SMALL WATERSHED ACTION PLAN
FOR DECLARATION RUN AND RIVERSIDE WATERSHEDS

Prepared for

Harford County
Department of Public Works
15 North Bond Street
Bel Air, Maryland, 21014

June 2014

URS Corporation
12420 Milestone Center Drive, Suite 150
Germantown, MD 20876

Table of Contents

Appendices

Figures

Tables

Acronyms and Abbreviations

BMP	Best Management Practice
CIP	Capital Improvement Program
County	Harford County
CPv	channel protection volume
EPA	Environmental Protection Agency
ESD	Environmental Site Design
GIS	Geographic Information System
HOA	Homeowners Association
in/hr	inches per hour
LID	Low Impact Development
MBSS	Maryland Biological Stream Survey
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
MEP	maximum extent practicable
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRD	Natural Resource District
PCB	polychlorinated biphenyl
PHI	Physical Habitat Index
RCP	reinforced concrete pipe
SHA	(Maryland) State Highway Administration
SWAP	Small Watershed Action Plan
SWM	stormwater management
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
URS	URS Corporation
WIP	Watershed Implementation Plan
WQv	water quality volume
WTM	Watershed Treatment Model

EXECUTIVE SUMMARY

This Small Watershed Action Plan (SWAP) was developed as a part of Harford County's efforts to improve the water quality and stream health conditions in Declaration Run and Riverside watersheds. Areas of concern include managing runoff from neighborhoods, commercial areas, and roads to improve watershed health. In addition, the County must adhere to state and federal stormwater regulations to remain compliant. The study watershed areas discharge to Bynum Run, Bush Run, and the Chesapeake Bay and are subject to the pollutant reductions associated with these receiving waterbodies including TMDLs, the Harford County Watershed Implementation Plan, and the County's Municipal Separate Storm Sewer System (MS4) National Pollutant Discharge Elimination System (NPDES) Permit.

Baseline watershed conditions were assessed to determine the impacts that existing land uses have on watershed habitat and water quality in the watershed. This evaluation included desktop analysis, field investigation, and discussion with County staff. Available County geographic information system (GIS) data, as-built plans, and staff input were used to determine locations of existing facilities, potential problem areas, and open areas available for stormwater improvements. Baseline pollutant contributions were estimated using the Watershed Treatment Model. Using the initial desktop analysis, field investigation of the land and streams in Declaration Run and Riverside watersheds was performed. The analysis provided a preliminary view into identifying site-specific potential restoration opportunities that could help meet the watershed goals.

Results of the baseline condition analysis indicated that there are few existing stormwater management facilities in either watershed and that the majority of land ownership is private. The main sources of sediment, nutrients and bacteria in both watersheds are from urban land uses and channel erosion. These issues demonstrate that there are many opportunities, and a need, for new and retrofit stormwater management and stream restoration throughout the watersheds.

Opportunities in neighborhoods were generally found to be nonstructural projects such as impervious pavement removal, downspout disconnections, and conservation landscaping. These types of projects would most likely be effective through an incentive program, such as reimbursement or tax benefits. Many green infrastructure retrofit opportunities exist for the existing stormwater practices since many are no longer functioning as designed. Outfall stabilization and stream restoration were identified to limit sediment impacts.

These site-specific opportunities were compared using variables such as cost, access, ownership, and benefits to prioritize and recommend a plan for implementation. A model of future loads was created based on suggested projects; both quantity and quality controls were considered to determine future loading from the study watersheds. This watershed action plan outlines structural and management strategies for each watershed and identifies priority projects along with planning level cost estimates and a schedule for implementation and monitoring that can be applied as a part of the County's capital improvement program.

SECTION ONE: INTRODUCTION

Harford County (County), Maryland, initiated the development of this Small Watershed Action Plan (SWAP) for the (unofficially named) Declaration Run and Riverside watersheds to improve the water quality and stream health conditions in the watersheds and by doing so, to meet regulatory requirements.

Declaration Run and Riverside watersheds are both within the town of Belcamp, Maryland. The Declaration Run watershed is a subwatershed of the Bynum Run watershed. The Riverside watershed is a subwatershed of the Bush River watershed and is east of and adjacent to the Declaration Run watershed. See Figure 1-1.

The Declaration Run watershed has seen significant development over the past 30 years and is dominated by medium- and high-density residential areas with pockets of commercial use. The natural stream network consists of the main stem of Declaration Run and many small, unnamed streams and intermittent stormwater channels. The eastern portion of the watershed contains estuarine/marine wetlands and forested/shrub wetlands, which help provide water quality and flood protection.

The Riverside watershed has also seen development over the past 30 years, primarily north of Pulaski Highway. Development has occurred south of Pulaski Highway in the past few years. The Riverside watershed is characterized by several swales and lack of streams with defined channels. The watershed is bordered on the south by estuarine and deep marine water in the Bush River. The Bush River flows into the Chesapeake Bay.

Harford County contracted URS Corporation (URS) to prepare this SWAP. The development of the SWAP included identifying and prioritizing water quality restoration projects that will help reduce pollutants in the watersheds and reduce the amount of storm runoff into the Chesapeake Bay. Managing the stormwater runoff from neighborhoods, commercial areas, and roadways will help minimize flooding and improve the water quality conditions of the streams.

Gaining an understanding of the dynamics of the Declaration Run and Riverside watersheds was a key component of developing recommendations for meeting regulatory requirements as efficiently as possible. Data review included an evaluation of the development progression in the watershed, key ecological components, and the past and current effects of human activities on the watershed.

Current watershed conditions were assessed through a review of information from the County and other data and through field reconnaissance, and discussions with County staff. The assessment allowed the team to identify opportunities for water quality improvements that could help meet the County's regulatory and watershed health goals. These opportunities were prioritized, and an implementation and monitoring plan was developed. The monitoring plan was created to track predicted versus actual pollutant load reductions after the improvements have been implemented.

PAGE INTENTIONALLY LEFT BLANK

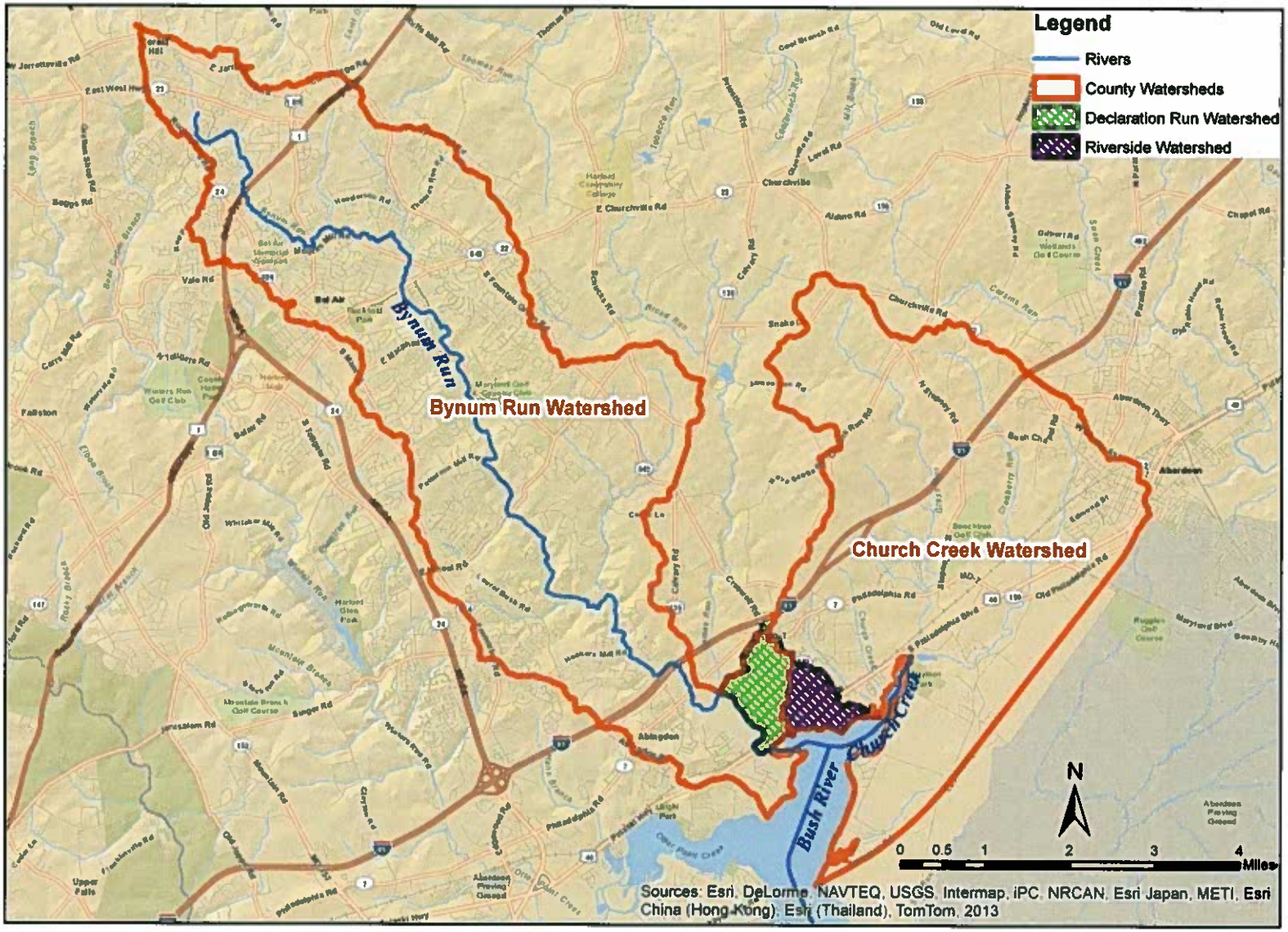


Figure 1-1: Location of Declaration Run and Riverside watersheds

PAGE INTENTIONALLY LEFT BLANK

1.1 WATERSHED REGULATIONS

The County is required by the following regulations to improve the water quality in its watersheds and waterbodies:

- Section 319 of the Clean Water Act of 1977, as amended (33 U.S.C. § 1329), commonly referred to as Environmental Protection Agency (EPA) Section 319 (Section 1.1.1 of this SWAP)
- The County's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit (Section 1.1.2 of this SWAP)
- The *Chesapeake Bay Total Maximum Daily Load [TMDL] for Nitrogen, Phosphorus and Sediment* (Chesapeake Bay TMDL) (EPA 2010) (Section 1.1.3 of this SWAP)

The County is required to plan and implement appropriate stormwater management techniques to reach nutrient reduction goals. The regulations are intended to produce positive impacts on the restoration of the Chesapeake Bay. One objective of the SWAP is to proactively identify projects and programmatic solutions to reduce pollutants in the watersheds that will help the County comply with regulatory requirements.

1.1.1 EPA Section 319

In order to receive funding for implementation of potential restoration projects under Section 319 of the Clean Water Act, the EPA requires the watershed assessment to include nine required components. They are referred to as "*a-i* criteria", and include elements and evaluations, which are discussed in this document along with recommendations for meeting the criteria. Table 1-1 is a list of the EPA Section 319 a-i criteria and the sections of the SWAP where they are discussed.

Table 1-1: Correlation of EPA Section 319 Criteria with SWAP Sections

Element	Evaluation	SWAP Section
a. Identification of Causes and Sources of Impairment	a. Sources of impairment are identified and described.	Section 2
	b. Sources of impairment are geographically identified.	Section 2 Appendices A and B
	c. Data sources are accurate and verifiable, and assumptions are reasonably justified.	Section 2 Appendices A and B
b. Expected Load Reductions	a. Load reductions achieve environmental goal.	Section 3
	b. Desired load reductions are quantified for each source of impairment identified in Element A.	Section 2
	c. Expected load reductions are estimated for each management measure identified in Element C.	Section 3
	d. Data sources and/or modeling process are accurate/ verifiable, and assumptions are reasonably justified.	Appendix C
c. Proposed Management Measures	a. Specific management measures are identified and rationalized.	Section 3
	b. Proposed management measures are strategic and feasible for the watershed.	Section 3

Element	Evaluation	SWAP Section
	c. Critical/priority implementation areas are identified.	Section 3 Appendix D
	d. The extent of expected implementation is quantified.	Section 3
d. Technical and Financial Assistance Needs	a. Cost estimates reflect all planning and implementation costs.	Section 3 Appendix B
	b. Cost estimates are provided for each management measure.	Section 3 Appendix B
	c. All potential federal, state, local, and private funding sources are identified.	Section 3
	d. Funding is strategically allocated; activities are funded with appropriate sources.	Section 3
e. Information, Education, and Public Participation Component	a. A stakeholder outreach strategy has been developed and documented.	Section 3
	b. All relevant stakeholders are identified, and procedures for involving them are defined.	Section 3
	c. Educational/outreach materials and dissemination methods are identified.	Section 3
f/g. Schedule and Milestones	a. Implementation schedule includes specific dates and expected accomplishments.	Section 4
	b. Implementation schedule follows a logical sequence.	Section 4
	c. Implementation schedule covers a reasonable time frame.	Section 4
	d. Measurable milestones with expected completion dates are identified to evaluate progress.	Section 4
	e. A phased approach with interim milestones is used to ensure continuous implementation.	Section 4
h. Load Reduction Evaluation Criteria	a. Proposed criteria effectively measure progress toward load reduction goal.	Section 3
	b. Criteria include both quantitative measures of implementation progress and pollution reduction and qualitative measures of overall program success.	Section 3
	c. Interim water quality indicator milestones are clearly identified.	Section 4
	d. An adaptive management approach is in place, with threshold criteria identified to trigger modifications.	Section 4
i. Monitoring Component	a. Monitoring plan includes an appropriate number of monitoring stations.	Section 5
	b. Monitoring plan has an adequate sampling frequency.	Section 5
	c. Monitoring plan will effectively measure evaluation criteria identified in element h	Section 5

1.1.2 National Pollutant Discharge Elimination System Permit

The County has an MS4 permit under the Phase I NPDES MS4 permit for stormwater discharges. Under the current permit, the County is defined as a medium municipality based on the 1990 Census population of 182,132 citizens. As a result, the County is committed to carrying out activities in the following areas:

- Pollutant Source Identification
- Discharge Characterization
- Stormwater Management
- Erosion and Sediment Control
- Illicit Discharge Detection and Elimination (IDDE)
- County Property Management
- Road Maintenance
- Public Education and Outreach
- Watershed Assessment and Planning
- Watershed Restoration
- Monitoring Controls
- Program Funding

The Maryland Department of the Environment (MDE) has administratively extended the current permit and has indicated that the new Phase I NPDES permits are expected to be published in the coming year. The renewed MS4 permit will likely include a new requirement to assess the impervious acreage in the County for adequate stormwater management and implement management practices for 20 percent of the impervious surface area that have not already been restored to the Maximum Extent Practicable (MEP). This requirement is a result of the Chesapeake Bay TMDL, which sets limits on the amounts of sediment, nitrogen, and phosphorus that can enter the Bay.

1.1.3 Chesapeake Bay Total Maximum Daily Load

The *Chesapeake Bay Total Maximum Daily Load [TMDL] for Nitrogen, Phosphorus and Sediment* (Chesapeake Bay TMDL) (EPA 2010) requires all states whose stormwater drains to the Chesapeake Bay to work together to reduce the amount of pollutants in their waters. The annual total pollutant loads that are allowed to enter the bay are:

- 185.9 million pounds of nitrogen
- 12.5 million pounds of phosphorus
- 6.45 billion pounds of sediment

The EPA has set a goal for Maryland, Delaware, Virginia, Pennsylvania, West Virginia, and Washington, D.C., to meet these reductions by 2025 and for 60 percent of the reductions to be met by 2017.

The Chesapeake Bay TMDL divides the nutrient reduction goals into individual goals for each state or jurisdiction, which gives states flexibility to delegate and enforce the pollution reduction goals in their own way. Additionally, states can develop TMDLs for waterbodies in their state that the EPA has deemed impaired.

1.1.4 Total Maximum Daily Loads for Receiving Waters

The streams within Declaration Run and Riverside watersheds have not been investigated for impairment by the EPA, so TMDLs specific to streams within the watersheds do not exist. However, these watersheds drain to receiving waters that do have TMDLs. Therefore, the runoff in Declaration Run and Riverside watersheds must be managed in such a way to adhere to the TMDLs for Bynum Run, Church Creek, and Bush River.

Bynum Run TMDLs

Declaration Run and its tributaries flow into Bynum Run before discharging into Bush Creek. The Bynum Run watershed has been determined impaired by the EPA for sediments, nutrients, PCBs, and impacts to biological communities. Currently, only one TMDL for sediment has been established for Bynum Run. TMDLs for nutrients have not been established for Bynum Run. Investigation of MDE's TMDL report indicated that Declaration Run watershed was not included as a part of the Bynum Run Watershed during the TMDL development; however, as Declaration Run drains to Bynum Run, it is assumed that the TMDL for sediment is applicable for Declaration Run.

BYNUM RUN

MDE-Designated Use III – Nontidal Cold Water

Water quality in this waterbody should support:

- Water contact sports
- Activities in which people contact surface water
- Fishing
- Growth and propagation of fish, trout, and wildlife
- Agricultural water supply
- Industrial water supply
- Self-sustaining trout populations and associated food organisms

As an MDE-Designated Use III waterbody, the water quality of Bynum Run needs to be improved and maintained at a level to support recreation, habitat, and water supply functions. A water quality analysis of eutrophication supported taking Bynum Run off the EPA 303(d) impaired waters list for nutrients and was approved, but a TMDL still exists to limit the sediment loads that Bynum Run receives. A goal for Declaration Run watershed should be to limit the amount of sediment discharged to Bynum Run. Table 1-2 lists the waste load allocations for Bynum Run which collects runoff from the Declaration Run watershed. Based on the TMDL report 14% of existing sediment loads in the watershed have to be reduced to achieve TMDL goals.

Table 1-2: TMDL Pollutant Reduction Goals Associated with Declaration Run

		Allocated Waste Load (tons/yr)		
Watershed	Stream	Sediment	Nitrogen	Phosphorus
Declaration Run	Bynum Run	4,690.1	N/A	N/A

N/A = not available

Church Creek and Bush River TMDLs

The Bush River TMDLs include the Riverside watershed. This reach was identified by the EPA as impaired by PCBs in 2002, nutrients and toxics in 2006, and nutrients and suspended solids in 2010. Impacts to biological communities were also identified for each assessment period since 2004. The 2010 Bush River TMDLs for nutrients and suspended sediment are applicable to the Riverside watershed. Table 1-3 lists the TMDL allocation for the waterbody that collect runoff from the Riverside watershed.

Table 1-3: TMDL Pollutant Reduction Goals Associated with Riverside

		Allocated Waste Load (tons/yr)		
Watershed	Stream	Sediment	Nitrogen	Phosphorus
Riverside	Bush River / Church Creek	6,598.3	222.8	16.6

1.1.5 Watershed Implementation Plan

MDE developed Phase I and II Watershed Implementation Plans (Maryland WIPs) (MDE 2010 and MDE 2012, respectively) as part of the effort to meet the Chesapeake Bay TMDL pollutant reduction goals. The WIPs support the "reasonable assurance of implementation" for Maryland's part of the TMDL. According to the Maryland WIPs, "reasonable assurance" is a demonstration that meeting the TMDL load reductions requirement can be met.

The targets for 2025 nutrient reductions in the five major basins in Maryland are provided in the WIPs. The Maryland baseline contributions of pollutants to the Chesapeake Bay in 2010 were:

- 52.76 million pounds per year of nitrogen
- 3.30 million pounds per year of phosphorus
- 1,376 million pounds per year of total suspended solids

The reduction goals are further divided into County level watershed goals.

Harford County lies within two of the five major basins: Susquehanna River and Western Shore. In order to meet the Chesapeake Bay TMDL requirements for these watersheds, the County developed the *Phase II Watershed Implementation Plan* (Harford County 2012). The County

WIP was developed by a core team comprising of staff from County, municipalities, state and federal agencies.

The County WIP sets milestones for the reduction of pollutants to the Chesapeake Bay. Reductions are provided for the Agriculture, Urban, Septic, Forest, and Wastewater Sectors. Table 1-4 shows the pollutant reduction goals for each sector over the timeline of the Chesapeake Bay TMDL.

Table 1-4: Harford County Phase II Watershed Implementation Plan Goals

	Total Nitrogen (lbs)			Total Phosphorus (lbs)		
Sector	2009 Baseline	2017 Target	2025 Goal	2009 Baseline	2017 Target	2025 Goal
Agriculture	895,763	657,846	555,881	48,600	40,447	36,953
Urban	698,945	566,572	509,841	42,058	31,159	26,488
Septic	175,325	125,305	103,867	—	—	—
Forest	366,899	368,995	368,894	8,953	9,015	9,042
Wastewater	411,272	246,715	378,725	36,342	19,865	31,362

The County WIP suggests strategies that each sector can implement to meet the goals. For example, installing enhanced nutrient removal systems in wastewater treatment plants throughout the County would reduce nutrients by an estimated 50 percent for the sector of concern. The County's primary strategies to reduce the Septic Sector's nutrient loads are gradually replacing septic systems with a public sewer system and adding a denitrifying system to the septic tank.

The focus in the Declaration Run and Riverside watersheds will be on the Urban and Forest Sectors. Agricultural land use and wastewater plants do not exist in either the watershed. There are only two dwellings in Declaration Run watershed that have septic system. Strategies in the County WIP to manage urban pollutants include urban nutrient management, outreach, and tracking. To help meet the WIP goals, the County is developing Small Watershed Action Plans such as this SWAP, for other watersheds in the County to define effective pollutant reduction strategies.

MDE is responsible for enforcing the implementation of the WIP through the NPDES MS4 permits. WIP participants are expected to meet the interim target (60 percent of the final target) by 2017. The final targets are to be met by 2025.

1.1.6 Critical Area Commission for the Chesapeake and Atlantic Coastal Bays

The Critical Area is the area between the State's tidal waters, wetlands, and tributaries to 1,000 feet inland. This area is ideally filled with trees, bushes, and other vegetation to help filter pollutants from runoff. MDNR established a Critical Area Program in 1986 to help jurisdictions plan, develop, manage, and use future development in the Critical Area in an environmentally

responsible manner. The program has three land classifications: Intensely Developed Area, Limited Development Area, and Resource Conservation Area.

The Critical Area Program's development-related regulations (e.g., housing density, land use) in each land classification are listed in Table 1-5. The objective of the restrictions is to promote new growth near existing development, provide infill development of similar use and intensity, and facilitate conservation of natural resources.

Table 1-5: Critical Area Program Regulations that Affect the Study Watersheds

Critical Area Land Classification	Housing Density	Predominant Land Uses	Critical Area Program Regulations
Intensely Developed Area	>4 units/acre	• Residential • Commercial • Institutional • Industrial	• Reduce pollutant loads at newly developed site to 10% less than pre-development conditions • Habitat protection areas must be identified and conserved
Limited Development Area	0.2 to 4 units/acre	• Natural resources(1) • Residential	• No development or disturbance where slopes exceed 15% • Limits lot coverage (imperviousness on a lot) to 15% of the parcel • Replacement of cleared forest in 1:1-1:3 ratio or pay a fee-in-lieu OR • If no previous tree cover, 15% of the area must be planted with trees
Resource Conservation Area	<0.2 units/acre	• Natural resources(1) • Residential	• New commercial, industrial, and institutional development is prohibited • New residential development must be 1 unit per 20 acres • Limits lot coverage (imperviousness on a lot) to 15% of the parcel • Replacement of cleared forest in 1:1-1:3 ratio or pay a fee-in-lieu OR • If no previous tree cover, 15% of the area must be planted with trees

(1) Natural resources include agriculture, wetlands, forests, barren land, surface water, or open space

1.2 EXISTING COUNTY STORMWATER PROGRAM

The County's Department of Public Works is responsible for identifying and restoring areas with water quality problems by implementing various management techniques. Current methods of controlling potential pollutant sources are erosion control, stormwater management, and monitoring of watersheds and streams. Most of the stormwater programs currently in place are state-mandated programs that were delegated to the County during the last 40 years. As such, MDE reviews the County's programs to ensure compliance with the state's mandated requirements.

Since the late 1970s, sediment and erosion controls have been required for new development that disturbs more than 5,000 square feet. The County reviews and approves development plans and inspects the installed sediment and erosion controls. Since 1984, the County has also managed a stormwater management program that has provided oversight during design and construction phases of a project.

Presently, new development must obtain an exemption or waiver from the County or provide stormwater management in the design to the MEP using Environmental Site Design (ESD), Low Impact Development (LID), or other Best Management Practices (BMPs). New development will be required to control runoff that is equal to or greater than the 10-year storm event based on the existing conditions in the area. The engineer in charge, hired by the developer, is required to inspect each BMP during construction for proper construction. The County is responsible for inspecting the BMP triennially throughout the life of the BMP to ensure proper maintenance.

In addition to this, Harford County has also adopted nonstructural stormwater management measures to improve the water quality of streams in the County. Non-structural stormwater management includes management in the form of planning and permitting, regulation, maintenance practices, and education or outreach activities.

Harford County established the County Land Preservation Program in 1977 to establish where development would be concentrated and where land would be conserved for agricultural or environmental needs. The program preserves 46,000 acres with easements to prevent private development. The concept was to focus development in areas where public water and sewer areas were available to reduce the risk of septic sewer leakages. Other regulatory management strategies in the Master Plan are the Forest Conservation Program, Natural Resources District (NRD), and Critical Area Program.

Harford County became one of the forerunners of protecting sensitive environmental areas such as streams and stream buffers, non-tidal wetlands, and steep slopes by establishing an NRD in 1982 to minimize soil disturbance and loss of natural ground cover. Accessory structures, play equipment, decks, pools, mass clearing, grading, and cutting are not permitted in NRD areas. The NRD protects non-tidal wetlands by providing a 75-foot buffer from the edge of the wetland. Slopes that are equal to or greater than 25 percent in an area with more than 0.91 acre are

protected from development to prevent nonpoint source pollution from erosion and slope failure. Streams in a Critical Area must have a minimum 75-foot buffer.

