiner	0.4				
Largemouth bass	0.3				
Bluegill	0.1				
Brown bullhead	0.1				
Pumpkinseed	0.1				

Water chemistry is also evaluated during the MBSS survey (**Table 4.8**). These data indicate that the dam may be causing shifts in water quality, though it is hard to discern these impacts from natural fluctuations based on interaction with tidal water or general fluctuations throughout the sampling interval. Note that not all samples were collected during the same period.

As a result of the data shown above and based on coordination with MD DNR staff, targeted species for this project include herring, American eel, and white and yellow perch. Considerations taken during dam removal design should include cruising and burst swimming speeds and durations, leaping ability, months of migration and allowances for turbulence and velocity.

Table 4.8- Water quality data collected during MBSS sampling

	CORS-125-X-2009	***CORS-109-X-2009***	***CORS-124-X-2009***
Proximity to Dam	DS	US	US
Assessment Date	6/23/2009	6/2/2009	6/15/2009
Acid Neutralizing Capacity	1085.6	1013.4	974
Dissolved Organic Carbon (mg/L)	3.2699	2.9664	2.1291
pH (lab)	7.24	7.18	7.35
pH (field)	7.5	7.6	6.7
Temperature ©	23.2	17.6	17.9
Dissolved Oxygen (mg/L)	9.1	8.4	7.8
Conductivity (mS/cm)	249	236	242
Fish IBI	3.33	3.33	4.33
Benthic IBI	3.86	4.71	4.71

5. Design

Design considerations for this project relate to effectively removing the dam to achieve project goals including providing fish passage to species including perch, herring and American eels, improving fisheries, benthic macro-invertebrate and wildlife habitats, restoring fish habitat, restoring/stabilizing stream channel and banks, and establishing native riparian vegetation consisting of trees, shrubs, and grasses. Removing the dam will be an effective way to achieve these goals.

It is anticipated that the dam will be fully removed. Contaminated materials will likely require dredging and offsite disposal. The dam may be removed using conventional equipment such as an excavator using a hydraulic hammer. Low ground pressure equipment incorporating non-toxic fluids can be utilized to minimize impacts. The channel will be diverted and pumps will be used to bypass the dam and allow for in-channel construction in dry conditions. The exact methods for dewatering and pump-arounds will be explored and provided in later reports.

The nature of the fine grained and potentially contaminated materials present in the impoundment upstream of the dam preclude a passive sediment management approach. As a result, the design will likely include the installation of a series of riffle features on top of existing materials designed to pass target fish species and eliminate erosion of bed and banks in the former impoundment. These features will also ensure the continuing function of the wetland upstream of the impoundment. Some dredging will also likely be required, as discussed below. Bioengineering and grading based on measured discharges and other geometric data collected at the site will be implemented to construct the channel between the riffle features. Careful placement of boulders and large woody debris materials may be included in order to retain function of the wetland upstream of the current impoundment. A reference reach approach may also be evaluated.

Fish blockage presented by the sewer line crossing downstream of the MD 213 Bridge may be addressed by backwatering the culvert and increasing water levels on each side of the blockage allowing for the passage of fish. An increase in water surface elevation near the culvert and at the sewer line crossing of approximately 1.5-feet would be required. At this time, it does not appear as though retrofitting (lowering) the sewer line presents a viable alternative. Backwatering the culvert may be completed by increasing roughness and bed surface elevation downstream of the culvert, likely through the installation of a riffle structure. Coordination will be required with the MD SHA followed by detailed modeling to ensure compliance with flood passage requirements through the upstream culvert.

Deposition of dredged materials will likely occur at an offsite landfill or processing facility certified to collect dredged materials. To satisfy requirements set forth by these destination facilities, further testing may be required and is unique to each facility. Dredging of the material can likely be completed using an excavator with a long-reach arm and the material will require transport to the chosen disposal location. If required, dewatering of dredged materials may occur in the area adjacent to the town garage. A preliminary estimate of 2300 cubic yards of impoundment material requiring dredging is suggested by preliminary geometry analysis. The estimate was made based on multiplying the approximate length and width of the impoundment by an estimated depth of potentially transported impoundment material, thereby representing a wedge of material. Depth of impoundment material is based on a regular slope extending from the bottom of the dam (the anticipated level of the proposed channel) upstream to the upper limits of the impoundment. This estimate is based on incomplete data however, and should be viewed as highly dynamic as more data are collected and analyzed.

An extensive planting plan for the area surrounding the current impoundment and the additional area exposed due to dam removal may be implemented. Plantings will help to improve the vegetative buffer and promote improved water quality. Plantings will work in concert with the riparian work that has recently been completed in the area of the town garage and elsewhere near the site.

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