1.3 GOALS FOR STUDY WATERSHEDS

The County is enhancing existing stormwater management facilities and techniques to improve water quality in the streams, to protect the community from flooding and avoid habitat disruption in local streams. The benefits are environmental as well as societal; updated stormwater management practices will limit pollution to the Chesapeake Bay and provide local communities with vegetated areas that enhance livability, cohesion, and property value.

The County's watershed goals are to meet the required regulations for pollutant reduction, protect the community and infrastructure from water-related issues, and provide community benefits. The creation of this SWAP is a planning-level tool to help meet the goals for these watersheds. The analysis of existing watershed conditions (Section 2) allows for a baseline understanding of the conditions of these watersheds and if routinely evaluated can show the progression of watershed health over time and development. The proposed projects (Section 3) can be included in the County's Capital Improvement Program (CIP) in accordance with the implementation plan (Section 4) in order to meet regulatory requirements. A suggested monitoring program (Section 5) will be important to ascertain whether projects are effective in meeting the physical, biological, and chemical goals.

SECTION TWO: EXISTING WATERSHED CONDITIONS

An analysis of the Declaration Run and Riverside watersheds included existing land use, impervious cover, soils, and natural resources. Sources of information were County geographic information system (GIS) data and field assessments that were conducted to evaluate stream health and habitat, erosion, stormwater management practices, and potential pollutant sources.

2.1 WATERSHED BACKGROUND

Belcamp, also commonly called Riverside, is located on the western shore of the Bush River in northeastern Maryland (see Figure 1-1). The town is sheltered from direct contact with the Chesapeake Bay by the peninsula containing the U.S. Army Garrison Aberdeen Proving Grounds. The unique attribute of being a waterfront town and being located in close proximity to the Chesapeake Bay, provides the town revenue and tourism opportunities through recreational activities such as swimming, boating, fishing, and crabbing. Due to its proximity to the I-95 and Route 40 corridors, the town attracts long-distance drivers and as a result, the primary commercial properties in this area were built to serve that community.

The town of Belcamp has a population of approximately 7,813 people with a population density of 2,235 people per square mile. The population consists primarily of married adults with a high school education. Thirty percent hold a bachelor's degree or higher. The majority of the population has white collar jobs. Thirteen percent carpool, and 82 percent drive to work alone. There has been an influx of residents since 2000, resulting in a population increase of approximately 34 percent. This rate of increase is one of the highest in Harford County.

The County has defined a "development envelope" that limits development to certain areas to preserve other areas for agriculture. Belcamp is in a designated development envelope. The envelope is likely the primary reason for the land use changes in Declaration Run and Riverside watersheds over the past 30 years. Future development or redevelopment is likely to occur in Belcamp as the County population is projected to increase by approximately 14.2 percent by 2030.

An understanding of the human population and the resulting effects on land use in the watersheds is important when considering ways to improve holistic watershed health. Opportunities for structural and nonstructural improvements and outreach greatly depend on human activities in the watersheds.

2.2 WATERSHED COMPONENTS

The Declaration Run watershed includes Bush Declaration Park, Church Creek Elementary School, Riverside Plaza and many commercial areas along Riverside Parkway. The residential neighborhoods in the watershed are Arborview, Chapelgate, Gilmer Woods, Riverside, Sanford Heights, Village of Church Creek, and West Property. Approximately 6.3 miles of tributaries

drain 427 acres (0.67 square miles) of the watershed to the south and discharge into Bynum Run, Bush River, and finally the Chesapeake Bay.

The Riverside watershed includes Lorien Riverside Nursing Home, Belcamp Park, and the neighborhoods of Village of Church Creek, Riverside, and Waters Edge. The watershed also includes commercial and business parks south of Pulaski Highway. There are no major streams in the watershed. Approximately 2.3 miles of grass swales and stormwater conveyance channels drain 303 acres (0.47 square miles) of the watershed to the south to eventually discharge into Church Creek, Bush River, and finally the Chesapeake Bay.

2.2.1 Land Use

Table 2-1 and Figure 2-1 show the land use in the Declaration Run and Riverside watersheds.

The land use cover for the watersheds was created by updating the County provided land use data to accurately represent the existing watershed conditions by overlaying it on the aerial imagery.

Table 2-1: Existing Land Use in Study Watersheds

	Declaration Run		Riverside	
Land Use	Area (acres)	Percent of Watershed	Area (acres)	Percent of Watershed
Commercial	22.8	5.3%	7.1	2.4%
Natural resources[1]	183.1	42.9%	32.8	10.8%
High-density residential	82.6	19.3%	51	16.9%
Medium-density residential	51.9	12.2%	45.6	15.1%
Low-density residential	1.9	0.4%	0	0.0%
Industrial	0	0.0%	24.6	8.1%
Institutional	15.4	3.6%	5.6	1.9%
Office	0.6	0.1%	22.1	7.3%
Other mixed use	0	0.0%	7.2	2.4%
Open space	8.9	2.2%	48.7	16.1%
Unimproved land	0	0.0%	8.4	2.8%
Transportation/utilities	60	14.0%	49.6	16.4%
Total	**426.9**	**100%**	**302.6**	**100%**

(1) Natural resources include forest, wetlands, and water

Based on the modified land use data, most of the Declaration Run watershed is occupied by high- and medium-density residential areas (total of 31 percent) and forested areas (30 percent). The other dominant types of land use are wetlands (12 percent) and land used for transportation (14 percent).

Similar to the Declaration Run watershed, high- and medium-density residential areas in the Riverside watershed together occupy approximately 32 percent of the land. Other dominant uses are open space (approximately 16 percent), forest (approximately 11 percent), and transportation (approximately 16 percent).

Because opportunities in public space that contain open space or forest are often the most cost-effective sites for stormwater management retrofits, further investigation of public areas was performed.

PAGE INTENTIONALLY LEFT BLANK

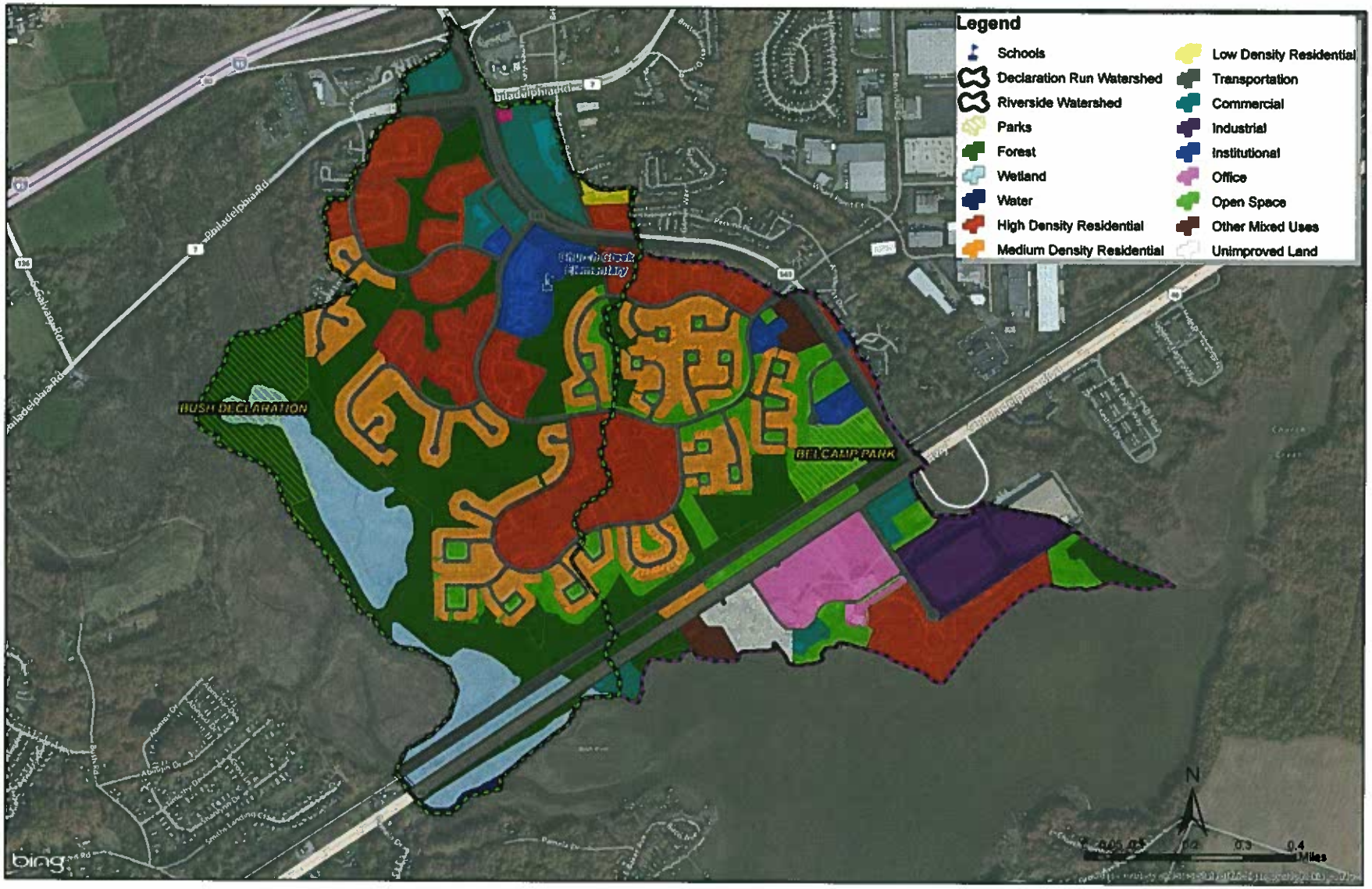


Figure 2-1: Existing land use in study watersheds

PAGE INTENTIONALLY LEFT BLANK

2.2.2 Soils

Soils are classified into Hydrologic Soil Groups A, B, C, or D (NRCS) using factors such as rate of infiltration and runoff potential. Hydrologic Soil Groups A and B have low runoff potential and high infiltration rates (>0.3 in/hr – 0.15 in/hr) due to high sand/loam content. Implementing infiltration stormwater management techniques on these types of soils is generally economical because fewer soil amendments are needed. Hydrologic Soil Groups C and D have low infiltration rates (0 – 0.15 in/hr) and high runoff potential because of their high clay contents. Soil enhancements and aeration are usually required to implement infiltration stormwater management practices on these soils to ensure proper functioning.

The majority of soils in the Declaration Run watershed are in Hydrologic Group B. Areas along the stream corridor and wetland areas in the watershed have soils in Hydrologic Group D. The remaining part of the watershed has soils in Hydrologic Group C. A small percentage of the watershed is occupied by Hydrologic Group A soils.

The Riverside watershed is dominated by soils in Hydrologic Groups B and C, primarily in areas north of Pulaski Highway. The remaining part of the watershed is occupied by soils in Hydrologic Groups A and D.

Table 2-2: Hydrologic Soil Group Distribution in the Study Watersheds

Hydrologic Soil Group	Declaration Run (%)	Riverside (%)
A	3%	1%
B	49%	42%
C	23%	46%
D	25%	11%

Table 2-2 and Figure 2-2 show the distribution of soils in the Declaration Run and Riverside watersheds.

PAGE INTENTIONALLY LEFT BLANK

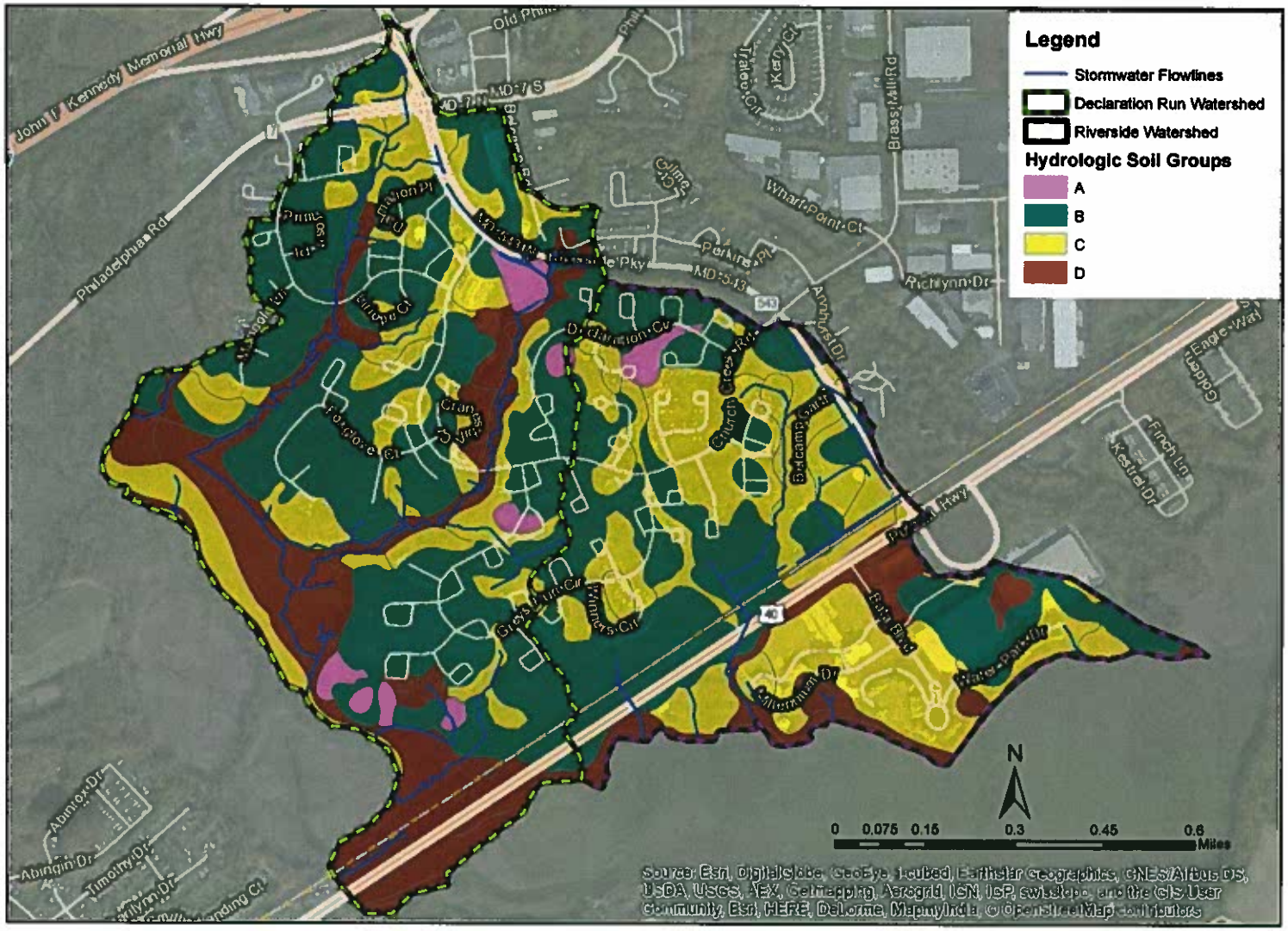


Figure 2-2: Existing hydrologic soil groups in study watersheds

PAGE INTENTIONALLY LEFT BLANK

2.2.3 Tree Canopy

Tree canopy refers to the branches, stems, and leaves of trees. The tree canopy intercepts precipitation before it hits the ground, reducing the velocity and quantity of precipitation that reaches the ground, which reduces the erosion that can occur when rainfall is heavy. Additionally, tree roots filter water in the surrounding water column, providing water quality benefits. Figure 2-3 shows the tree canopy in the two study watersheds.

The tree canopy provides:

- Wildlife habitat
- Windbreaks
- Water quality
- Air quality
- Aesthetics

The tree canopy covers approximately 25 percent (109.16 acres) of the Declaration Run watershed and 9.5 percent (28.72 acres) of the Riverside watershed. The tree canopy in both watersheds shows a tendency to be along stream corridors; though this is true more for Declaration Run than Riverside. If protected from development, the forested areas will provide a riparian buffer which offers habitat and water quality benefits. Of the streams, ditches, and connectors in Declaration Run watershed, 2.67 miles (46 percent) are within a forested buffer. In the Riverside watershed, only 0.21 miles (9 percent) of streams, ditches, and connectors are within a forested buffer.

PAGE INTENTIONALLY LEFT BLANK

Figure 2-3: Existing tree canopy and wetlands in study watersheds

PAGE INTENTIONALLY LEFT BLANK

2.2.4 Wetlands

The Declaration Run watershed has 52.7 acres of wetlands, primarily in the eastern portion of the watershed. The Riverside watershed does not have large areas of wetlands according to the County's land use data, but field reconnaissance revealed small pockets of wetland-like areas along the southern border of the watershed that may be designated wetland areas. The wetlands in the two study watersheds are shown in Figure 2-3. The land cover data used for the analysis are from 2007 and may have been produced on a diluted scale. If the data are updated, more refined boundaries between land cover practices may show wetland areas in the Riverside watershed.

2.2.5 Critical Areas

The Declaration Run watershed contains approximately 80 acres of Resource Conservation Areas surrounding wetlands in the Critical Area and 83 acres of Intensely Developed Areas with residential housing in the Critical Area. The Riverside watershed contains 120 acres of Intensely Developed Areas and only 1.4 acres of Resource Conservation Areas, which are located along the Church Creek waterfront.

In the Critical Area Program, water quality for a newly developed site must be 10 percent better than it was before the development or redevelopment (referred to as the 10 percent rule). Water quality is estimated based on the site's imperviousness and pre-developed conditions and an assumption of "woods in good condition." The current version of the Critical Area program was released in 2013 and includes updates associated with the Chesapeake Bay TMDL.

2.2.6 Public Areas

Public lands were analyzed to identify potential sites for stormwater management techniques. The benefits of siting stormwater projects on public lands are twofold: land ownership is often not private, and public access provides an opportunity for outreach to educate citizens about stormwater. For example, a wet pond in a public park may have a walking path around it with an information sign describing what the pond is used for, why it is important, and how it works. This type of outreach is a simple, cost-effective, and a low-maintenance way of reaching the public.

Based on the County GIS data, the two watersheds contain approximately 64 acres of public land. Table 2-3 provides a list of the public areas.

Table 2-3: Existing Public Areas in the Study Watersheds

Watershed	Name	Parcel	Owner	Acres	Use
Declaration Run	Bush Declaration Natural Management Area	Bush Road	Maryland Department of Natural Resources	29.31	Wetland and recreation
	Church Creek Elementary School	4299 Church Creek Road	Harford County Board of Education	20.51	School
Riverside	Belcamp Park	1119 Belcamp Garth	Harford County	10.59	Recreation
	Riverside Community Center	1 Church Creek Road	Riverside Community Association	3.6	Recreation

Public lands in the Declaration Run watershed include the Maryland Department of Natural Resources (MDNR) Bush Declaration Park, which occupies approximately 29 acres (approximately 7 percent) of the watershed.

The County owns Belcamp Park, which contains 10.6 acres that is used for recreation and grass channels that provide some stormwater filtering. The park was investigated to identify potential sites for stormwater retrofits, and one site was identified (see the discussion of proposed project R-NS-1 in Section 3.1.1).

The Harford County Board of Education owns Church Creek Elementary School. Stormwater retrofits on school property could require interdepartmental agreements. Several potential sites for stormwater management opportunities were identified during field reconnaissance (see the discussion of proposed projects D-NS-12 and D-SWM0110 (ES-1) in Section 3.1.1). The other public lands in the Declaration Run and Riverside watersheds are privately owned or owned by the state.

2.2.7 Impervious Area

Accurately determining the amount of impervious area is an important part of meeting NPDES permit and EPA Section 319 requirements. The County maintains impervious area data to keep track of development in the County. It is important to keep this information updated as development continues to increase because it is a key factor in determining the type and amount of stormwater projects necessary to protect watershed health.

MDE requires future development to implement environmental site design (ESD) to the MEP, which will help mitigate future problems with stream health. However, understanding the extent of current development and its impact on the watersheds is an important aspect of determining the number of stormwater projects that will be necessary to meet permit requirements.

Based on the County's impervious area data and aerial imagery, the Declaration Run watershed has 108.5 acres (approximately 25.4 percent of the watershed) of impervious area in residential, institutional, and transportation development. The Riverside watershed has 104.6 acres (approximately 34.6 percent of the watershed) of impervious area, which is composed of

primarily residential, transportation, and commercial areas. Figure 2.3 shows the impervious areas of both watersheds and the time frames that the development occurred.

Many studies have shown that stream health shows signs of deterioration when greater than 15 percent of the upland watershed is impervious. Stream deterioration in both watersheds is expected, particularly since most of the impervious areas were installed before current stormwater management practices were required. Figure 2-4 shows the existing impervious cover in the study watersheds.

PAGE INTENTIONALLY LEFT BLANK

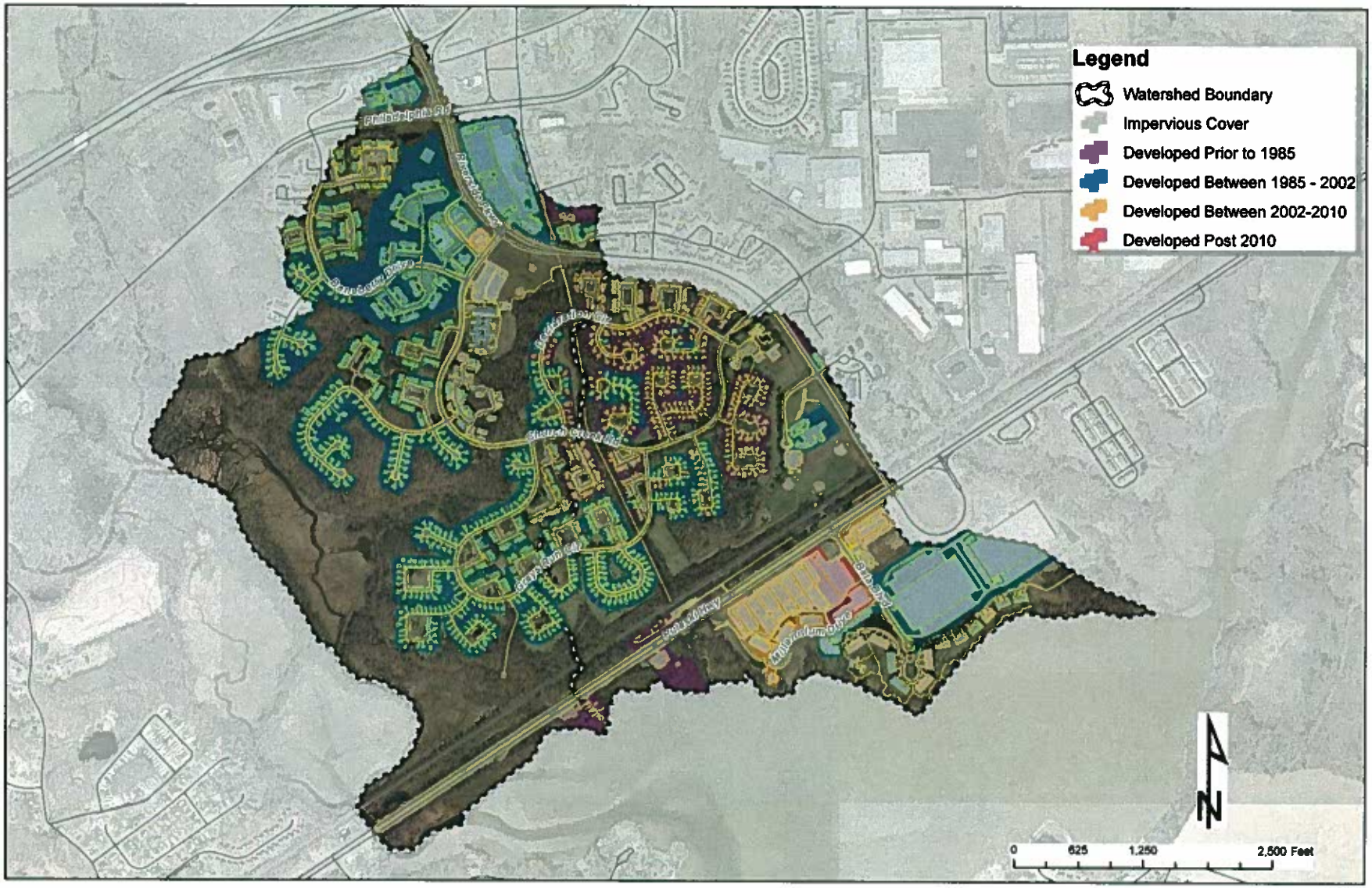


Figure 2-4: Existing impervious cover in study watersheds

PAGE INTENTIONALLY LEFT BLANK

2.2.8 Stormwater Hotspots

According to EPA, stormwater hotspots are areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater runoff. Stormwater hotspots generally include operations related to commercial, industrial, and transportation and require additional measures to stormwater management facilities to mitigate the pollutants. The County's GIS data were used to identify potential stormwater hotspots, which were investigated during the field reconnaissance.

The two sites with NPDES permits in the Declaration Run watershed were identified as potential stormwater hotspots (see Table 2-4). Marriott Spring Hill Suites has a General NPDES permit for its pool, and Arborview Apartments has a General NPDES permit for groundwater discharge. The permits have been administratively extended. No significant issues at these sites were identified during the field reconnaissance, and the sites are therefore not assumed to be stormwater hotspots.

Table 2-4: Existing NPDES Permits in the Declaration Run Watershed

NPDES ID	Facility	Address	Issued
MDG766014	Spring Hill Suites by Marriott Edgewood/Aberdeen	1420 Handlir Drive	4/26/2002
MDG766778	Arborview Apartments	1300 Liriope Court	7/18/2003

The Riverside watershed has one facility (Onguard Industries) with an NPDES permit related to surface discharges directly to the state waters though it is a minor NPDES permit and likely related to rooftop runoff. Waters Edge Condominiums has coverage under a general permit through 2017 that is most likely related to surface runoff since this area is located next to Church Creek. See Table 2-5.

Table 2-5: Existing NPDES Permits in the Riverside Watershed

NPDES ID	Facility	Address	Issued
MD0001431	Onguard Industries, LLC	4501 Pulaski Highway	7/1/2002
MDG766949	Waters Edge Condominiums	4702 Water Park Drive	2/9/2005
MDR002347	Lifoam Industries	121 Bata Boulevard	5/2/2013

No hotspots (other than those previously mentioned) or hotspot activities were observed during the field reconnaissance, but regular inspections of maintenance yards, construction sites, and industrial areas are important.

2.3 EXISTING STORMWATER MANAGEMENT

Stormwater management in Declaration Run and Riverside watersheds includes a combination of structural and non-structural management. The nonstructural techniques have been primarily planning and permitting requirements that have guided the types of structural techniques based on the era of development.

2.3.1 Existing Structural Stormwater Management

Development timeframes have influenced the type of stormwater management in each watershed. Waivers for stormwater quantity control had been given in many residential areas in both watersheds during design and construction; therefore there are very few areas in these watersheds that contain both stormwater quality and quantity control. Based on County GIS data and the County-provided stormwater management plans, there are approximately 14 and 8 existing stormwater management facilities in the Declaration Run and Riverside watershed respectively.

Tables 2-6 and 2-7 relate the County GIS-specified neighborhood areas with development periods and whether stormwater management during the eras would equate to expected management standards today.

Table 2-6: Development Trends in Declaration Run Watershed

Neighborhood	Portion of Watershed	Developed (ac)		Undeveloped (ac)	Adequate Structural SWM?
		Pre-1985	1985-2002	Open Space	
Riverside	42.2%	7.1	89.6	83.3	No
Arborview	8.4%	0.0	4.1	31.9	No
West Property	0.9%	0.0	3.9	0	No
Chapelgate	0.6%	1.5	1.0	0.04	No
Village of Church Creek	0.5%	0.0	0.6	1.4	No
Sanford Heights	0.1%	0.3	0.05	0	No
Gilmer Woods	0.04%	0.0	0.00	0.2	N/A
Total	52.74%	8.9	99.25	116.84	N/A

SWM = stormwater management

N/A = not applicable

Table 2-7: Development Trends in Riverside Watershed

Neighborhood	Portion of Watershed	Developed (ac)			Undeveloped (ac)	Adequate Structural SWM?
		Pre-1985	1985-2002	2003-2010	Open Space	
Riverside	44.6%	42.3	9.8	0	83.0	No
Village of Church Creek	4.4%	0	6.3	0	7.1	No
Waters Edge	7.4%	0	22.3	9.4	0	Some
Totals	56.40%	42.3	38.4	9.4	90.1	

SWM = stormwater management

The land use distribution in the watersheds is the result of the pattern of development and urbanization. According to MDE's guidance, areas developed prior to 1985 have limited/no stormwater management as the stormwater regulations during that time did not require implementation of BMPs to treat runoff from impervious areas. These areas are good locations to evaluate retrofit opportunities because of their limited stormwater management. Approximately 8.9 acres of Declaration Run was built prior to 1985 and lacks adequate stormwater management. Runoff from approximately 121 acres of Riverside watershed is captured by a stormwater management facility that was built prior to 1985.

The stormwater regulations for areas developed between 1985-2002 did not require pollutant load reduction efficiencies for stormwater management facilities. The stormwater management facilities implemented in this period were primarily designed for quantity control only and have low pollutant reduction efficiencies. These stormwater management facilities are also good candidates for retrofits. Most of Declaration Run watershed was built between 1985 and 2002 and is almost entirely residential. Many of these properties were observed during GIS analysis and field reconnaissance to have old erosion and sediment control basins (water quality traps) that have filled in and are no longer functioning as designed. URS assessed these facilities during field reconnaissance for potential retrofit options.

In both the scenarios, ownership issues can often make retrofits in these areas more difficult to implement. URS team assessed both watersheds for potential retrofits to existing stormwater management facilities, while considering the pre-1985 developed areas and potential ownership issues.

Declaration Run developments tend to have been built earlier than Riverside, primarily in the early 1990s and is almost entirely residential housing facilities. Newer and ongoing development in the Waters Edge neighborhood of Riverside watershed has led to stormwater management practices that align closer with current policies.

These development era trends show the likelihood that measures in the field provide adequate stormwater management and align with the results found for the existing facilities during stormwater field reconnaissance (Section 2.4). Due to the limited County-ownership of land in these watersheds, understanding the effect of these specific neighborhood areas and the development trends in relation to stormwater management provides a way to plan or prioritize potential public-private partnerships and specific outreach activities.

2.3.2 Existing Nonstructural Stormwater Management

Harford County's existing nonstructural stormwater management primarily includes planning and regulation to conserve existing green infrastructure. The County has also been implementing maintenance practices such as street sweeping, catch basin cleanouts, and tree planting and outreach activities under the MS4 Phase I permit.

2.4 FIELD RECONNAISSANCE

To prepare for the field reconnaissance, the URS team conducted a desktop analysis consisting of a review of County GIS data and stormwater management plans to identify potential sites for stormwater BMPs and stream restoration. The GIS data included property ownership, 2-foot contours, storm drains, existing stormwater management facilities, land use, and impervious cover. The team also reviewed County-provided design plans for existing stormwater management facilities because the information had not been translated into GIS data.

2.4.1 Stormwater Field Reconnaissance

The stormwater field reconnaissance was focused on determining whether in-field conditions were appropriate for BMPs that could obtain additional water quality treatment for stormwater runoff. Private ownership did not limit the properties in which field reconnaissance was done or the opportunity for a project, since the majority of both watersheds are owned privately. The team conducted the stormwater field reconnaissance in July 2013 and identified 23 locations in the Declaration Run watershed and 14 locations in the Riverside watershed as potential BMP sites to investigate during field reconnaissance. The data that were collected during the field reconnaissance consisted of:

- Potential BMP/stream improvements
- Land use in surrounding area
- Percent impervious area
- Recommendations for the site
- Benefits and constraints
- Potential conflicts with existing utilities
- Potential permits/regulatory approvals
- Any observed problems

Table 2-8 and Figure 2-5 show the sites assessed during field reconnaissance for stormwater improvements in the two watersheds.

Table 2-8: Stormwater Management Facilities Assessed During Field Reconnaissance

Watershed	Site ID	Location	Developed (acres)	Existing Facility	Proposed Project
Declaration Run	D-ES-2	End of Oreganum Court	11.3	Water quality trap	Retrofit to wetland
	D-ES-3	Liriope Court and Baneberry Diver	7.8	Water quality trap	N/A
	D-ES-4	West of Arabis Court	7.4	Water quality trap	N/A
	D-ES-5	North end of Foxglove Court	8.9	Extended detention basin	Bioretention
	D-ES-6	Germander Drive	3.4	Water quality trap	Bioretention
	D-ES-7	Germander Drive and Church Creek Road	2.8	Water quality trap	Bioswale and bioretention
	D-ES-8	Baneberry Drive	7.8	Water quality trap	Step pool conveyance system
	D-ES-9	Baneberry Drive and Primrose Place	4.5	Water quality trap	N/A
	D-ES-10	Baneberry Drive and Golden Rod Court	7.2	Water quality trap	N/A
	D-ES-11	Lavender Drive	1.4	Water quality trap	N/A
	D-ES-12	End of Marigold Lane	1.8	Water quality trap	Micropool and wetland
	D-ES-15	Procedure Way	3.3	Dry pond	Bioretention
	D-NS-3	Liriope Court	0.1	Sloped impervious roofs	Green roofs
	D-NS-4	Church Creek Road	2.1	Wide sidewalks	Green street bump out
	D-NS-7	Foxglove Court	6.0	Outfall	Step pool conveyance system
	D-NS-8	Dalmation Place	4.6	Outfall	Bioretention
	D-NS-9	Golden Rod Court	6.3	Traditional storm drains	Tree box filters
	D-NS-10	Philadelphia Road	6.2	Maryland SHA wet pond	N/A
	D-NS-11	Philadelphia Road	3.3	Maryland SHA swale	N/A
	D-NS-12	Church Creek Elementary School	0.9	Traditional storm drain	Bioretention and tree box filters
	D-NS-13	Church Creek Road	0.8	Impervious right-of-way	Green street bump out
	D-SWM0110 (ES-1)	Church Creek Elementary School	8.2	Infiltration basin	Wetland plantings
	D-SWM0630	Policy Drive	0.6	Underground sand filters	N/A

Watershed	Site ID	Location	Developed (acres)	Existing Facility	Proposed Project
Riverside	R-ES-1	Halls Chance Road	130.4	Grass swale	Bioswale and check dams
	R-NS-1	Belcamp Park	5.5	Traditional storm drain	Bioretention
	R-NS-4	Bata Boulevard	0.0	Wet Pond	N/A
	R-NS-6	Winners Circle	1.3	Open space	Rain garden
	R-NS-7	Caldwell Court South	64.3	Grass swale	Bioswale and check dams
	R-NS-8	Carlyle Garth	1.9	Grass swale	Bioswale and check dams
	R-SWM0267	Water Park Drive	0.0	Facility removed	N/A
	R-SWM0491	West end of Millennium Drive	4.9	Grass swales	Filter strips
	R-SWM0624	Millennium Drive	2.8	Grass swales	N/A
	R-SWM0627	Millennium Drive	4.6	Grass swales	Filter strips
	R-SWM0638	Water Park Drive	3.9	Sand filter	N/A
	R-SWM0864	Millennium Drive	0.9	ESD	N/A
	R-SWM0865	Millennium Drive	4.5	Grass Swales	N/A
	R-SWM0866	Route 40	2.5	Grass Swale	N/A

N/A = not applicable

SHA = (Maryland) State Highway Administration

Site ID Descriptions:

"D" = Declaration Run Watershed

"R" = Riverside Watershed

"ES" = Existing Site

"NS" = New Site

"SWM" = Stormwater Management (Based on County GIS data)

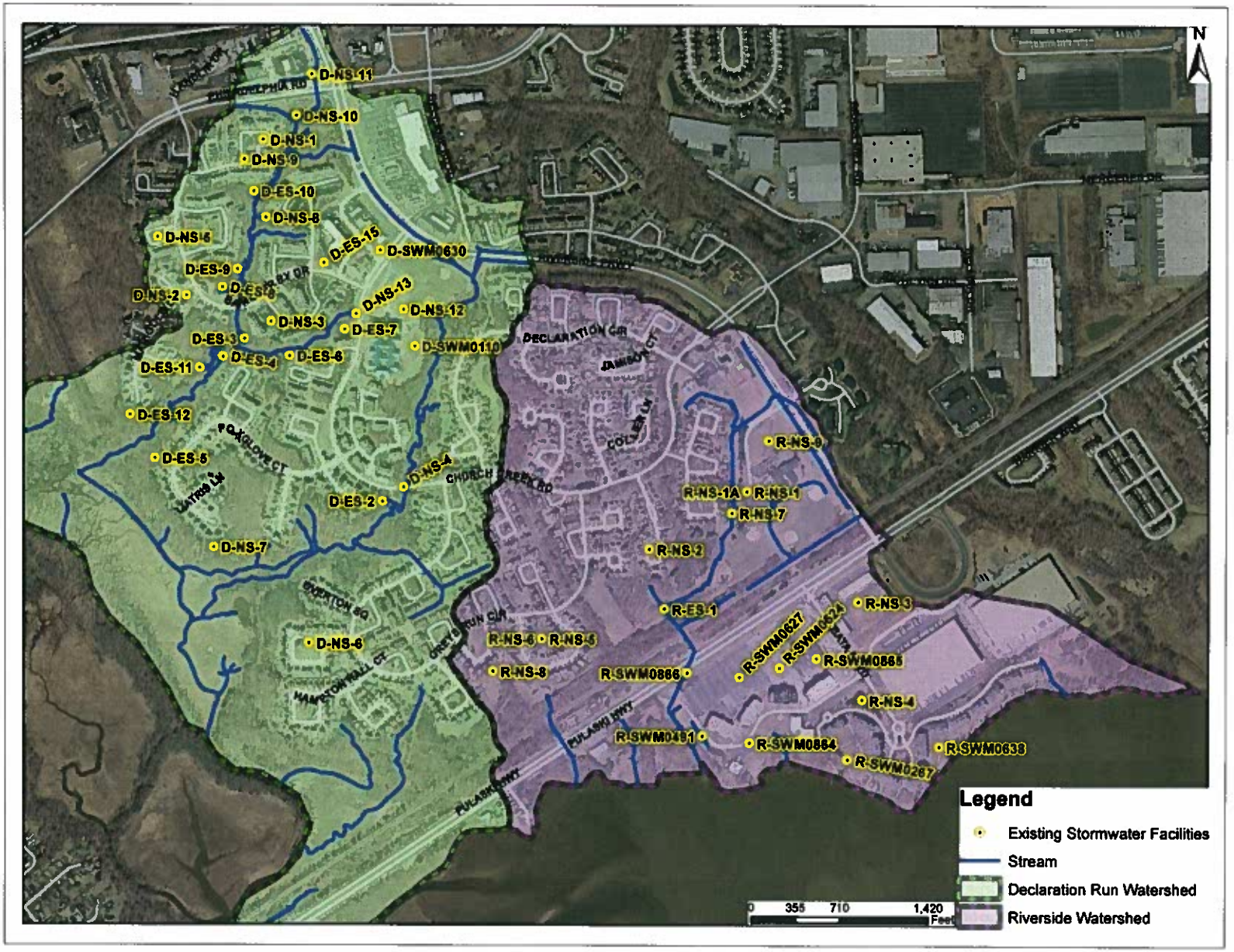


Figure 2-5: Sites assessed as a part of stormwater field reconnaissance

PAGE INTENTIONALLY LEFT BLANK

The 37 sites were assessed during the field reconnaissance for feasibility of new or retrofit BMPs. The BMPs under consideration included ESD, LID, green infrastructure, and traditional structural techniques. Programmatic management strategies that could be implemented on a watershed level were also considered. Additional information on the desktop analysis and field reconnaissance for stormwater sites is provided in Appendix A. The prioritization of field reconnaissance projects is discussed in Appendix D and the projects selected for concept design are discussed in Section 3.

2.4.2 Stream Field Reconnaissance

Ten stream reaches within the Declaration Run and Riverside watersheds were chosen for field reconnaissance based on available County GIS data. Effort was made to choose equal sites within both reaches; however, since Riverside has no natural stream channels, the majority of assessments were in Declaration Run watershed.

Stream walks along each of the 10 chosen reaches were conducted in September and October 2013 for a total of approximately four miles of streams. This visual assessment during stream walks included noting areas of bank erosion, streambed degradation, presence of invasive species, outfall deterioration, and stream buffer concerns such as encroachment or dumping. The stream walks provided the understanding necessary to choose areas representative of the overall stream condition to perform detailed assessments.

The team conducted a detailed assessment at locations along each stream that were deemed to be representative of the quality and conditions of that reach of the stream. Detailed assessments at representative locations included:

- Maryland Biological Stream Survey (MBSS) Habitat Assessment :
- Bank Erosion Hazard Index Assessment (BEHI)
- Measured cross sections and stream classification
- Restoration site assessment

Tributary CC2A in Riverside watershed was walked to determine if there were any possible segments that could be used for detailed assessments; however, it was found that there was no natural channel. Therefore, no habitat assessment, cross sections, BEHI assessment, or restoration assessment was performed. In addition, Declaration Run Reach 2 did not have a high bank, so a BEHI was not conducted at this site.

Table 2-9 shows the streams, reaches walked, and the assessment point locations associated with studied reaches.

Table 2-9: Stream Reaches Assessed During Field Reconnaissance

Watershed	Stream Name	Reach ID	Monitoring Point ID	Location	Proposed Project
Declaration Run	Declaration Run	Reach 1	DR-1	Upstream of Baneberry Drive	Remediating two headcuts by installing riffle grade control structures or step pools
	Declaration Run	Reach 2	DR-2	Downstream of Baneberry Drive, West of Arabis Court and Foxglove Court	Outfall stabilization
	Tributary 5 to Declaration Run	Tributary DR5*	T5DR	Downstream of Baneberry Drive and north of and between Arabis Court and Germander Drive	Correcting minor headcut with grade control structures and remediating a slope failure at a storm drain outfall
	Tributary 9 to Declaration Run	Reach 1	T9DR-1	Downstream of Riverside Parkway, East of Church Creek Elementary School toward Church Creek Road	Stabilizing the stream bed banks, removing a failed in-stream stormwater management feature, grade and stabilize high stream banks, remediating three headcuts, and remediating a failed storm drain outfall[1]
	Tributary 9 to Declaration Run	Reach 2	T9DR-2	Downstream of Church Creek Elementary School and upstream of Church Creek Road	Stabilizing the stream bed banks, removing a failed in-stream stormwater management feature, grade and stabilize high stream banks, remediating three headcuts, and remediating a failed storm drain outfall[1]
	Tributary 9 to Declaration Run	Reach 3	T9DR-3	Downstream of Tributary DR9C and opposite Trillium Court	No restoration measure recommended
	Tributary 9C to Declaration Run	Tributary DR9C[2]	T9CDR	Downstream of Church Creek Road and west of Greys Run Circle	No restoration measure recommended
	Tributary 2 to Bynum Run	Tributary BR2[2]	T2BR	North of Pulaski Highway and on tributary north of Tributary BR3	No restoration measure recommended
	Tributary 3 to Bynum Run	Tributary BR3[2]	T3BR	North of Pulaski Highway and on tributary south of Tributary BR2	No restoration measure recommended
Riverside	Tributary 2A to Church Creek	Tributary CC2A*	N/A	(Riverside watershed, no detailed assessments) North of Pulaski Highway and west of Riverside Parkway	No restoration measure recommended

(1) Projects for Tributary 9 to Declaration Run Reach 1 and Reach 2 combined as one project

(2) Reach discussed refers to entire stream length.

The purpose of these assessments was to be able to compare the reaches in the watersheds to determine relative health conditions and to help identify optimal restoration sites and for use in developing preliminary concept plans. The assessment methodologies and results are described in Appendix B.

Figure 2-6 shows the stream reaches walked, and the assessment locations associated with studied reaches. Tables 2-10 and 2-11 show the results of stream assessments for Declaration Run and Riverside watersheds

PAGE INTENTIONALLY LEFT BLANK

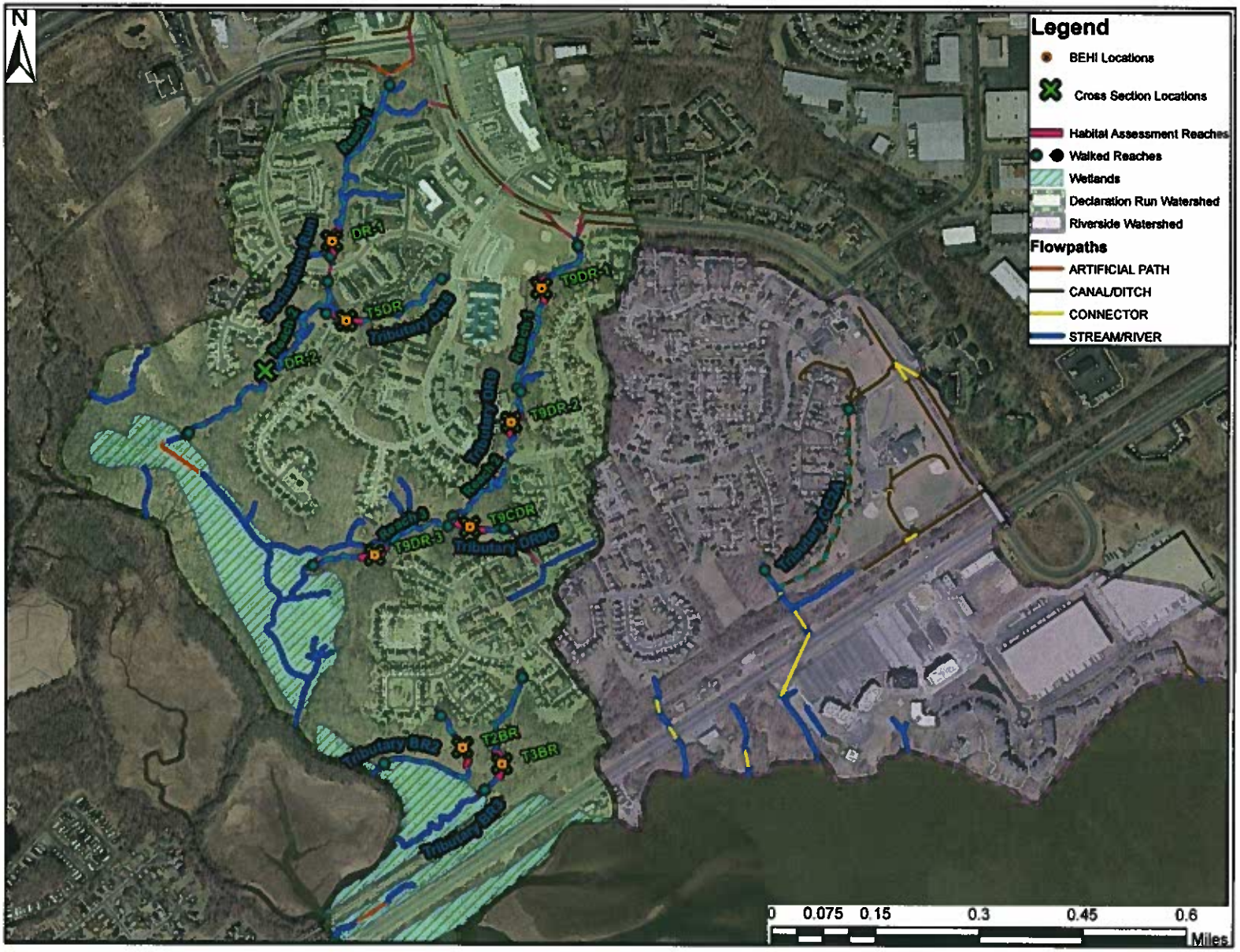


Figure 2-6: Stream reconnaissance assessment reaches

Table 2-10: MBSS Protocol Physical Habitat Index Ratings for Assessed Streams

Watershed	Stream Reach ID	Reach ID	Instream Habitat	Epifaunal Substrate	Bank Stability	Embedded-ness	Percent Shading	Remote-ness	No. Woody Debris / Rootwads	Riffle Quality	PHI Score	PHI Rating
Declaration Run	Declaration Run	Reach 1	5	2	5	50	90%	10	3	0	42.5	Fair
	Tributary 5 to Declaration Run	Tributary DR5	2	1	10	80	100%	10	3	0	40.0	Poor
	Declaration Run	Reach 2	2	2	15	90	80%	10	8	2	44.1	Fair
	Tributary 9 to Declaration Run	Reach 1	3	3	10	80	70%	10	9	5	47.5	Fair
	Tributary 9 to Declaration Run	Reach 2	1	3	5	85	70%	10	2	6	34.7	Poor
	Tributary 9C to Declaration Run	Tributary DR9C	5	4	10	80	85%	10	10	5	53.1	Fair
	Tributary 9 to Declaration Run	Reach 3	6	4	10	90	20%	10	6	5	40.5	Poor
	Tributary 2 to Bynum Run	Tributary BR2	2	2	5	50	75%	10	9	6	47.7	Fair
	Tributary 3 to Bynum Run	Tributary BR 3	5	2	10	90	70%	10	5	4	42.2	Fair
Riverside	Tributary 2A to Church Creek	Tributary CC2A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 2-11: BEHI Scores and Descriptive Ratings for Assessed Streams

Watershed	Stream Reach ID	Reach ID	BEHI	
			Score	Rating
Declaration Run	Declaration Run	Reach 1	42.42	Very High
	Tributary 5 to Declaration Run	Tributary DR5	37.49	High
	Declaration Run	Reach 2	N/A*	N/A*
	Tributary 9 to Declaration Run	Reach 1	30.72	High
	Tributary 9 to Declaration Run	Reach 2	39.9	Very High
	Tributary 9C to Declaration Run	Tributary DR9C	38.34	High
	Tributary 9 to Declaration Run	Reach 3	30.65	High
	Tributary 2 to Bynum Run	Tributary BR2	41.84	Very High
	Tributary 3 to Bynum Run	Tributary BR 3	37.88	High
Riverside	Tributary 2A to Church Creek	Tributary CC2A	N/A	N/A

(*)- Low Bank

2.5 BASELINE POLLUTANT LOAD ESTIMATES

The URS team used the Watershed Treatment Model (WTM) to estimate the pollutant loads generated by existing land uses and hydrologic characteristics in the watersheds. WTM is a spreadsheet-based model developed by the Center for Watershed Protection to estimate the pollutant load concentrations for nitrogen, phosphorus, sediment and bacteria from primary and secondary sources (Center for Watershed Protection, 2013).

The model was also used to assess the effectiveness of existing and proposed stormwater management controls in reducing the pollutant load concentrations conveyed downstream. The WTM 2013 Custom version was used to calculate the pollutant load concentrations. Table 2-12 shows the pollutant load and runoff volume estimates for the Declaration Run watershed and Riverside watershed.

Table 2-12: Baseline Pollutant Load Estimates for Study Watersheds

Source Watershed	Receiving Waterbody Type	TN (lb/yr)	TP (lb/yr)	TSS (lbs/yr)	Fecal Coliform (Billion/yr)	Runoff Volume (ac-ft/yr)
Declaration Run	Surface Water	3,005	501	180,126	157,734	437
Riverside	Surface Water	3,456	628	148,405	176,594	492

Appendix C presents the inputs and results of the WTM model for the Declaration Run and Riverside watersheds.

SECTION THREE: PROPOSED WATERSHED IMPROVEMENTS

A proposed suite of watershed improvement measures have been proposed that include structural improvements, non-structural measures and management strategies to improve and enhance the natural resources and water quality conditions in the watershed. These measures were identified based on the desktop analyses, field assessments of the watersheds and discussion with the County staff. The sections below provide a discussion of watershed improvement measures proposed in the watersheds, their benefits and potential funding sources for their implementation.

3.1 PROPOSED STRUCTURAL IMPROVEMENTS

The proposed structural improvements include restoring streams, improving aquatic and terrestrial habitat conditions, and removing pollutants from stormwater runoff. The proposed structural improvements are categorized as stormwater structural improvements (Section 3.1.1) and stream restoration projects (Section 3.1.2).

3.1.1 Proposed Stormwater Structural Improvements

Stormwater BMPs are designed to provide quality and/or quantity control to the contributing drainage areas. Quantity control measures are designed to collect stormwater runoff in a storage facility and release the runoff at a slower, controlled rate to prevent localized flooding and downstream erosion. Stormwater quality control measures are designed to remove pollutants such as total nitrogen, total phosphorus, sediment, and heavy metals from the stormwater runoff through processes such as filtration and infiltration before conveying the runoff to downstream waterbodies.

The BMPs proposed as a part of this SWAP included ESD, LID, green infrastructure and traditional structural techniques. As described in Section 2.4, 34 sites were identified during the field reconnaissance for feasibility of new or retrofit BMPs.

A priority ranking was developed to identify high-priority proposed stormwater structural improvement projects in both watersheds using weighted criteria. The prioritization was performed using nine evaluation criterions that included:

- Property ownership
- Access to project site
- Drainage area
- Contributing impervious area
- Cost
- Utility impacts
- Environmental impacts

- Stormwater management era
- Estimated pollutant load reductions

Appendix D includes a description of the prioritization process, evaluation criteria, and priority ranking for both study watersheds. Planning level cost estimates for all the proposed projects were developed using the University of Maryland's publication *"Cost of Stormwater Management Practices in Maryland Counties"*. Based on the publication, the total initial costs per impervious acre treated depending on the type of BMP were used. These initial costs included costs for site discovery, surveying, design, planning, permitting, labor, material and overhead costs.

All the proposed projects were included in the future conditions WTM model to estimate the potential pollutant load reductions that would be achieved from each proposed project.

Water quality volumes and channel protection volumes (Appendix E) were calculated for all applicable projects. Detailed mapping and concepts were provided for sites that were identified as high priority projects by the County.

Figure 3-1 shows the locations of the proposed stormwater projects in both study watersheds. The projects in the Declaration Run watershed and the Riverside watershed are discussed in the sections below.

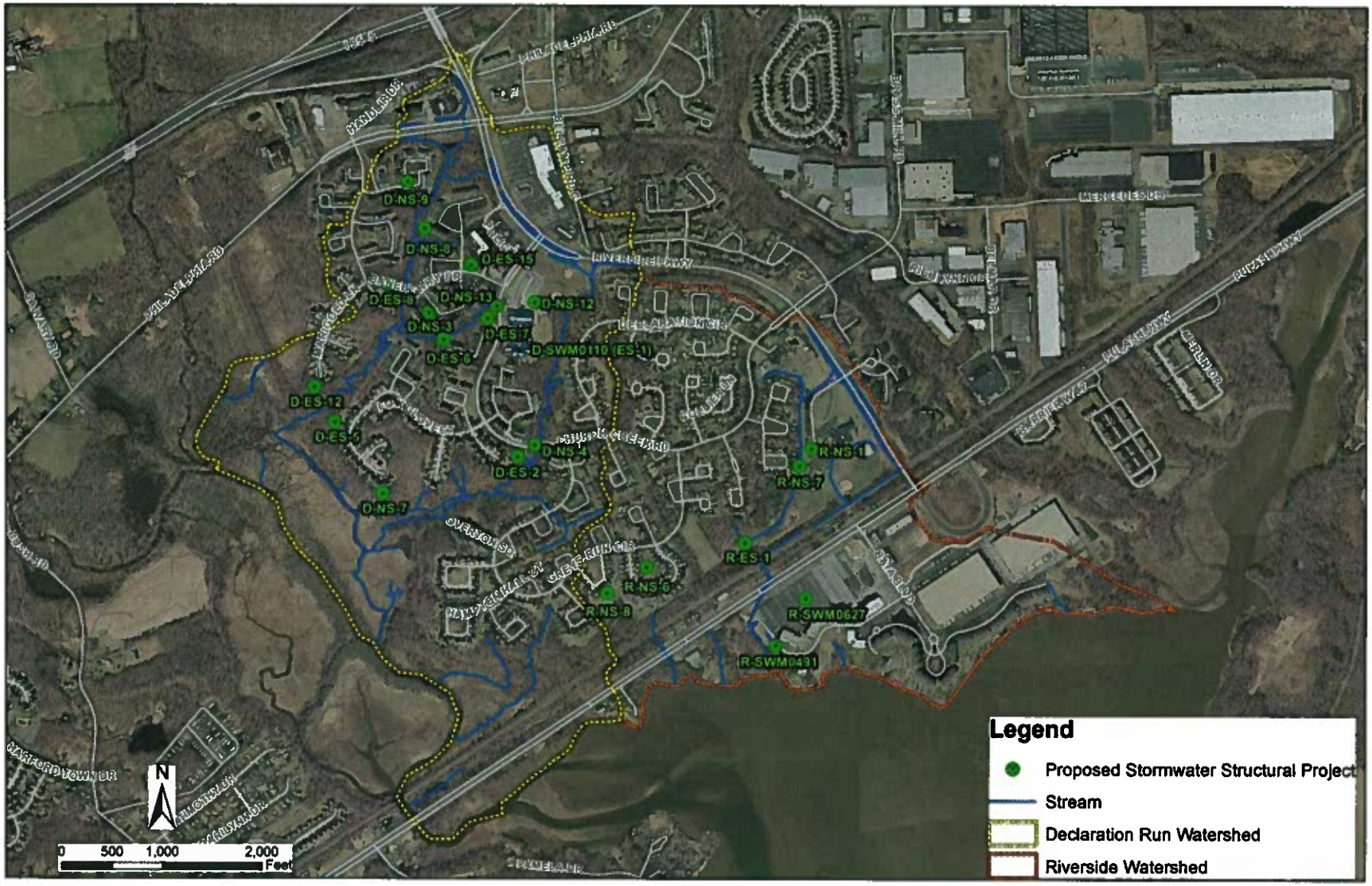


Figure 3-1: Proposed stormwater structural projects in study watersheds

PAGE INTENTIONALLY LEFT BLANK

Proposed Stormwater Structural Projects in the Declaration Run Watershed

The proposed stormwater structural improvements in the Declaration Run watershed are listed in Tables 3-1 and 3-2 and provide a summary of all the projects.

Table 3-1: List of Proposed Stormwater Structural Projects in the Declaration Run Watershed

Site ID	Proposed Project	Location	County Priority Type
D-ES-2	Wetland	End of Oreganum Court	High
D-ES-5	Bioretention	North end of Foxglove Court	Low
D-ES-6	Bioretention	Germander Drive	Medium
D-ES-7	Bioswale and Bioretention	Germander Drive and Church Creek Road	High
D-ES-8	Wetland and Step Pool Conveyance System	Baneberry Drive	High
D-ES-12	Micropool and Wetland	End of Marigold Lane	Medium
D-ES-15	Bioretention	Procedure Way	High
D-NS-3	Green Roofs	Liriope Court	Low
D-NS-4	Green Street Bump Out	Church Creek Road	Medium
D-NS-7	Step Pool Conveyance System	Foxglove Court	Low
D-NS-8	Bioretention	Dalmation Place	High
D-NS-9	Tree Box Filters	Golden Rod Court	Low
D-NS-12	Bioretention or Tree Box Filters	Church Creek Elementary School	High
D-NS-13	Green Street Bump Out	Church Creek Road	High
D-SWM0110 (ES-1)	Upgrade Infiltration Basin	Church Creek Elementary School	High

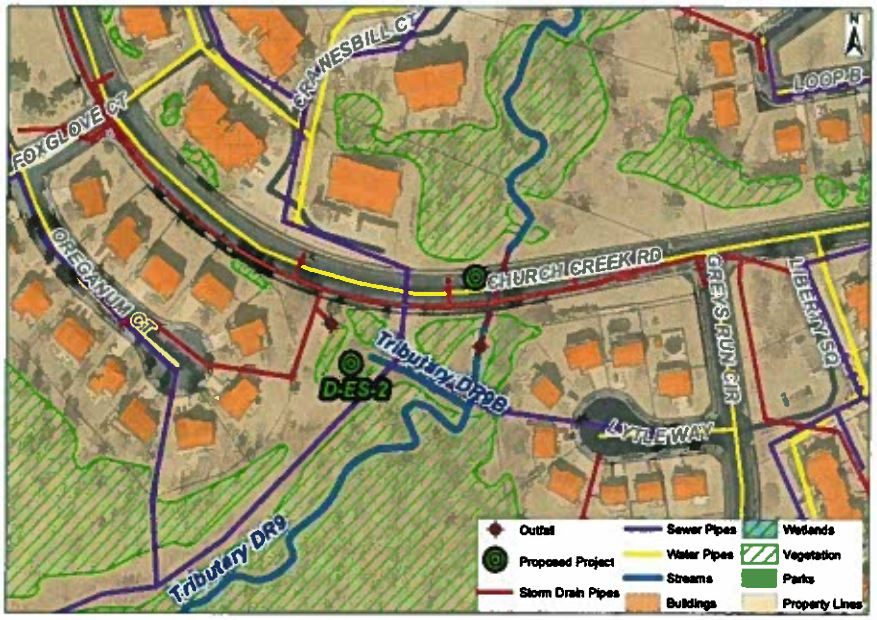
PAGE INTENTIONALLY LEFT BLANK

Table 3-2: Summary of Proposed Stormwater Structural Projects in the Declaration Run Watershed

Site ID	Proposed Project	Cost	Pollutant Load Reductions			Impervious Area Treated (acres)	Project Priority
			TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)		
D-ES-2	Wetland	$325,000	42	3	754	4.9	High
D-ES-7	Bioswale and Bioretention	$78,600	11	2	400	1.3	High
D-ES-8	Wetland and Step Pool Conveyance System	$195,100	57	11	1,658	3.3	High
D-ES-15	Bioretention	$110,100	25	4	819	2.0	High
D-NS-8	Bioretention	$125,200	34	6	1058	2.0	High
D-NS-12	Bioretention or Tree Box Filters	$39,900	5	1	251	0.9	High
D-NS-13	Green Street Bump Out	$140,900	4	1	204	0.8	High
D-SWM0110 (ES-1)	Upgrade Infiltration Basin	$207,200	57	10	1,682	4.4	High
D-ES-6	Bioretention	$80,400	20	4	742	Up to 1.6	Medium
D-ES-12	Micropool and Wetland	$63,000	13	2	407	Up to 1.0	Medium
D-NS-4	Green Street Bump Out	$300,900	15	2	529	Up to 1.6	Medium
D-ES-5	Bioretention	$140,000	63	12	1,740	Up to 2.8	Low
D-NS-3	Green Roofs	$78,800	0.5	0.1	21	Up to 0.1	Low
D-NS-7	Step Pool Conveyance System	$363,300	43	8	1,203	Up to 2.1	Low
D-NS-9	Tree Box Filters	$180,000	26	5	1,358	Up to 3.6	Low

PAGE INTENTIONALLY LEFT BLANK

D-ES-2 (High Priority)



Site ID: D-ES-2	
Drainage area	11.3 acres
Impervious area	4.9 acres
WQv	0.4 acre-foot
CPv	0.83 acre-foot
Pollutant removal estimate:	
Total nitrogen	42 lbs/yr
Total phosphorus	3 lbs/yr
TSS	754 lbs/yr
Planning-level cost estimate	$325,000
Impervious area treated	4.9 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The D-ES-2 site has a stormwater wetland located east of Oreganum Court and along Church Creek Road. The facility was identified from the design plans provided by the County as a part of data collection and review for field reconnaissance. According to the County-provided data, the facility was designed in 1993 to capture and treat runoff from the neighborhoods along Oreganum Court, Foxglove Square, Greys Run Circle, and Liberty Square. The facility also captures runoff from a part of Church Creek Road. At the time of the field visit, ponded water with trash and debris was observed in the facility. Severe erosion was observed in the outfall area and along the banks of the facility.

Ponded water observed in the facility

The proposed improvement consists of converting the facility to a wetland to improve the pollutant removal capacity of the facility and create improved aquatic habitat conditions and to restore and stabilize the eroding outfall area. The project site has good access from Church Creek Road. Because a sewer line is near the outfall, the project should be limited to avoid affecting the utility. Trees with more than 12 inches in diameter around the facility may be affected during project implementation. This site was selected as a high priority project by the County. Figure 3-2 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

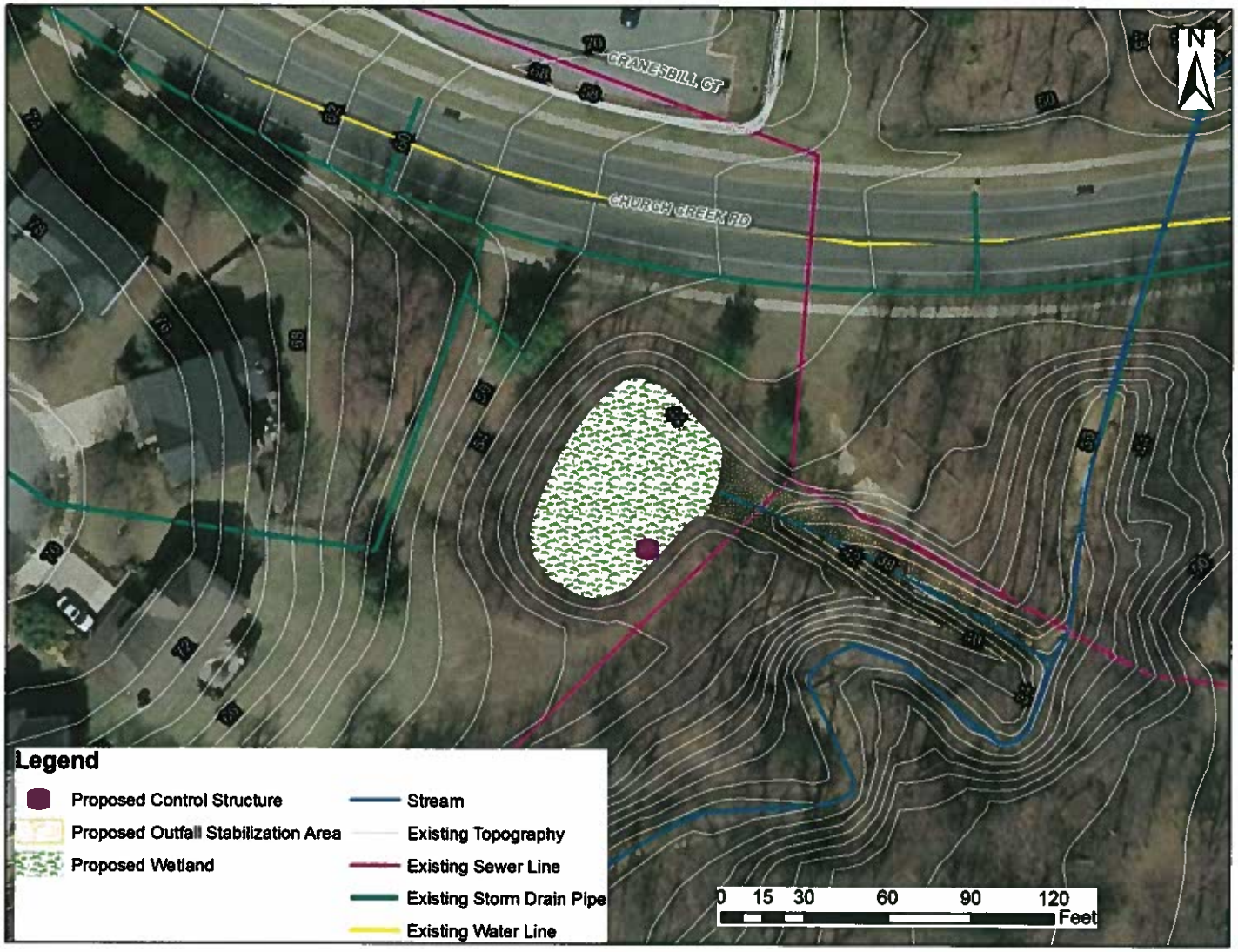
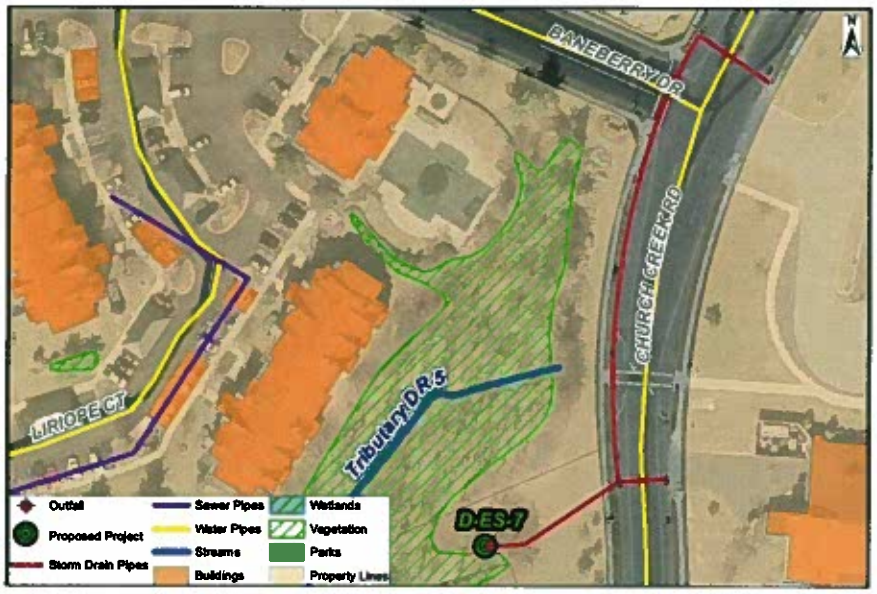


Figure 3-2: Proposed structural stormwater improvement at site D-ES-2

PAGE INTENTIONALLY LEFT BLANK

D-ES-7 (High Priority)



Site ID: D-ES-7	
Drainage area	2.8 acres
Impervious area	1.6 acres
WQv	0.1 acre-foot
CPv	0.3 acre-foot
Pollutant removal estimate:	
Total nitrogen	11 lbs/yr
Total phosphorus	2 lbs/yr
TSS	400 lbs/yr
Planning-level cost estimate	$78,600
Impervious area treated	1.3 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing facility at site D-ES7 is a water quality trap downstream of a 24-inch RCP outfall that is north of Germander Drive along Church Creek Road. The facility was identified from the design plans provided by the County as a part of data collection and review for field reconnaissance. The facility was designed in 1991 to capture runoff from a portion of Church Creek Road and Church Creek Elementary School before discharging into Tributary DR5. A grass channel that captures a portion of runoff from Baneberry Drive also conveys runoff to the facility. Accumulation of sediment in the riprap area of the water quality trap was observed during field assessment.

The proposed improvement consists of converting the grass channel to a water quality swale to capture and treat runoff from Baneberry Drive. A bioretention facility is also proposed in the open area to capture and treat runoff from Church Creek Road and Church Creek Elementary School. The existing 24-inch RCP would be modified to add a flow diversion structure to divert the water quality volume to the proposed bioretention facility and divert the remaining flows to the existing water quality trap before flowing into Tributary DR5. Removing the sediment that has accumulated in the water quality trap is recommended to improve function. The project site is accessible from from Church Creek Road. The few small trees (less than 12 inches in diameter) near the site may be affected during project implementation. This site was selected as a high priority project by the County and Figure 3-3 shows the detailed structural stormwater improvements at the site.

Grass channel that conveys runoff to the outfall

PAGE INTENTIONALLY LEFT BLANK

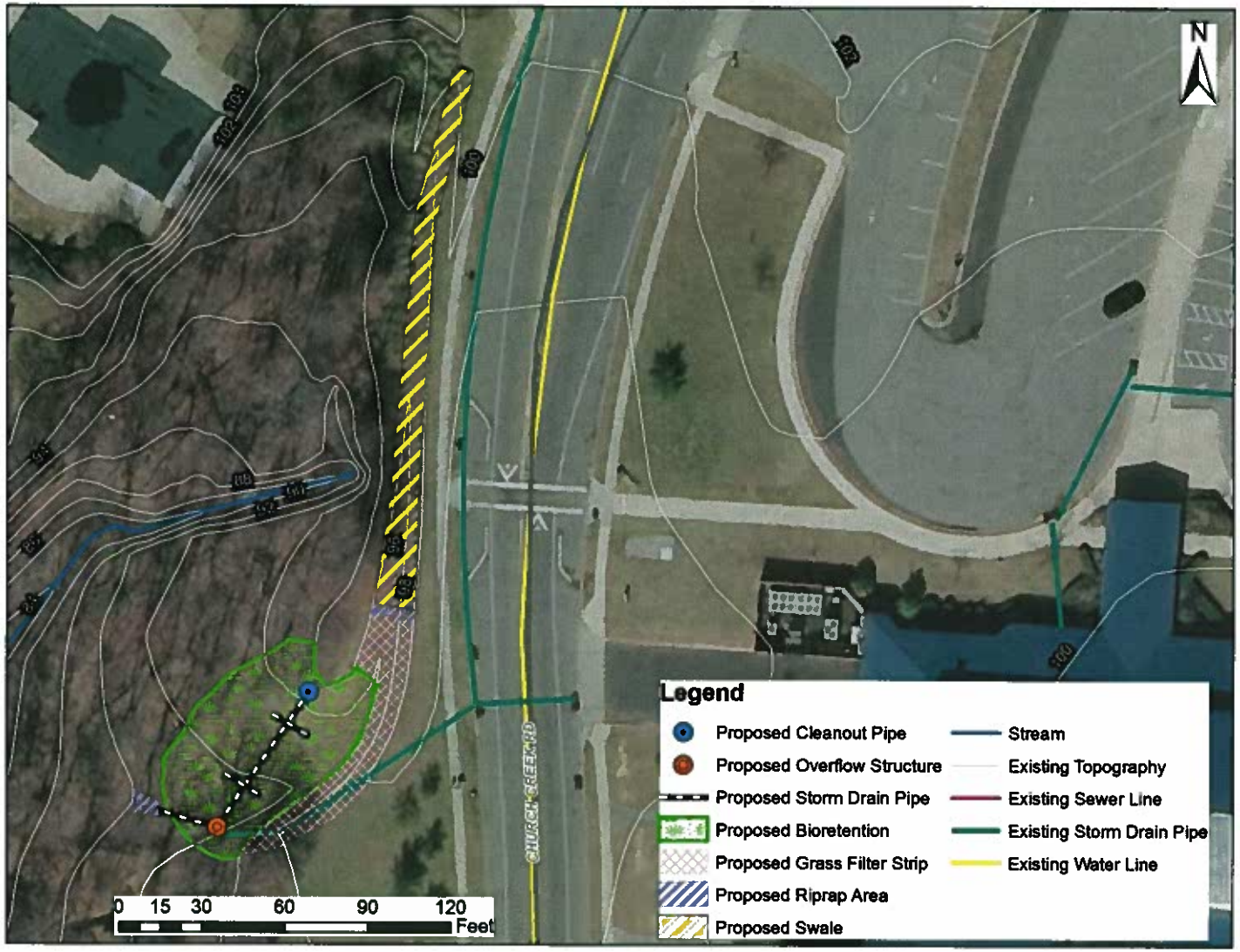
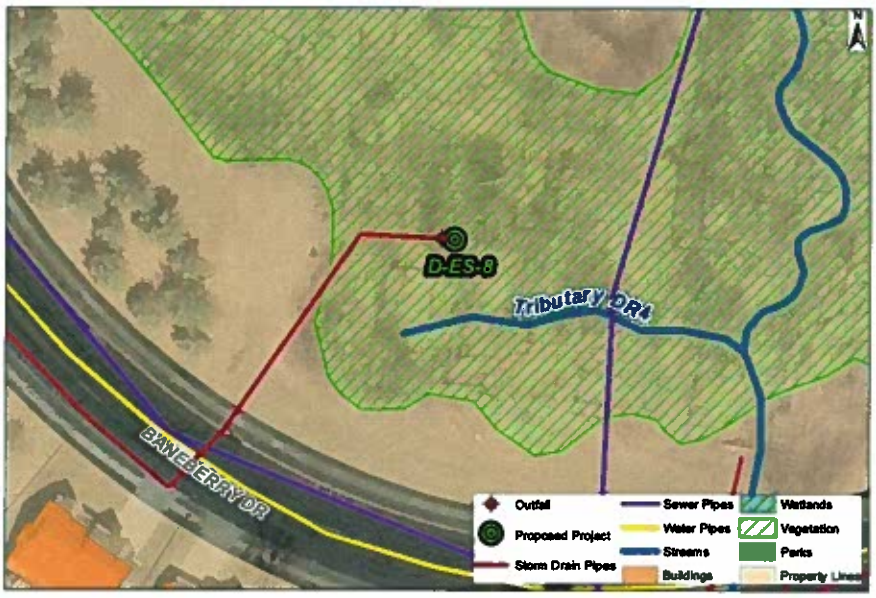


Figure 3-3: Proposed structural stormwater improvement at site D-ES-7

PAGE INTENTIONALLY LEFT BLANK

D-ES-8 (High Priority)



Site ID: D-ES-8	
Drainage area	7.8 acres
Impervious area	3.3 acres
WQv	0.3 acre-foot
CPv	0.5 acre-foot
Pollutant removal estimate:	
Total nitrogen	57 lbs/yr
Total phosphorus	11 lbs/yr
TSS	1,658 lbs/yr
Planning-level cost estimate	$195,100
Impervious area treated	3.3 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing facility at site D-ES-8 is a water quality trap downstream of a 24-inch RCP that is south of Primrose Place along Baneberry Drive. The facility was identified from the design plans provided by the County as part of data collection and review for the field reconnaissance. The facility was designed in 1990 to capture runoff from neighborhood areas along Sedum Square, Clary Court, and Marigold Lane. The facility also captures runoff from a portion of Baneberry Drive. Ponded water with trash and debris was observed in the facility at the time of field visit. The outfall area from the facility to Tributary DR4 appeared to be eroded.

The proposed improvement consists of constructing a step pool conveyance system at the outfall area. The system would have surface pools and subsurface sand seepage filters that would treat and infiltrate the stormwater runoff. Stabilizing the eroded areas, removing trash, and retrofitting the water quality trap with plantings are also recommended.

Existing water quality trap

The project site is accessible from Baneberry Drive or from the parking lot on Primrose Place. Since the project site is located in a wooded area, impacts to trees and non-tidal wetlands are anticipated during project implementation. This site was selected as a high priority project by the County and Figure 3-4 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

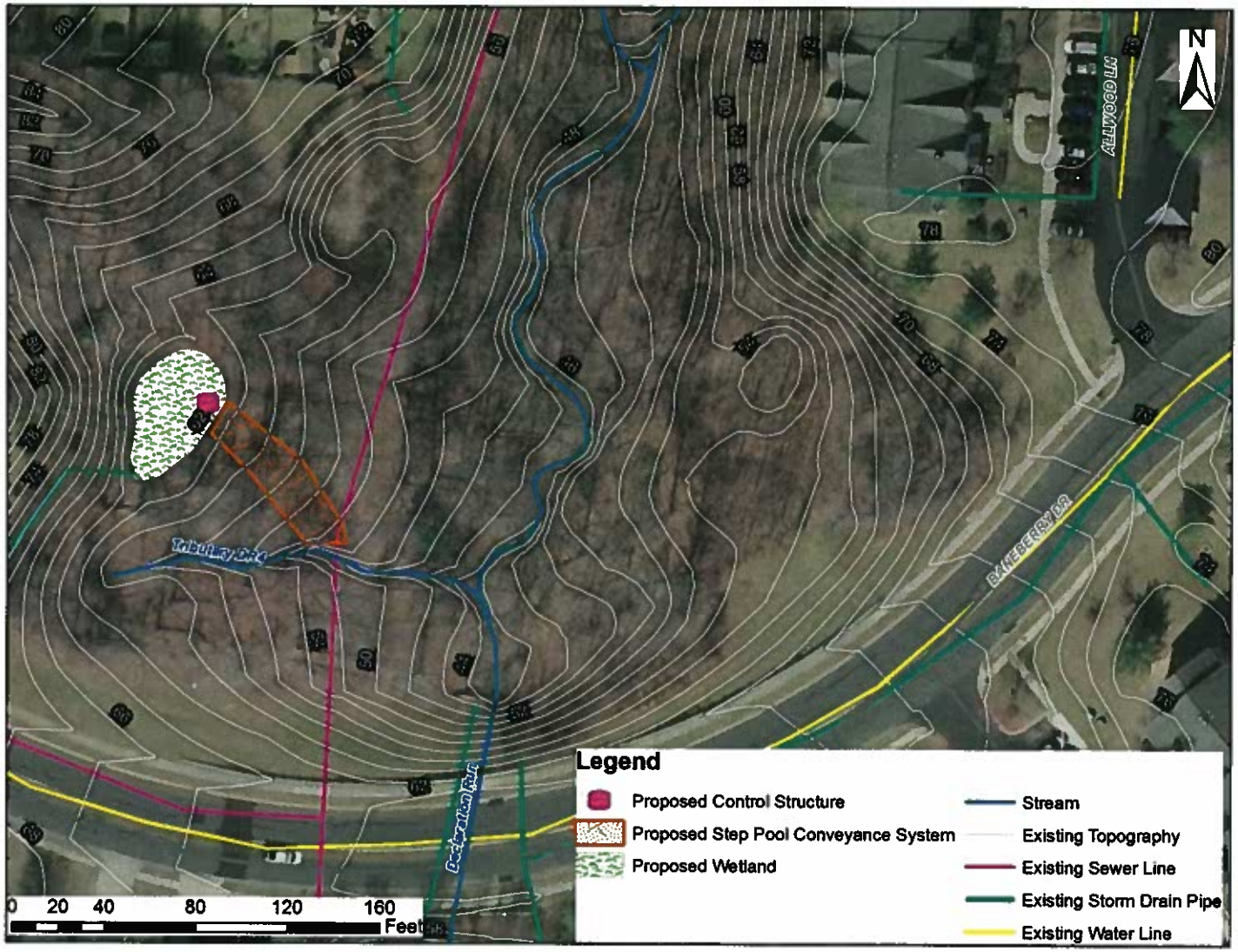


Figure 3-4: Proposed structural stormwater improvement at site D-ES-8

PAGE INTENTIONALLY LEFT BLANK

D-ES-15 (High Priority)

Site ID: D-ES-15	
Drainage area	3.3 acres
Impervious area	2.2 acres
WQv	0.2 acre-foot
CPv	0.3 acre-foot
Pollutant removal estimate:	
Total nitrogen	25 lbs/yr
Total phosphorus	4 lbs/yr
TSS	819 lbs/yr
Planning-level cost estimate	$110,100
Impervious area treated	2.0 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing facility at site D-ES-15 is a dry pond that captures and treats runoff from a portion of the commercial area on Policy Drive and Procedure Way. The facility was identified from the design plans provided by the County as a part of data collection and review for field reconnaissance. The pond appeared to be over gown during the field reconnaissance. The runoff is conveyed to the facility through an 18-inch RCP.

The proposed improvement consists of retrofitting the facility to convert it to a bioretention system to provide water quality treatment for the runoff. The existing storm drain system would be modified to include a flow diversion structure at the inlet of the facility to divert the water quality volume to the proposed bioretention system and divert the overflows to the storm drain system.

The facility is accessible from the parking lot on Procedure Way. A sewer line was observed in the proximity of the project site, but minimal utility impacts are anticipated. The existing trees at the facility would be affected during project implementation. This site was selected as a high priority project by the County and Figure 3-5 shows the detailed structural stormwater improvements at the site.

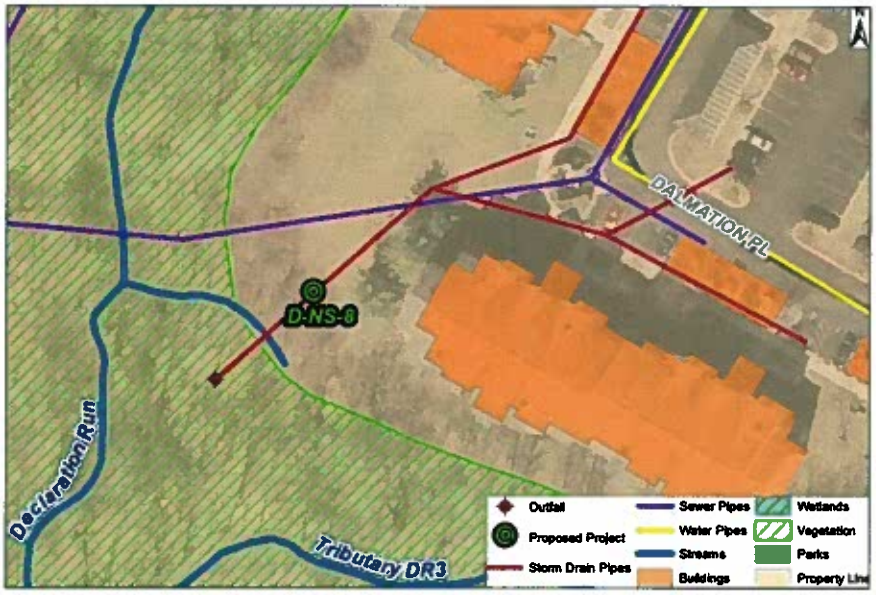
Overgrown vegetation at the inlet

PAGE INTENTIONALLY LEFT BLANK

Figure 3-5: Proposed structural stormwater improvement at site D-ES-15

PAGE INTENTIONALLY LEFT BLANK

D-NS-8 (High Priority)



Site ID: D-NS-8	
Drainage area	4.6 acres
Impervious area	2.5 acres
WQv	0.2 acre-foot
CPv	0.3 acre-foot
Pollutant removal estimate:	
Total nitrogen	34 lbs/yr
Total phosphorus	6 lbs/yr
TSS	1,058 lbs/yr
Planning-level cost estimate	$125,200
Impervious area treated	2.0 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

Site D-NS-8 is an outfall pipe that captures runoff from a high-density residential area on Dalmation Place. The flow eventually discharges into Declaration Run without any treatment.

The proposed improvement consists of implementing a bioretention facility in the open area at the west end of Dalmation Place. The existing storm drain system would be modified to add a flow diversion structure that would divert the water quality volume to the proposed bioretention system and divert the remaining flows to the forested area before flowing into Declaration Run.

The project site is accessible from the parking lot on Dalmation Place. An existing sewer system is located in the project area, and utility conflicts are therefore anticipated. This site was selected as a high priority project by the County and Figure 3-6 shows the detailed structural stormwater improvements at the site.

Existing outfall with riprap area

PAGE INTENTIONALLY LEFT BLANK

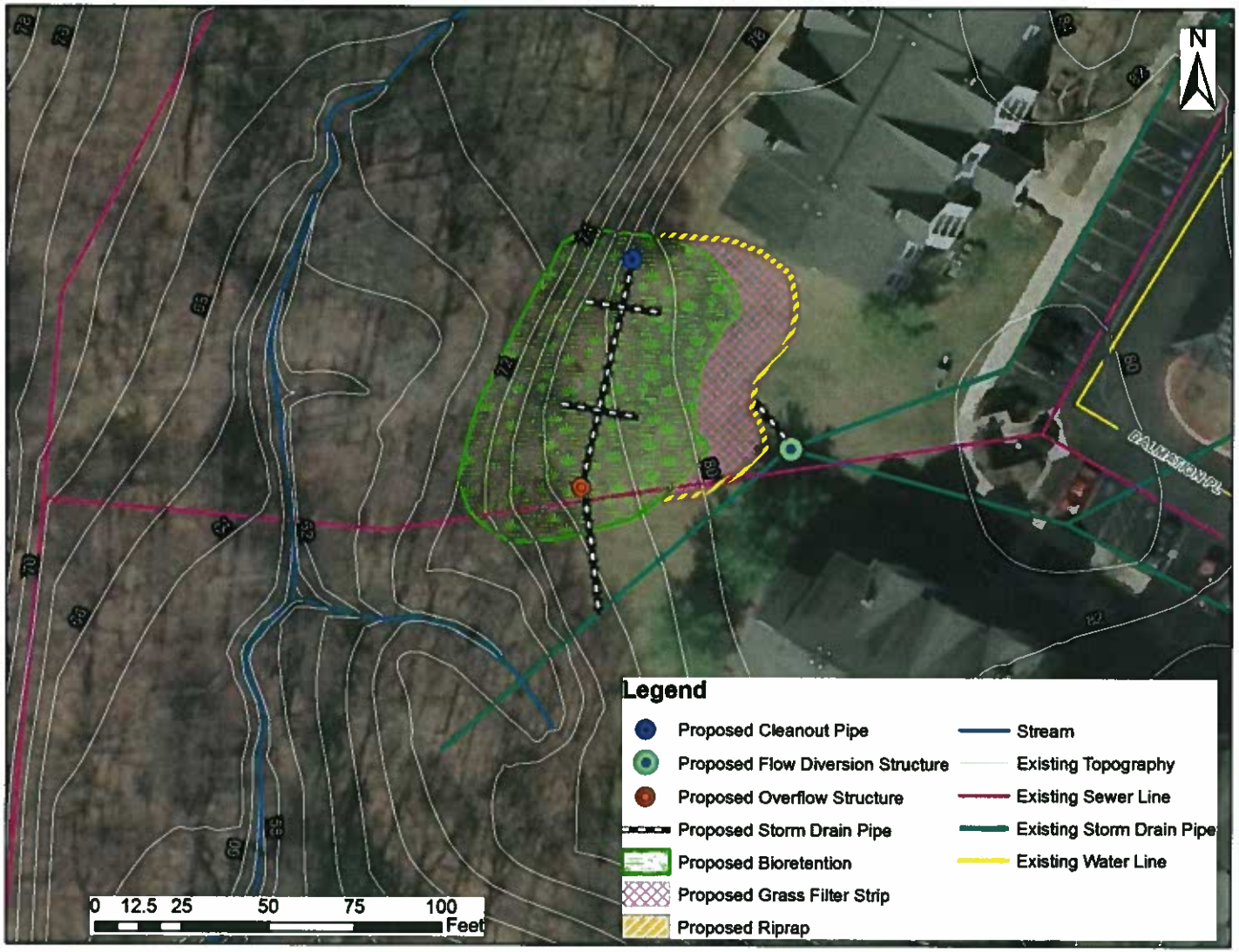


Figure 3-6: Proposed structural stormwater improvement at site D-NS-8

PAGE INTENTIONALLY LEFT BLANK

D-NS-12 (High Priority)

Site ID: D-NS-12	
Drainage area	0.9 acre
Impervious area	0.9 acre
WQv	0.1 acre-foot
CPv	Not Required
Pollutant removal estimate:	
Total nitrogen	5 lbs/yr
Total phosphorus	1 lbs/yr
TSS	251 lbs/yr
Planning-level cost estimate	$39,900
Impervious area treated	0.9 acre

CPv = channel protection volume
TSS = total suspended solids
WQv = water quality volume

Site D-NS-12 has runoff from the eastern portion of the parking lot in Church Creek Elementary School that is captured by a storm drain inlet at the southern end of the parking lot and is eventually conveyed to an onsite infiltration basin.

The proposed improvement consists of implementing a bioretention facility in an open area east of the parking lot, next to a baseball field. The proposed facility would capture and treat the impervious runoff from 0.9 acres of the parking area. The existing storm drain system would be modified and would include the addition of a flow diversion structure that would divert the water quality volume to the project site and divert the remaining flows to the onsite stormwater management facility through storm drains. Tree box filters could be used as an alternative for this site. The project is recommended to be implemented in conjunction with the project at site D-SWM0110 (ES-1). This site was selected as a high priority project by the County and Figure 3-7 shows the detailed structural stormwater improvements at the site.

Proposed open area for bioretention

The project site has good access from the parking lot of the elementary school.

PAGE INTENTIONALLY LEFT BLANK

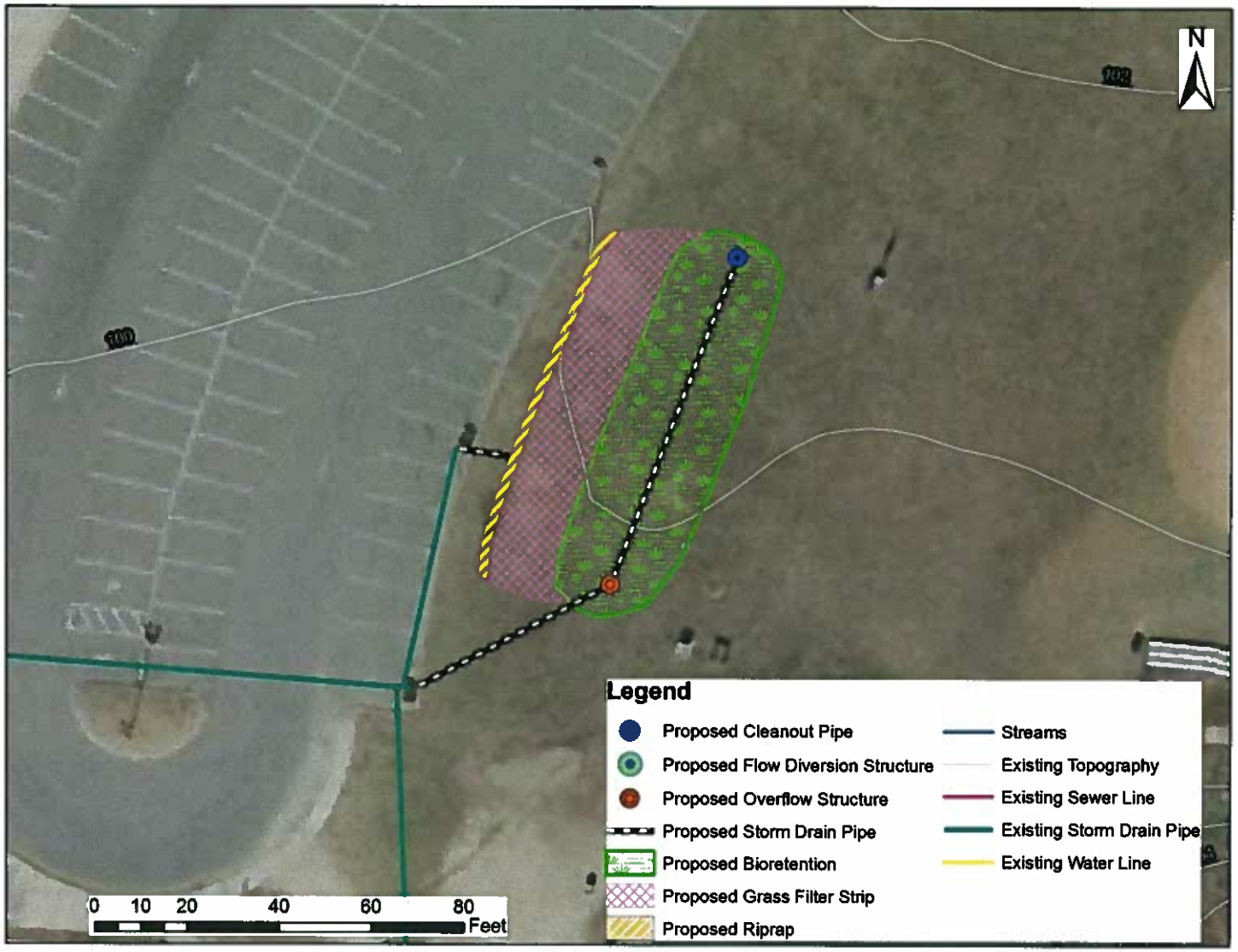
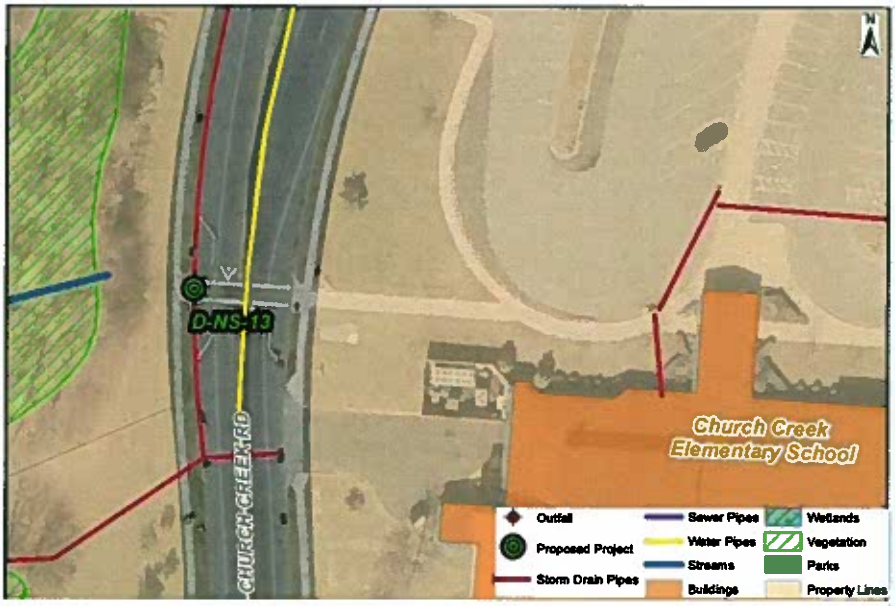


Figure 3-7: Proposed structural stormwater improvement at site D-NS-12

PAGE INTENTIONALLY LEFT BLANK

D-NS-13 (High Priority)

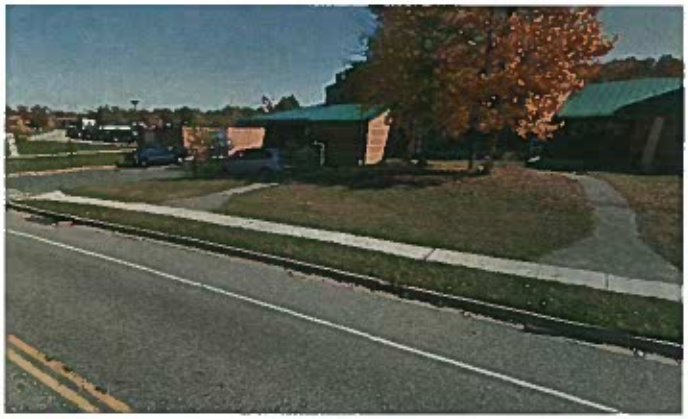


Site ID: D-NS-13	
Drainage area	0.9 acre
Impervious area	0.8 acre
WQv	0.1 acre-foot
CPv	0.1 acre-foot
Pollutant removal estimate:	
Total nitrogen	4 lbs/yr
Total phosphorus	1 lb/yr
TSS	204 lbs/yr
Planning-level cost estimate	$140,900
Impervious area treated	0.8 acre

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

Site D-NS-13 is a section of Church Creek Road between Baneberry Drive and Germander Drive across from Church Creek Elementary School. The site has sidewalks with grassed areas that (combined) are approximately 10 feet wide on either side of the road. The roadway has storm drain inlets that capture runoff during storm events and discharge to the water quality trap at site D-ES-7.

The proposed improvement consists of retrofitting the existing grassed area between the road and the sidewalks to include bioretention facilities that would capture and treat the runoff from the road before discharging it to the water quality trap at site D-ES-7. The project would reduce the volume of runoff conveyed to site D-ES-7, thereby improving the performance of the water quality trap.



Potential area for green street bump out

The project site is accessible from Church Creek Road. A water line which runs through the middle of the road may be impacted during project implementation. This site was selected as a high priority project by the County and Figure 3-8 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

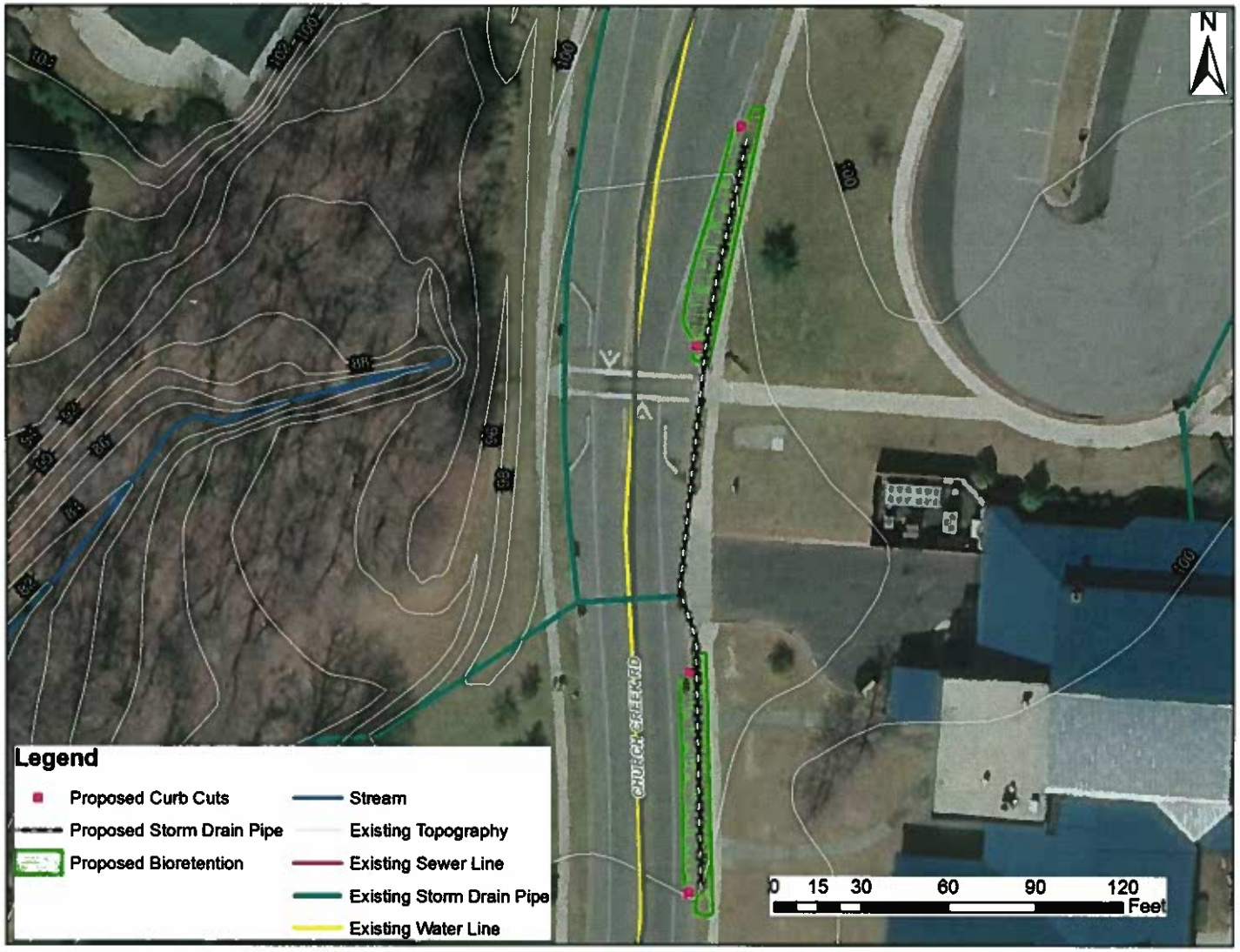
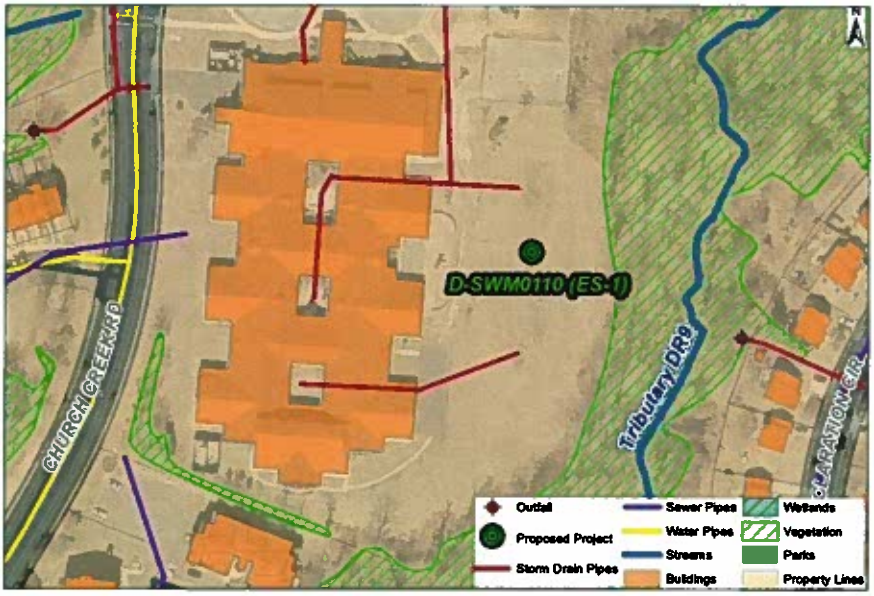


Figure 3-8: Proposed structural stormwater improvement at site D-NS-13

PAGE INTENTIONALLY LEFT BLANK

D-SWM0110 (ES-1) (High Priority)



Site ID: D-SWM0110 (ES-1)	
Drainage area	8.2 acres
Impervious area	4.4 acres
WQv	0.4 acre-foot
CPv	0.5 acre-foot
Pollutant removal estimate:	
Total nitrogen	57 lbs/yr
Total phosphorus	10 lbs/yr
TSS	1,682 lbs/yr
Planning-level cost estimate	$207,200
Impervious area treated	4.4 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

According to the County-provided GIS data and design plans, the existing stormwater management facility at site D-SWM0110 (ES-1) was designed in 1994 as an infiltration basin that would capture runoff from the parking lot and rooftop of Church Creek Elementary School.

The proposed improvement consists of retrofitting the facility to meet the new Maryland stormwater management standards by planting the basin area with wetland plants with high pollutant removal efficiencies. It is recommended to implement this project in conjunction with the project at site D-NS-12.

Another potential retrofit option for this facility is to convert it to a shallow pocket wetland; however, safety features such as fence around the facility are recommended if this option is chosen.

Existing infiltration basin

The facility has good access from the parking lot of the elementary school. This site was selected as a high priority project by the County and Figure 3-9 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

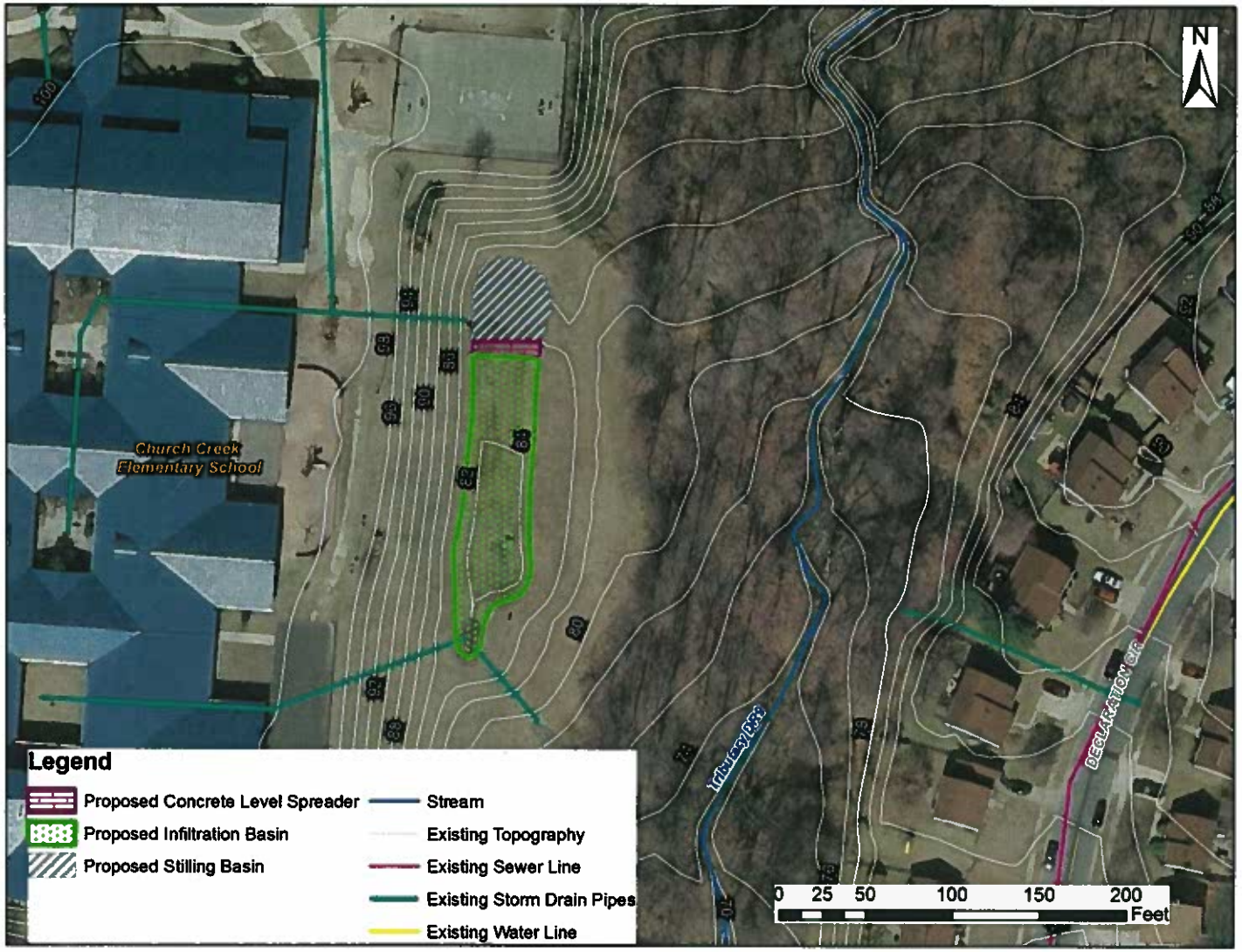
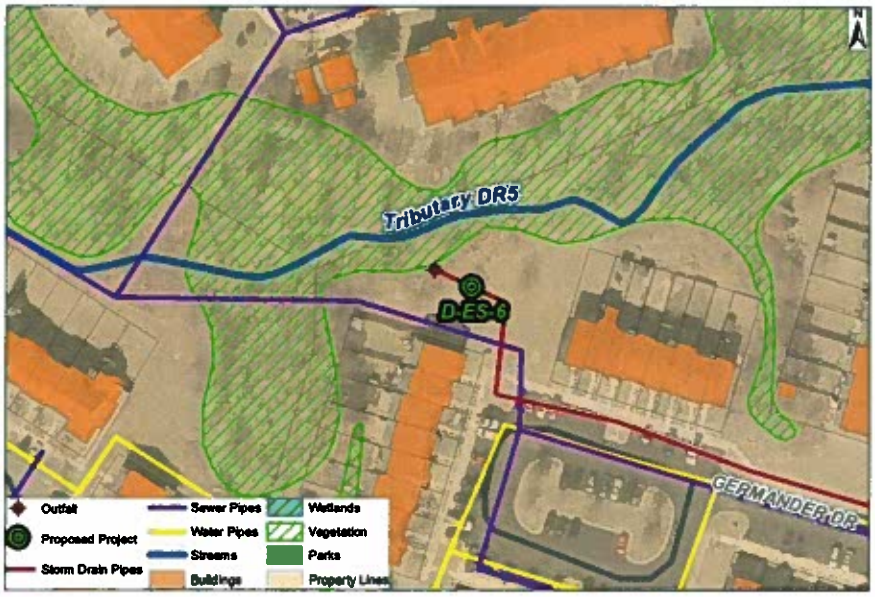


Figure 3-9: Proposed structural stormwater improvement at site D-SWM0110 (ES-1)

PAGE INTENTIONALLY LEFT BLANK

D-ES-6 (Medium Priority)



Site ID: D-ES-6	
Drainage area	3.4 acres
Impervious area	1.6 acres
WQv	0.1 acre-foot
CPv	0.3 acre-foot
Pollutant removal estimate:	
Total nitrogen	20 lbs/yr
Total phosphorus	4 lbs/yr
TSS	742 lbs/yr
Planning-level cost estimate	$80,400
Impervious area treated	up to 1.6 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing facility at site D-ES-6 is a water quality trap in the Homeowners Association (HOA) property at the end of Germander Drive. The facility was identified from the design plans provided by the County as a part of data collection and review for field reconnaissance. The facility was designed in 1991to capture stormwater runoff from the high-density residential area along Germander Drive. An 18-inch outfall pipe captures the runoff and conveys it to the facility. Some trash and debris were observed at the facility during the field reconnaissance.

The proposed improvement consists of implementing a bioretention facility in the available open space on the HOA property. The outfall pipe would be modified to include a flow diversion structure that would divert the water quality volume to the proposed bioretention facility and the remaining flows to the existing water quality trap before eventually flowing into Tributary DR5.

The project site is accessible from the parking lot on Germander Drive. A sanitary sewer line is adjacent to the project site, but proposed project would not affect it.

Existing outfall at end of Germander Drive

D-ES-12 (Medium Priority)

Site ID: D-ES-12	
Drainage area	1.8 acres
Impervious area	1.0 acre
WQv	0.1 acre-foot
CPv	0.1 acre-foot
Pollutant removal estimate:	
Total nitrogen	13 lbs/yr
Total phosphorus	2 lbs/yr
TSS	407 lbs/yr
Planning-level implementation cost	$63,000
Impervious area treated	up to 1.0 acre

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

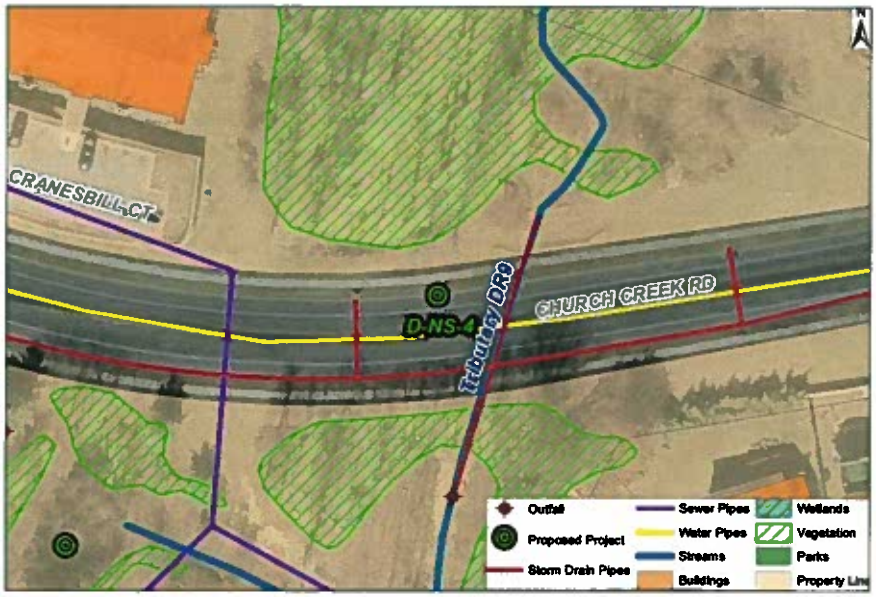
The existing facility at site D-ES-12 is a water quality trap downstream of a 21-inch RCP at the end of Marigold Lane. The facility was identified from the design plans provided by the County and was designed in 1999 to capture stormwater runoff from a single-family residential area along Marigold Lane. At the time of field reconnaissance, ponded water was observed at the inlet to the facility, and animal burrows were observed along the embankment.

The proposed improvement consists of retrofitting the facility to include a micropool area with wetland plantings that would provide some water quality treatment for the runoff before it is conveyed to Declaration Run.

The project site is accessible from Marigold Lane. A few 6- to 12-inch-diameter trees along the edges of the facility may be affected.

Existing water quality trap

D-NS-4 (Medium Priority)



Site ID: D-NS-4	
Drainage area	2.1 acres
Impervious area	1.6 acres
WQv	0.1 acre-foot
CPv	0.3 acre-foot
Pollutant removal estimate:	
Total nitrogen	15 lbs/yr
Total phosphorus	2 lbs/yr
TSS	529 lbs/yr
Planning-level cost estimate	$300,900
Impervious area treated	up to 1.6 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The D-NS-4 site is a section of Church Creek Road between Declaration Circle and Cranesbill Court that has wide sidewalks with grassed areas that are (combined) approximately 10-feet wide on either side of the road. The roadway has storm drain inlets that capture runoff during storm events and convey to Declaration Run.

The proposed improvement consists of retrofitting the wide grassed areas between the sidewalks and road right-of-way to include a green street bump out, a curb extension area that will include as a bioretention system. The system would capture and treat runoff from the road before discharging it into the storm drain system.

The project site is accessible from Church Creek Road. Water and sewer lines are located along the roadway and may be affected during project implementation.

Potential area for green street bump out

D-ES-5 (Low Priority)

Site ID: D-ES-5	
Drainage area	8.9 acres
Impervious area	2.8 acres
WQv	0.2 acre-foot
CPv	0.4 acre-foot
Pollutant removal estimate:	
Total nitrogen	63 lbs/yr
Total phosphorus	12 lbs/yr
TSS	1,740 lbs/yr
Planning-level cost estimate	$140,000
Impervious area treated	up to 2.8 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

According to County data, the existing facility at site D-ES-5 is an extended detention basin that was designed in 1992 to capture stormwater runoff from residential area along Foxglove Court and Lobelian Lane. However, the basin could not be located during the field reconnaissance, but a 20-inch × 28-inch reinforced concrete pipe (RCP) outfall was observed. The outfall conveyed runoff to a riprap area.

The proposed improvement consists of implementing a bioretention facility at the outfall area to capture and treat runoff from the adjacent residential area. The existing storm drain system could be modified to add a flow diversion structure to divert the water quality volume to the proposed bioretention facility and divert the remaining flows to the forested area before eventually flowing into Declaration Run.

Existing Outfall with riprap area

The project site is adjacent to residential housing and is accessible from the open area between the houses along Foxglove Court. Mature trees with more than 12 inches in diameter around the project site may be affected.

D-NS-3 (Low Priority)

Site ID: D-NS-3	
Drainage area	0.1 acre
Impervious area	0.1 acre
WQv	0.01 acre-foot
CPv	Not Required
Pollutant removal estimate:	
Total nitrogen	0.5 lb/yr
Total phosphorus	0.1 lb/yr
TSS	21 lbs/yr
Planning-level cost estimate	$78,800
Impervious area treated	up to 0.1 acre

CPv = channel protection volume
TSS = total suspended solids
WQv = water quality volume

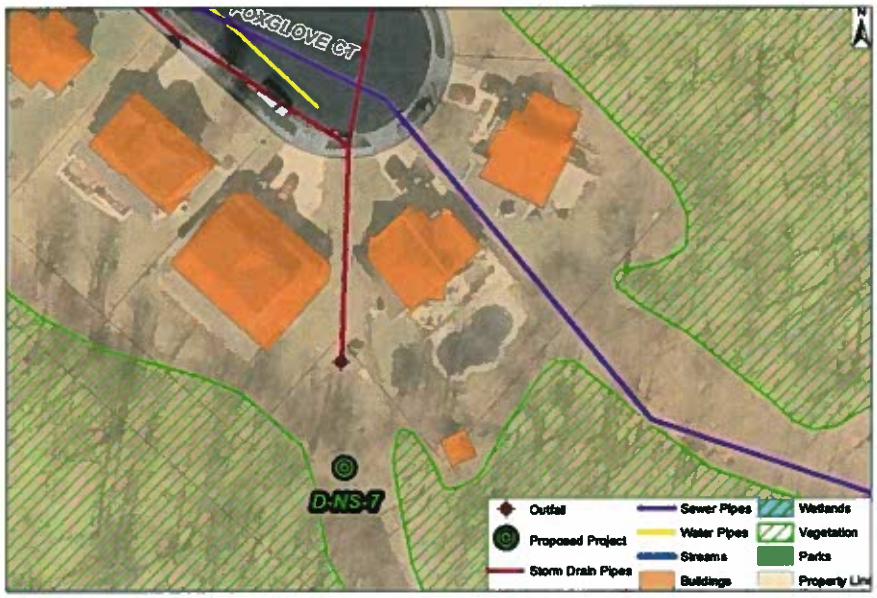
Site D-NS-3 has parking areas that are covered with sloping roofs in a high-density residential area on Liriope Court. The parking lot roofs have a total impervious area of 0.1 acre.

The proposed improvement consists of adding vegetation to the roofs in the parking lot to promote precipitation uptake by the plants and reduce the amount of impervious runoff.

The project site is accessible from the parking lot of Liriope Court.

Covered parking areas for potential vegetated roofs

D-NS-7 (Low Priority)



Site ID: D-NS-7	
Drainage area	6.0 acres
Impervious area	2.1 acres
WQv	0.2 acre-foot
CPv	0.2 acre-foot
Pollutant removal estimate:	
Total nitrogen	43 lbs/yr
Total phosphorus	8 lbs/yr
TSS	1,203 lbs/yr
Planning-level cost estimate	$363,300
Impervious area treated	up to 2.1 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

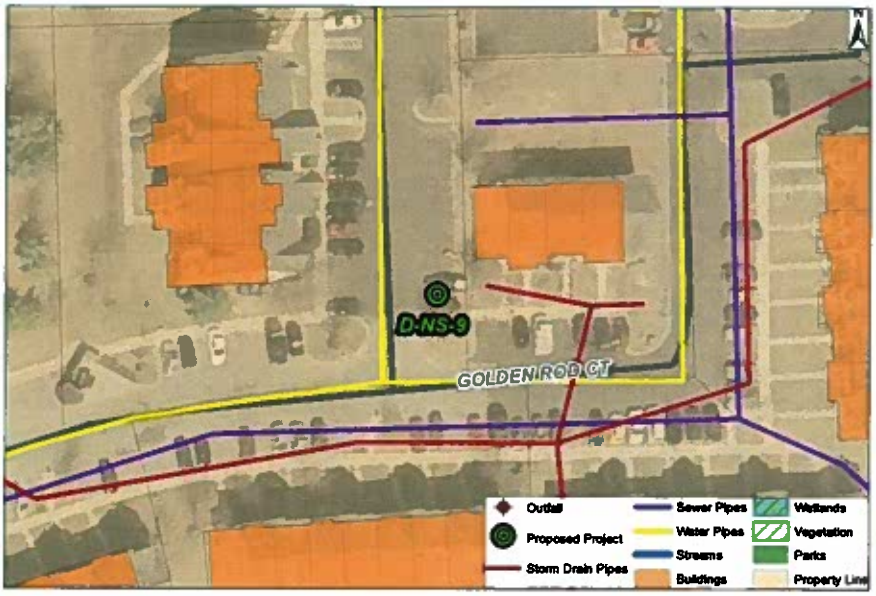
Site D-NS-7 has an existing 24-inch RCP that captures runoff from a single-family residential neighborhood along a portion of Foxglove Court and Liatris Lane. The RCP conveys to Tributary DR8. Some trash was observed downstream of the outfall during the field reconnaissance.

The proposed improvement consists of installing a step pool conveyance system downstream of the outfall pipe. The proposed facility would include surface pools and subsurface sand seepage filter that would treat and infiltrate the stormwater. Removal of trash downstream of the outfall is also recommended.

The project site is accessible from open area between the single-family houses at the end Foxglove Court. Some mature trees around the project site would be affected during project implementation.

Existing outfall at end of Foxglove Court

D-NS-9 (Low Priority)



Site ID: D-NS-9	
Drainage area	6.3 acres
Impervious area	3.6 acres
WQv	0.3 acre-foot
CPv	0.5 acre-foot
Pollutant removal estimate:	
Total nitrogen	26 lbs/yr
Total phosphorus	5 lbs/yr
TSS	1,358 lbs/yr
Planning-level cost estimate	$180,000
Impervious area treated	up to 3.6 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

Site D-NS-9 has impervious surface runoff from the buildings and parking lot in a high-density residential area on Golden Rod Court. The runoff is captured by six storm drain inlets along the edges of the parking lot.

The proposed improvement consists of retrofitting six existing storm drain inlets with tree box filters that would provide water quality treatment for the runoff from the impervious area by removing pollutants and sediment.

The project site is accessible from the parking lot on Golden Rod Court. The existing sewer lines along the edge of the parking lot may be affected during project implementation.

Existing storm drain inlet

Proposed Stormwater Structural Projects in the Riverside Watershed

A summary of the proposed stormwater structural improvements in the Riverside watershed is shown in Tables 3-3 and 3.4. The locations of these sites are shown in Figure 3.1.

Table 3-3: List of Proposed Stormwater Structural Projects in the Riverside Watersheds

Site ID	Proposed Project	Location	County Priority Type
R-ES-1	Upgraded Dry Pond	Halls Chance Road	High
R-NS-1	Bioretention	Belcamp Park	High
R-NS-6	Rain Garden	Winners Circle	Low
R-NS-7	Bioswale and Check Dams	Caldwell Court South	High
R-NS-8	Bioswale and Check Dams	Carlyle Garth	High
R-SWM0491	Filter Strips	West end of Millennium Drive	Low
R-SWM0627	Filter Strips	Millennium Drive	Low

Table 3-4: Summary of Proposed Stormwater Structural Projects in the Riverside Watersheds

Site ID	Proposed Project	Cost	Pollutant Load Reductions			Impervious Area Treated (acres)	Project Priority
			TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)		
R-ES-1	Upgrade Dry Pond	$2,662,400	219	53	11,347	40.3	High
R-NS-1	Bioretention	$85,728	66	13	1,695	1.7	High
R-NS-7	Bioswale and Check Dams	$555,400	554	115	15,511	3.5	High
R-NS-8	Bioswale and Check Dams	$31,000	19	3	734	0.7	High
R-NS-6	Rain Garden	$10,900	15	3	371	Up to 0.2	Low
R-SWMM0491	Filter Strips	$80,800	42	8	1,549	Up to 3.1	Low
R-SWM0627	Filter Strips	$87,100	37	7	1,525	Up to 3.3	Low

PAGE INTENTIONALLY LEFT BLANK

R-ES-1 (High Priority)

Site ID: R-ES-1	
Drainage area	130.4 acres
Impervious area	40.3 acres
WQv	3.6 acre-feet
CPv	7.4 acre-feet
Pollutant removal estimate:	
Total nitrogen	219 lbs/yr
Total phosphorus	53 lbs/yr
TSS	11,347 lbs/yr
Planning-level cost estimate	$2,662,400
Impervious area treated	40.3 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing facility at site R-ES-1 is a large dry pond that captures runoff from approximately 130 acres of the Riverside watershed. The facility was identified from the design plans provided by the County as a part of data collection and review for field reconnaissance. The facility was designed in 1981 as a detention pond with a corrugated metal pipe riser structure to capture large storm events. At the time of the field reconnaissance, the pond appeared to be overgrown with a large number of mature trees. The runoff is conveyed to the pond through two RCP pipes and a swale system. One RCP pipe has a 48-inch diameter, and the other has an 18-inch diameter.

The proposed improvement consists of upgrading the pond to the current Maryland stormwater management standards, which would involve implementing forebay areas at the two RCP inlets and at the swale inlet to provide water quality treatment for the captured runoff. The proposed project would also include replacing an existing riser with a new concrete riser.

Existing facility and CMP riser

The facility is accessible from the easement on Greys Run Circle where construction equipment could be parked. Implementation of the retrofit would involve removing large number of trees with a more than 12-inch diameter. This site was selected as a high priority project by the County and Figure 3-10 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

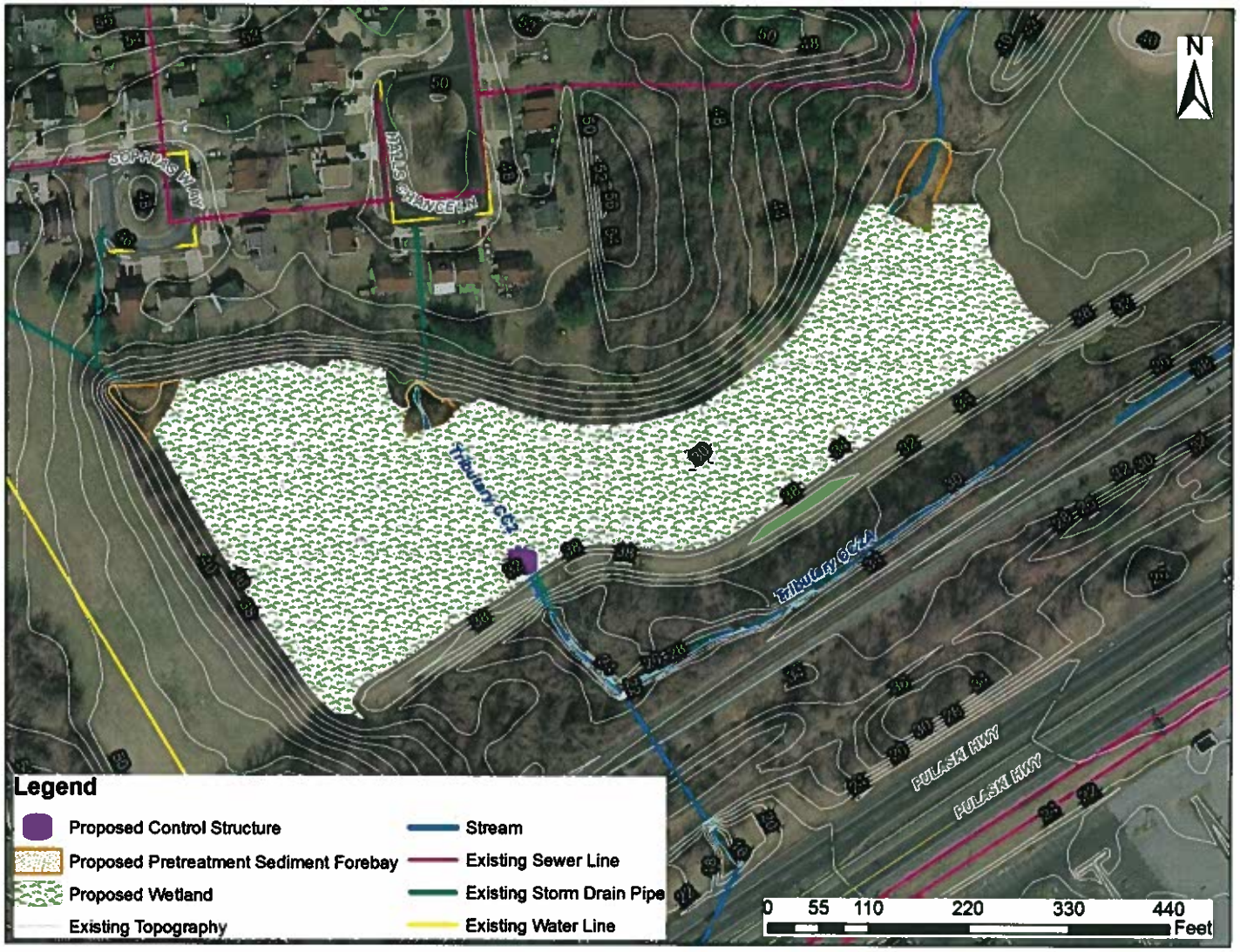
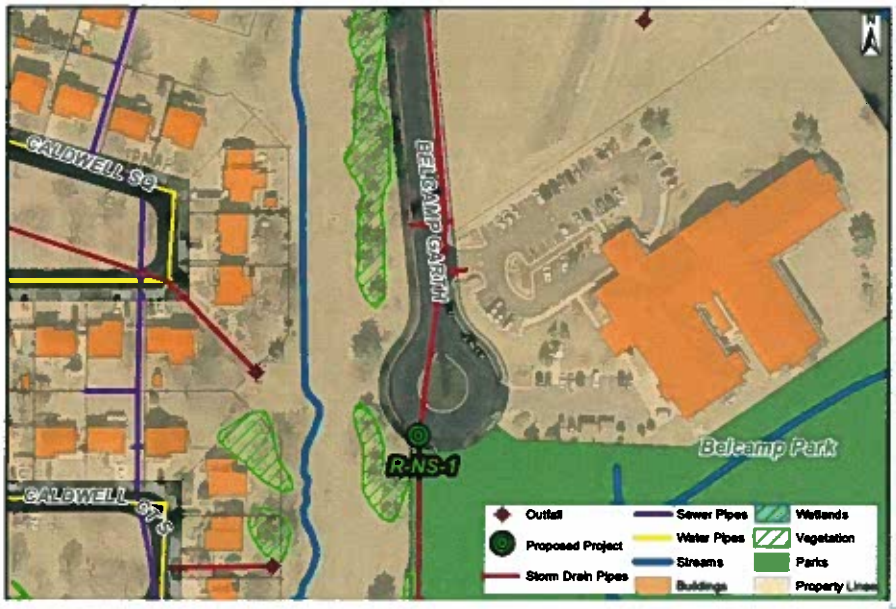


Figure 3-10: Proposed structural stormwater improvement at site R-ES-1

PAGE INTENTIONALLY LEFT BLANK

R-NS-1 (High Priority)



Site ID: R-NS-1	
Drainage area	5.5 acres
Impervious area	1.7 acres
WQv	0.2 acre-foot
CPv	0.4 acre-foot
Pollutant removal estimate:	
Total nitrogen	66 lbs/yr
Total phosphorus	13 lbs/yr
TSS	1,695 lbs/yr
Planning-level cost estimate	$85,728
Impervious area treated	1.7 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

Site R-NS-1 has an existing storm drain inlet at the end of Belcamp Garth at the Riverside Lorien Nursing Home that captures runoff from the parking lot and a part of the rooftop and conveys it to the dry pond at site R-ES-1 through a swale.

The proposed improvement consists of implementing a bioretention facility at the open space adjacent to the inlet. The existing storm drain system would be modified to divert the water quality volume to the proposed bioretention and divert the remaining flows to the swale and eventually to the dry pond at site R-ES-1.

Existing inlet that captures stormwater runoff

The project site is accessible from Belcamp Garth. Implementation of the project would involve removal of few trees with 6-inch to 12-inch located in the project area. This site was selected as a high priority project by the County and Figure 3-11 shows the detailed structural stormwater improvements at the site.

PAGE INTENTIONALLY LEFT BLANK

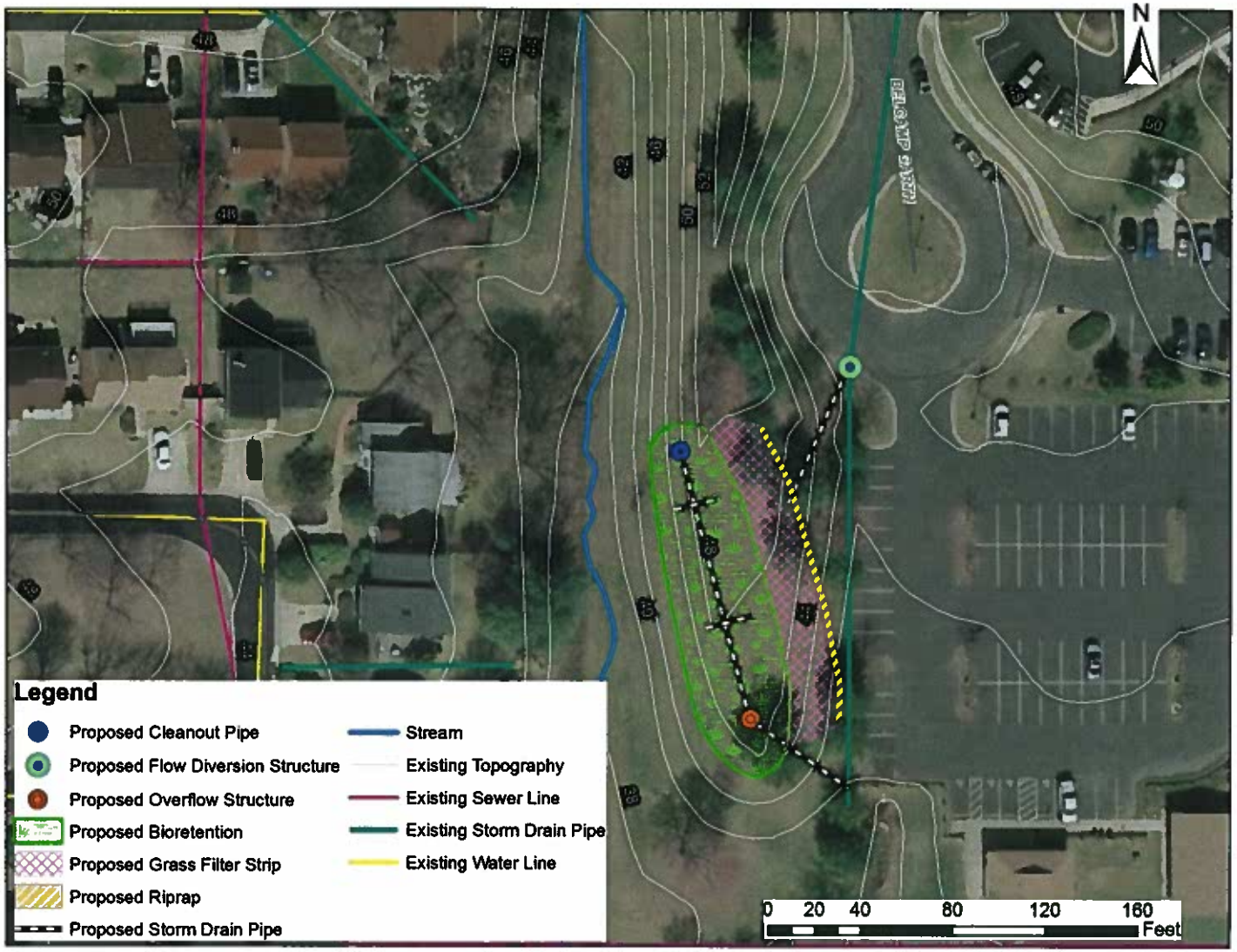
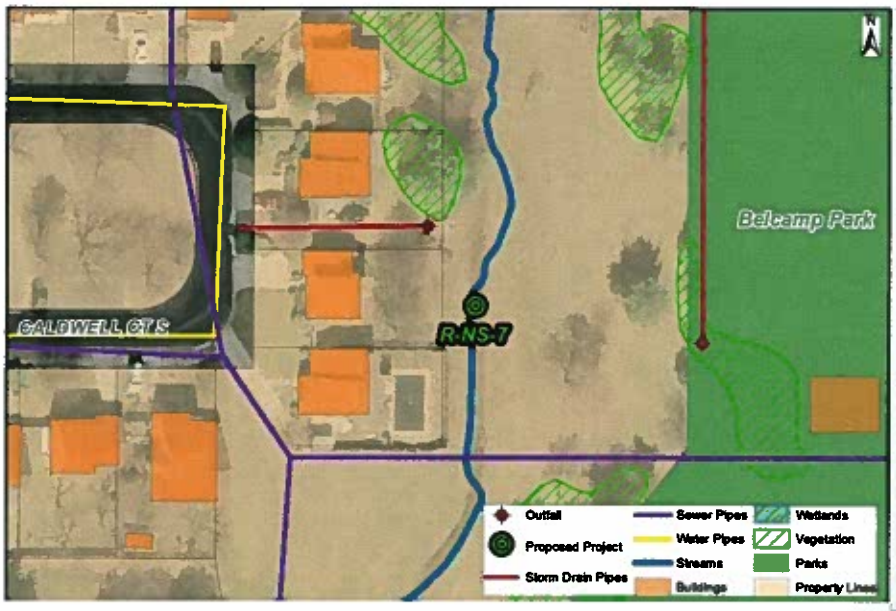


Figure 3-11: Proposed structural stormwater improvement at site R-NS-1

PAGE INTENTIONALLY LEFT BLANK

R-NS-7 (High Priority)



Site ID: R-NS-7

Drainage area	64.3 acres
Impervious area	21.4 acres
WQv	1.9 acre-feet
CPv	4.2 acre-feet
Pollutant removal estimate:	
Total nitrogen	554 lbs/yr
Total phosphorus	115 lbs/yr
TSS	15,511 lbs/yr
Planning-level cost estimate	$555,400
Impervious area treated	3.5 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

The existing 1,100-foot swale at site R-NS-7 captures and conveys runoff to the dry pond at site R-ES-1. The swale receives runoff from three RCP outfalls.

The proposed improvement consists of converting the existing swale to a bioswale that would capture and treat the runoff from the three outfall pipes. Pretreatment forebays are recommended at each outfall to treat some portion of the runoff before discharging into the swale. Check dams are recommended to reduce erosion and promote detention.

The project site can be accessed from Caldwell Court South or from Belcamp Garth. There is an existing sewer line that runs through the swale that may impact project implementation. This site was selected as a high priority project by the County and Figure 3-12 shows the detailed structural stormwater improvements at the site.

Swale behind Caldwell Court

PAGE INTENTIONALLY LEFT BLANK

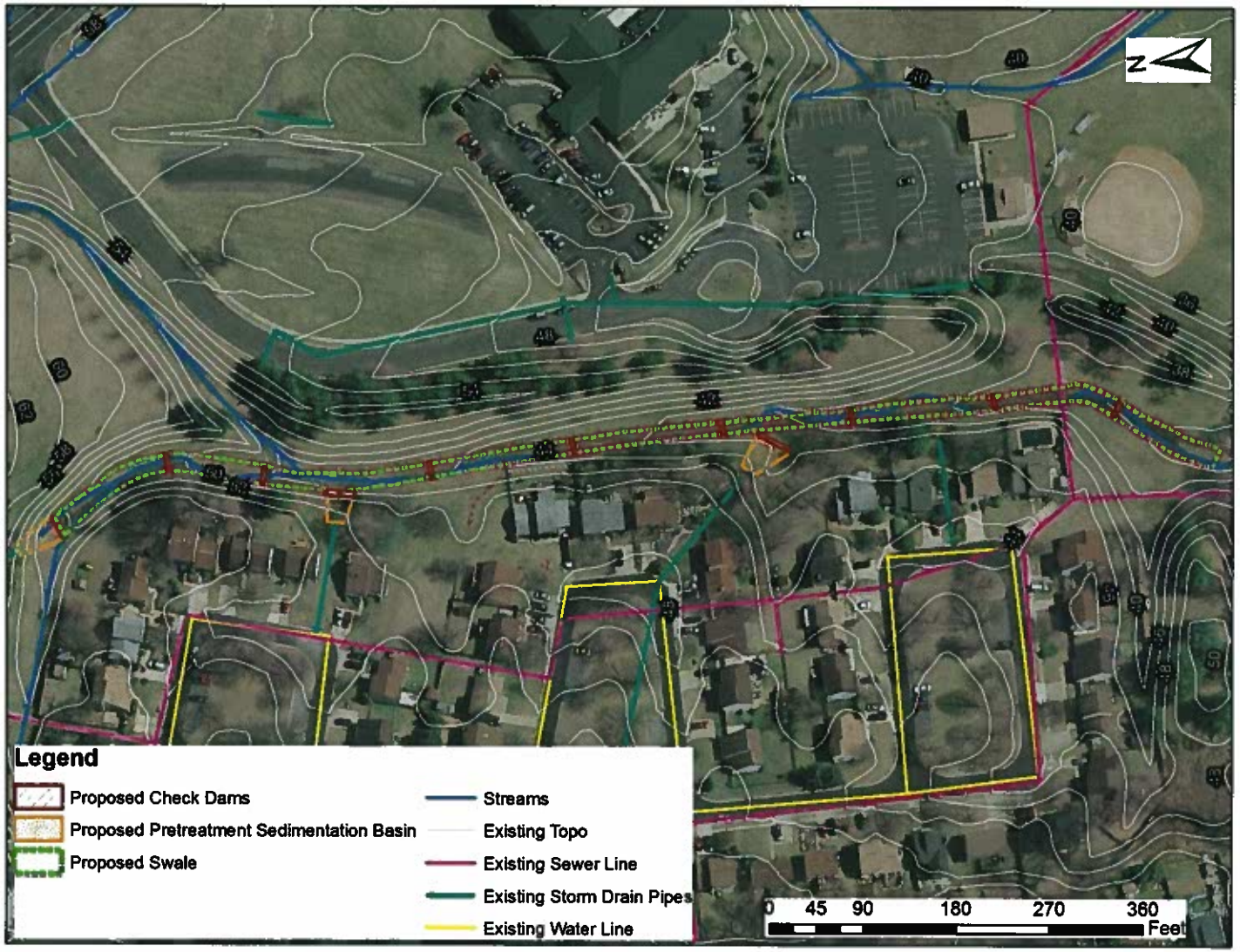


Figure 3-12: Proposed structural stormwater improvement at site R-NS-7

PAGE INTENTIONALLY LEFT BLANK

R-NS-8 (High Priority)

Site ID: R-NS-8	
Drainage area	1.8 acres
Impervious area	0.7 acre
WQv	0.9 acre-foot
CPv	0.1 acre-foot
Pollutant removal estimate:	
Total nitrogen	19 lbs/yr
Total phosphorus	3 lbs/yr
TSS	734 lbs/yr
Planning-level cost estimate	$31,000
Impervious area treated	0.7 acre

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

At site R-NS-8, approximately 400 feet of swale captures impervious runoff from houses along Carlyle Garth from an 18-inch-diameter RCP and discharges to a dry pond at site R-ES-1.

The proposed improvement consists of converting the existing swale to a bioswale that would provide water quality treatment to the runoff captured from the outfall pipe. A pretreatment forebay is recommended at the outfall to provide some treatment to the runoff before discharging into the swale. Check dams are recommended to reduce erosive velocities and allow pollutants and sediment to settle.

The project site can be accessed from Carlyle Garth. There is an existing sewer line that runs through the swale that might be impacted during project implementation. Figure 3-13 shows the detailed structural stormwater improvements at the site.

Swale behind Carlyle Garth

PAGE INTENTIONALLY LEFT BLANK

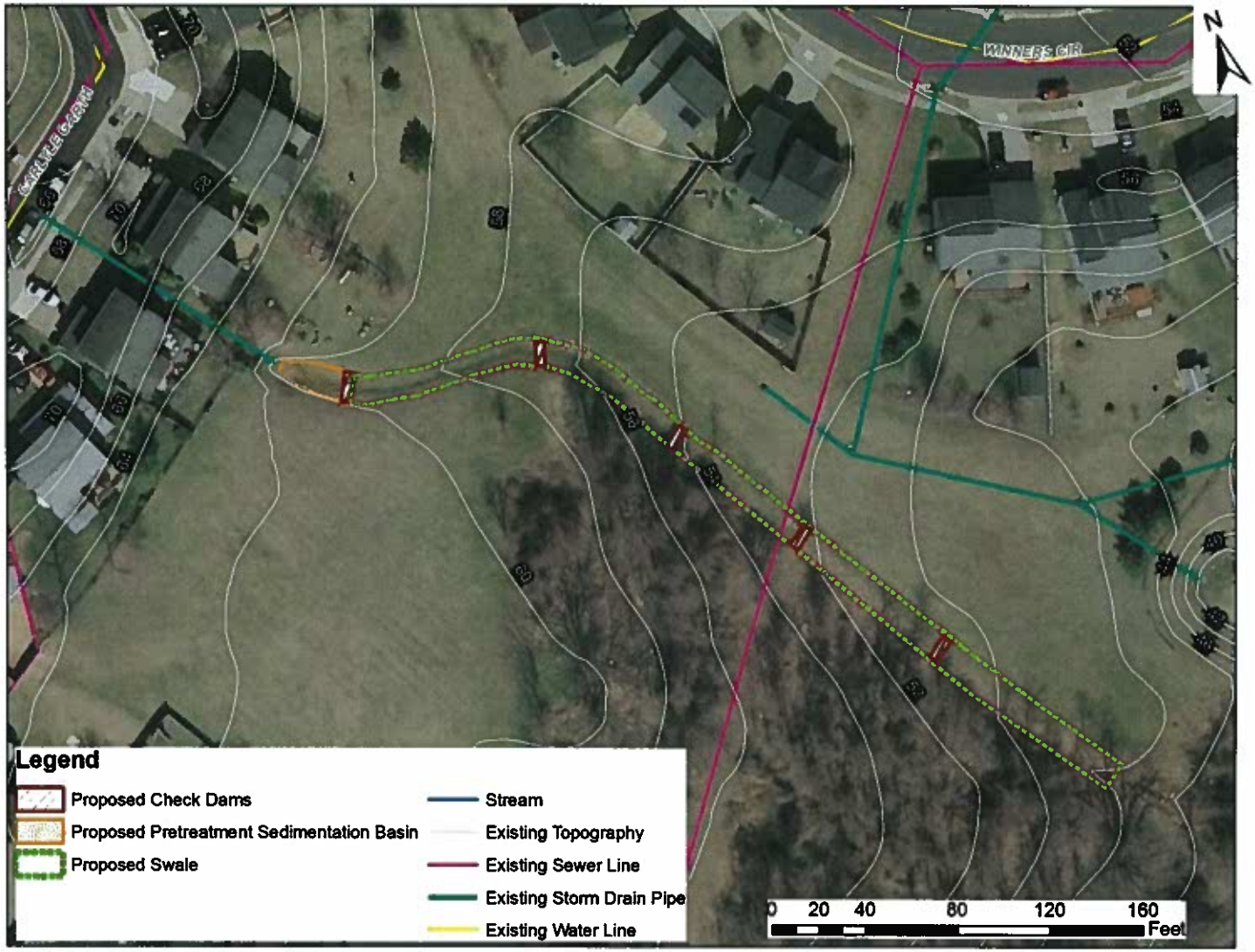


Figure 3-13: Proposed structural stormwater improvement at site R-NS-8

PAGE INTENTIONALLY LEFT BLANK

R-NS-6 (Low Priority)

Site ID: R-NS-6	
Drainage area	1.3 acres
Impervious area	0.2 acre
WQv	0.2 acre-foot
CPv	Not Required
Pollutant removal estimate:	
Total nitrogen	15 lbs/yr
Total phosphorus	3 lbs/yr
TSS	371 lbs/yr
Planning-level cost estimate	$10,900
Impervious area treated	up to 0.2 acre

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

At site R-NS-6, the existing HOA open area between the homes on Winner's Circle has two yard inlets that capture runoff from rooftops of the houses.

The proposed improvement consists of implementing a rain garden in the HOA open area between the single-family homes to infiltrate the runoff and provide water quality treatment.

The project site can be accessed from either Greys Run Circle or Winners Circle.

Existing yard inlet

R-SWM0491 (Low Priority)

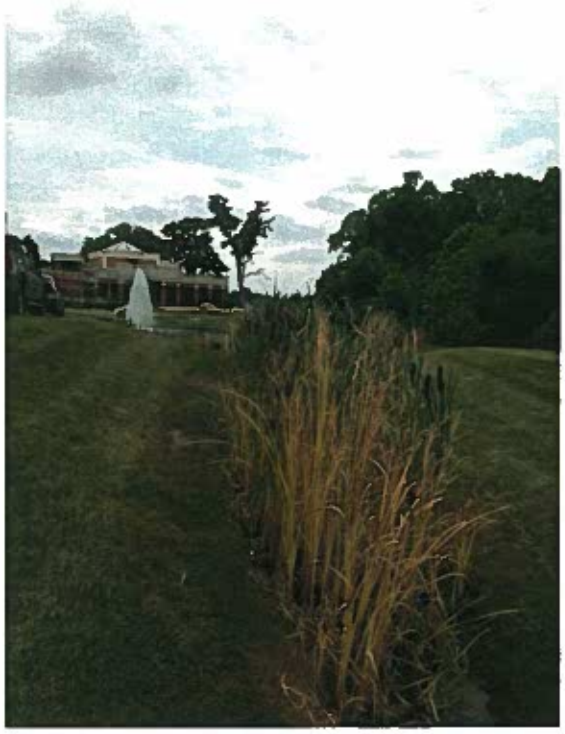
Site ID: R-SWM0491	
Drainage area	4.9 acres
Impervious area	3.1 acres
WQv	0.3 acre-foot
CPv	0.5 acre-foot
Pollutant removal estimate:	
Total nitrogen	42 lbs/yr
Total phosphorus	8 lbs/yr
TSS	1,549 lbs/yr
Planning-level cost estimate	$80,800
Impervious area treated	up to 3.1 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

According to the County GIS data and design plans for site R-SWM0491, runoff from the parking lot and building in the office complex on Millennium Drive is captured by a series of swales that outfall to a pond. Some erosion was observed in the swales.

The proposed improvements consist of installing filter strips on either side of the swale in the parking lot to reduce erosion and retrofitting the swale to the pond with check dams to reduce erosion and promote settling of nutrients and sediment.

The project site can be accessed from the parking lot on Millennium Drive.



Existing Swale that conveys treated runoff to the pond

R-SWM0627 (Low Priority)

Site ID: R-SWM0627	
Drainage area	4.6 acres
Impervious area	3.3 acres
WQv	0.3 acre-foot
CPv	0.5 acre-foot
Pollutant removal:	
Total nitrogen	39 lbs/yr
Total phosphorus	7 lbs/yr
TSS	1,525 lbs/yr
Planning-level cost estimate	$87,100
Impervious area treated	up to 3.3 acres

WQv = Water quality volume
CPv = channel protection volume
TSS = total suspended solids

According to County GIS data and design plans for site R-SWM0627, runoff from the parking lot and four-story office building on Millennium Drive is captured by two grass swales. Erosion was observed along the side slope during the field reconnaissance.

The proposed improvements consist of installing filter strips to reduce erosion and retrofitting the swales with check dams to reduce erosion and promote settling of pollutants and sediment.

The project site can be accessed from the parking lot on Millennium Drive.

Existing swale with filter strips

3.1.2 Proposed Stream Restoration Projects

Streams and riparian buffers in good health offer a variety of benefits such as storage for flood waters, healthy aquatic habitat, and recharge of groundwater. As described in Section 2.4.2, the URS team conducted stream walks of approximately 4 miles of the streams in the Declaration Run and Riverside watersheds to assess stream conditions, bank erosion, streambed degradation, presence of invasive species, and stream buffer concerns. Detailed assessments were conducted for nine stream reaches in Declaration Run watershed. One stream reach in the Riverside watershed was evaluated but determined to be unsuitable for a detailed assessment. Appendix B of this report includes the description of each of these assessments, an overview of the detailed stream assessment performed, proposed restoration measures and cost estimates.

Of the nine stream reaches that were assessed, five were identified as sites for proposed stream restoration projects. The proposed projects are described in sections below.

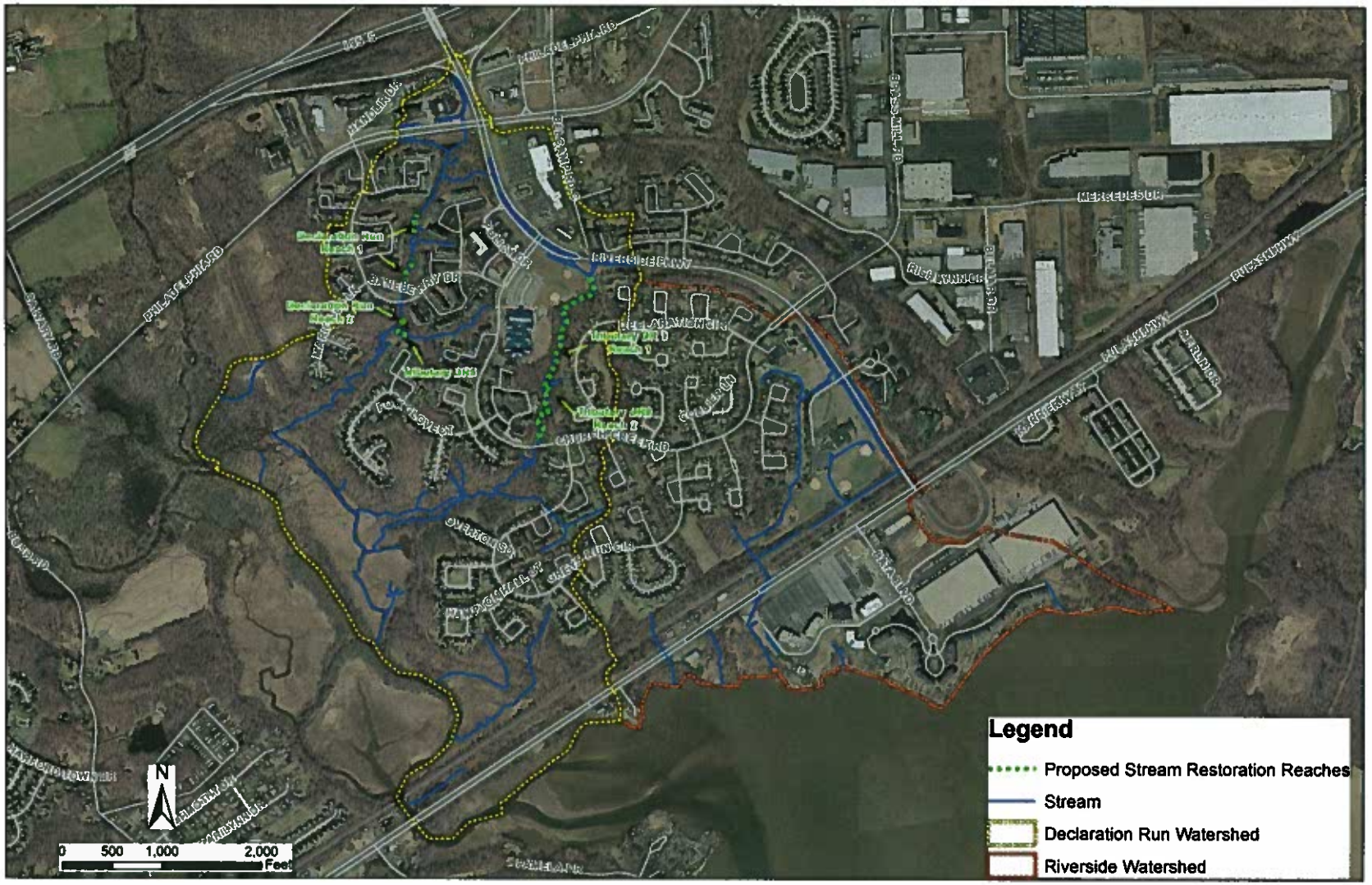


Figure 3-14: Proposed stream restoration projects in study watersheds

PAGE INTENTIONALLY LEFT BLANK

Declaration Run Watershed

As shown in Tables 3-5 and 3-6, the proposed stream restoration projects in the Declaration Run watershed are Declaration Run Reach 1, Tributary DR5, Declaration Run Reach 2, and Tributary DR9 Reaches 1 and 2. The projects are discussed below.

Table 3-5: List of Proposed Stream Restoration Projects in Declaration Run Watershed

Stream Reach ID	Reach ID	Location
Declaration Run	Reach 1	Upstream of Baneberry Drive
Tributary DR5		Downstream of Baneberry Drive and north of and between Arabis Court and Germander Drive
Declaration Run	Reach 2	Downstream of Baneberry Drive, and west of Arabis Court and Foxglove Court
Tributary DR9	Reach 1	Downstream of Riverside Parkway and east of Church Creek Elementary School toward Church Creek Road
Tributary DR9	Reach 2	Downstream of Church Creek Elementary School and upstream of Church Creek Road

PAGE INTENTIONALLY LEFT BLANK

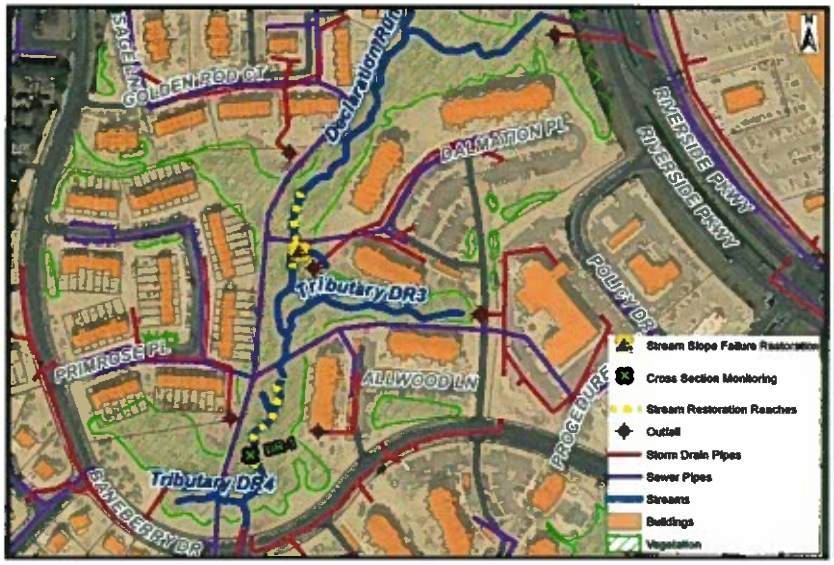
Table 3-6: Summary of Proposed Stream Restoration Projects in Declaration Run

Stream ID	Proposed Project	Cost	Pollutant Load Reductions			Equivalent Impervious Area Treated (acres)	Project Priority
			TN (lbs/year)	TP (lbs/year)	TSS (lbs/year)		
Declaration Run Reach 1	Remediating two headcuts by installing riffle grade control structures or step pools	$296,522	7	1	918	3.6	High
Tributary DR5	Correcting minor headcut with grade control structures and remediating a slope failure at a storm drain outfall	$175,576	2	0.4	306	1.2	High
Declaration Run Reach 2	Outfall stabilization	$92,290	N/A	N/A	N/A	N/A	High
Tributary DR9 Reach 1 and Tributary DR9 Reach 2	Stabilizing the stream bed banks, removing a failed in-stream stormwater management feature, grade and stabilize high stream banks, remediating three headcuts, and remediating a failed storm drain outfall	$836,605	45	8	5,738	19	High

N/A- MDE guidance not available for pollutant load reductions and impervious area treated for outfall stabilization

PAGE INTENTIONALLY LEFT BLANK

Declaration Run Reach 1



Declaration Run Reach 1:

Restoration Length: 360 feet

Grade Control: 12 structures

Outfall Stabilization: 1 site

Pollutant removal:

Total nitrogen	7 lbs/yr
Total phosphorus	1 lbs/yr
TSS	918 lbs/yr

Planning-level cost estimate $296,522

Equivalent impervious area treated 3.6 acres

The Declaration Run Reach1 project is north (upstream) of Baneberry Drive and extends upstream to Riverside Parkway and Maryland Route (MD) 7. The stream is highly degraded, and stream conditions are highly variable. Just upstream of Baneberry Drive, the stream is somewhat incised with 3- to 4-foot-high banks. Farther upstream, the channel becomes deeply incised, extending up to an 8-foot-deep headcut. Above the headcut, the stream is only 1- to 2-feet deep but contains a heavy load of sand and gravel. Farther upstream, toward the headwaters, the stream becomes incised again, with 4-foot-high banks. There is a slope failure at a storm drain outfall opposite Dalmation Place and another headcut farther upstream in the stream channel. The Declaration Run Reach 1 site is rated a high-priority for restoration.

This 8 foot deep headcut will be remediated by the proposed project.

Recommended stream restoration at Declaration Run Reach 1 includes remediating two headcuts; one approximately 4 feet deep and the other one approximately 8 feet deep. Measures to remediate headcuts include installing riffle grade control structures or step pools. The stream channel is narrow, making it more conducive to rock riffles than step pools.

Constructed riffles typically have slopes ranging from 15:1 (6.7 percent) to 20:1 (5 percent). Assuming a 5 percent slope on the riffle and a 1-foot drop per riffle, each riffle would be 20-feet long. Riffles are typically spaced 5 to 7 bankfull widths apart. At a stream width of 6 feet and

riffle spacing at 5 bankfull widths apart (30 feet), each foot of headcut drop would require a stream length of 30 feet (20 feet of riffle plus 10 additional feet to make up the 30-foot spacing).

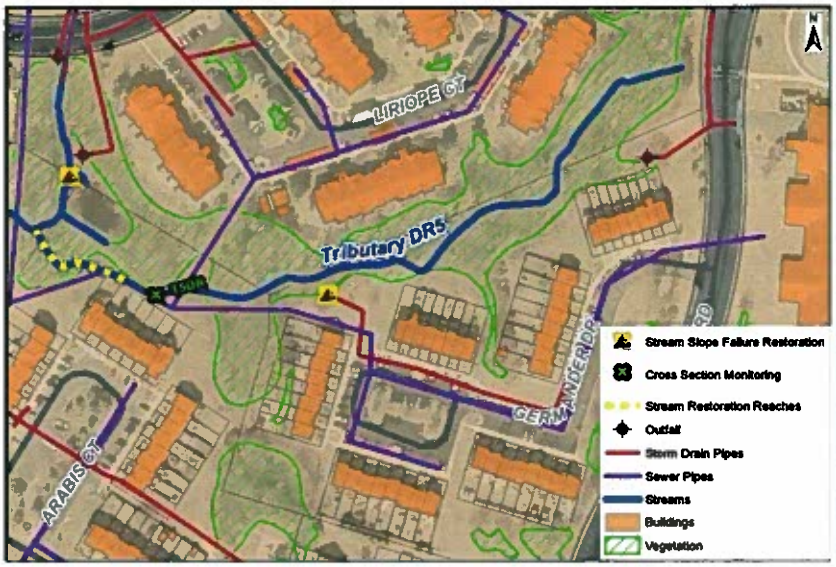
Therefore, the 4-foot-deep headcut at this stream would require 4 riffle grade control structures and 120 feet of stream restoration, and the 8-foot-deep headcut would require 8 riffle grade control structures and 240 feet of stream restoration. The rock used in the grade control structures would extend up to the top of the bank, thereby stabilizing the stream banks. Double rock toe protection is proposed for the 10 feet between the riffles. Minor grading of the banks would be required for installation of the riffles and the toe protection.

The other recommended restoration action in this stream reach is to correct the slope failure at a storm drain outfall, which would involve regrading the slope and placing additional rock against the slope.

The benefits of this concept are stabilization of the streambed and banks for a total of 360 feet of stream, remediation of two headcuts, and restoration of a slope failure at a storm drain outfall.

Construction access to the site would be difficult. Construction equipment could access the stream from either Riverside Parkway or Baneberry Drive. Both access paths would require constructing a temporary access road within the forested stream valley and removing trees. Trees would be replaced after the stream restoration work has been completed. Tree replacement is included in the estimated cost of the project.

Tributary DR5



Tributary DR5:

Restoration Length: 120 feet

Grade Control: 4 structures

Outfall Stabilization: 1 site

Pollutant removal estimate:

Total nitrogen	2 lbs/yr
Total phosphorus	0.4 lbs/yr
TSS	306 lbs/yr

Planning-level cost estimate: $175,576

Equivalent impervious area treated: 1.2 acres

The Tributary DR5 stream reach is south of Baneberry Drive and runs east-west between Arabis Court and Germander Drive. The stream is an ephemeral channel and is moderately incised with little aquatic habitat potential. There are two problem areas that need to be addressed: a slope failure at a storm drain outfall from a detention basin and

a 2foot deep headcut within the stream channel. This stream reach is rated moderate for restoration potential, but the slope failure at the storm drain outfall should be addressed.

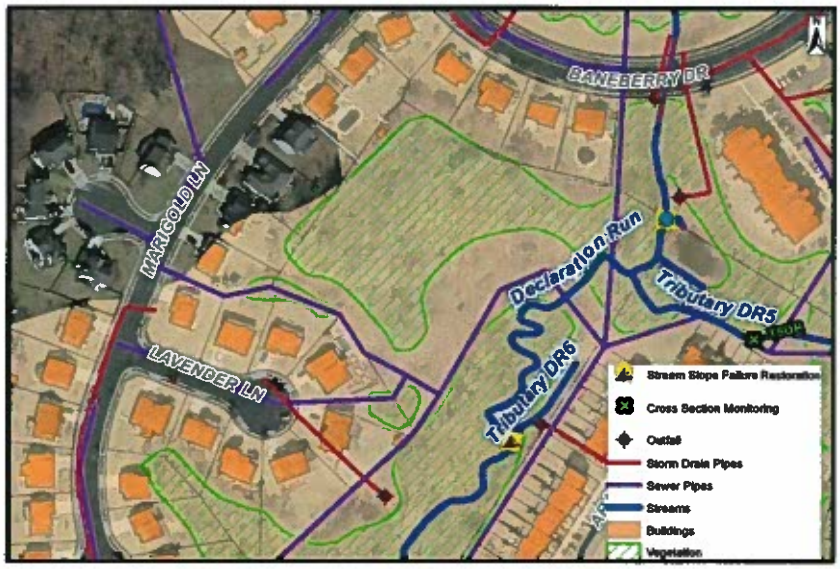
Recommended restoration is limited to correcting a minor headcut with grade control structures and remediating a slope failure at a storm drain outfall. Remediating the headcut would require approximately 120 feet of stream restoration with four riffle grade control structures. The rock used in the grade control structures would extend up to the top of the bank, thereby stabilizing the stream banks. Double rock toe protection is proposed for the 10 feet between the riffles. Minor grading of the banks would be required for the installation of the riffles and toe protection.

A headcut in the stream near Arabis Court will be remediated with the Tributary DR5 Restoration project.

The benefits of this concept include are stabilization of the stream bed and banks for a total of 120 feet of stream, remediation of one headcut, and restoration of a slope failure at a storm drain outfall.

Construction access to the site will be difficult. Construction equipment could access the stream from either Baneberry Drive or Church Creek Road. However, access from Baneberry Drive would require traversing down a steep slope on the southern side of the road. Both access paths would require constructing a temporary access road within the forested stream valley and removing trees. The trees would be replaced after the stream restoration work has been completed. Tree replacement is included in the estimated cost of the project.

Declaration Run Reach 2



Declaration Run Reach 2:

Restoration Length: 0 feet

Grade Control: 0 structures

Outfall Stabilization: 2 sites

Pollutant removal estimate:

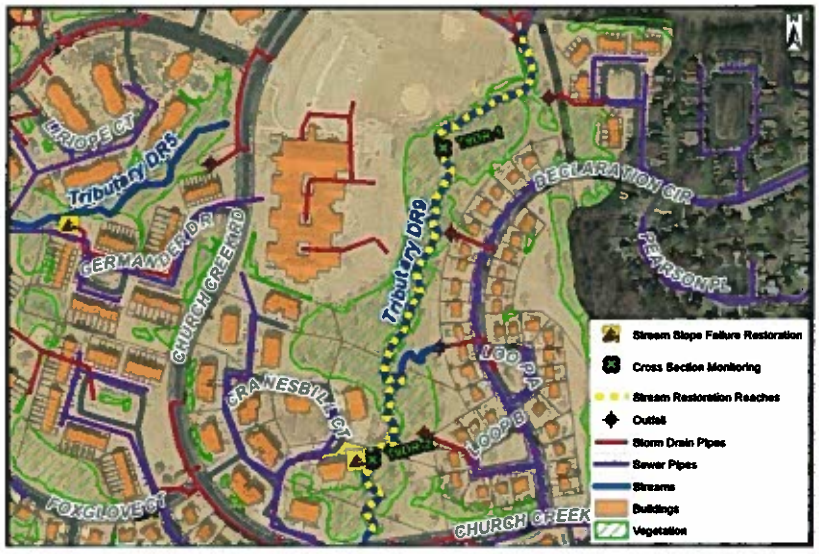
Outfall stabilization is listed as an alternate BMP to meet NPDES restoration requirements. Reduction credits will be given when clear performance criteria are set and monitoring data documenting pollutant removal capability are submitted to MDE for approval.

Planning-level cost estimate	$92,290

The Declaration Run 2 stream reach has high, eroding banks downstream of the confluence with the Tributary DR5 stream reach. Streambank erosion is common on the outside of meander bends. The reach includes a small pond located at this area, and further bank erosion would result in failure of the pond. Stabilizing the high, eroding banks would require significant grading and tree clearing, and stream restoration is not recommended at this time for this stream reach. Prior attempts at placing rock against the eroding banks have been largely unsuccessful, probably because bed grade control was not provided, and as the stream continued to incise, the rocks slid off the banks. In addition, it appears that the rock used in the slope protection was undersized for this second-order perennial stream. There is a slope failure at a 36-inch storm drain outfall and a second slope failure immediately upstream of the small Tributary DR5 stream. This stream reach is rated moderate for stream restoration potential, but the slope failure at the storm drain outfalls requires immediate attention. The recommended project is limited to outfall stabilization at the 36-inch culverts both upstream and downstream of the confluence with Tributary DR5.

The existing wet pond outfall failure that contributes to the deterioration of Declaration Run Reach 2 collects stormwater from Baneberry Drive and Liriope Court.

Tributary DR9 Reaches 1 and 2



Tributary DR9 Reaches 1 and 2:

Restoration Length: 1,900 feet

Grade Control: 10 structures

Outfall Stabilization estimate: 1 site

Pollutant removal:

Total nitrogen	45 lbs/yr
Total phosphorus	8 lbs/yr
TSS	5,738 lbs/yr

Planning-level cost estimate $836,605

Equivalent impervious area treated 19 acres

Tributary DR9 Reach 1, located south of Riverside Parkway to the southern end of Church Creek Elementary School, receives drainage from Riverside Parkway and the shopping center on the northern side of Riverside Parkway. Downstream of the culvert draining the shopping center and Riverside Parkway, there is a flat section of stream with

no thalweg where fresh sand and gravel have accumulated over the stream bed. Below this section, there is a failed stormwater management feature made of white polyvinyl chloride.

The in-stream stormwater retention facility that appears to have been built is not functional because the berm that was constructed across the stream has failed. A severe scour hole exists along the left bank in this area. Below this area, the stream has 3- to 4- foot-high eroding banks. Sand and gravel have accumulated over the stream bed covering over the thalweg. Downstream of this area, the steep stream banks increase in height, up to 8 feet in one area. Approaching the cross section location, the banks decrease in height to approximately 2 feet. There are three headcuts in this area. Two are less than 2 feet deep, and one is about 4 feet deep.

This reach that extends down to the southern end of the Church Creek Elementary School and is rated a high-priority restoration site.

Tributary DR9 Reach 2 extends from Riverside Parkway and Church Creek Elementary School to Church Creek Road Drive. Nearly vertical banks, up to 10-feet tall, exist throughout this reach. There is a failed storm drain outfall that discharges into a short side channel. Two sections of RCP have separated from the outfall. Because of the height and steepness of the stream banks, restoration options are limited without significant grading and tree clearing. However, the erosion at the failing outfall requires immediate attention. This reach is the most severely eroded stream channel that was observed in the watershed and is assumed to be contributing the most sediment to Declaration Run. It is rated a high-priority restoration site.

A combined project for Reaches 1 and 2 for Tributary DR9 has the highest potential for restoration. The project stream reach stretches from Riverside Parkway and Church Creek Road. Starting at the upstream end of Reach 1 to the downstream end of Reach 2, the elements of the restoration consist of:

- Stabilize the streambed and banks for approximately 300 feet at the upstream limit of the stream down to the point where the banks become very high and steep
- Remove a failed in-stream stormwater management feature and stabilize approximately 50 feet of stream left bank immediately downstream of the failed structure
- Grade the high, steep banks back for a distance of approximately 100 feet and install grade control structures

Reach 1, the most upstream reach, needs stabilization of the bed and banks.

- Remediate three headcuts in the vicinity of Church Creek Elementary School by the installing step pools varying in depth from 2 to 4 feet
- Grade and stabilize the high stream banks and streambed from the southern end of the school to Church Creek Road for a stream length of approximately 1,300 feet
- Remediate a failed storm drain outfall that discharges stormwater from Cranesbill Court

Reach 2, located just upstream of Church Creek Road, needs stabilization of stream banks and remediation of failed outfalls.

The benefits of this concept are stabilization of the stream bed and banks for approximately 1,900 feet of stream, remediation of three headcuts, and restoration of a slope failure at a storm drain outfall.

Construction access to the site will be difficult. Construction equipment could access the stream from either Riverside Parkway or Church Creek Road. Both access paths would require constructing a temporary access road within the forested stream valley and removing trees. The trees would be replaced after the stream restoration work has been completed. Tree replacement is included in the estimated cost of the project.

3.1.2.2 Riverside Watershed – Proposed Stream Restoration Projects

There are no proposed stream restoration projects in the Riverside watershed.

3.2 OTHER PROPOSED RESTORATION IMPROVEMENTS

Structural stormwater management projects often require large areas for implementation in order to treat the storm water runoff and receive restoration credits. Even though open space is available in the Declaration Run and Riverside watersheds, existing use or ownership may add challenges that could prevent the County from implementing the structural stormwater management projects that would achieve the watershed goals.

Additional improvements such as stormwater nonstructural projects that are aimed to control stormwater at the source would be a valuable tool for the County to achieve restoration credits. The County is already incorporating some of these strategies into its current stormwater management program. Inclusion of additional strategies may help the County achieve additional pollutant reductions and restoration credits.

3.2.1 Stormwater Nonstructural Projects

Stormwater nonstructural projects to control stormwater runoff were identified as a part of the field reconnaissance. For example, neighborhoods where downspouts from the roof were directed to impervious surfaces or directly connected to the storm drain system were identified in both watersheds. Disconnecting downspouts to direct stormwater runoff to flat, pervious areas or to a rainwater harvesting device is recommended for all of the identified neighborhoods. It is important when implementing this strategy that roof leaders be oriented to a location that will provide adequate infiltration rather than to locations that would have additional pollutants or contribute to additional erosion.

Conserving forested areas and reforestation is a green infrastructure practice. As a part of field reconnaissance, open areas for potential tree planting were identified. Tree planting is an MDE approved BMP and obtaining pollutant removal credits for it can help the County meet permit requirements. Preserving existing forested areas that provide a buffer to streams can also help meet requirements. To receive credits from MDE for tree buffers, a survival rate of at least 100 trees per acre is necessary, and 50 percent of the trees must be at least 2 inches in diameter and have a 4.5-foot-tall trunk.

Both watersheds are characterized by medium-density residential areas that have parking areas and large, open medians. Under existing conditions, the runoff from the parking lots is directed to storm drains. Curb cuts in the parking lots are proposed for all of the neighborhoods with large, open medians to direct the impervious runoff to pervious areas. In addition, areas with excess impervious cover such as wide residential driveways that have potential for impervious surface reduction were also identified as a part of field reconnaissance.

Table 3-7 and Figure 3-15 show specific sites for stormwater nonstructural projects identified in the Declaration Run and Riverside watersheds.

Table 3-7: Proposed Stormwater Nonstructural Projects in the Study Watersheds

Watershed	Project	Type	Location
Declaration Run	D-NS-1	Downspout disconnection	Golden Rod Court Neighborhood
	D-NS-2	Reduction of impervious surface	Wide residential driveways on Marigold Lane
	D-NS-5	Curb cuts in parking lots direct the stormwater runoff to open areas	Sedum Square, Homer Lane, Downs Square, Baylis Court
	D-NS-6	Curb cuts in parking lots to direct stormwater runoff to open areas	Magness Court, Hampton Hall Court, Talbots Square
Riverside	R-NS-2	Curb cuts in parking lots to direct the stormwater runoff to open areas	Halls Chance Lane, Caldwell Court, Caldwell Lane, Griffith Place, Independence Square, Rigbie Hall Court, Bartley Place, Jervis Square, and Courtney Lane
	R-NS-3	Curb cuts in parking lots to direct the stormwater runoff to open areas	Commercial Complex on Bata Boulevard
	R-NS-5	Tree planting	Winners Circle and Carlyle Garth
	R-NS-9	Reduction of impervious surface	Lorien Health Center on Belcamp Garth

Other general observations during field reconnaissance were that trash was not a large problem; there were not any observed hotspots, and no maintenance yards or golf courses. Since these items were not observed as issues in the study watersheds, recommendations on nonstructural measures such as pollution prevention, good housekeeping, and trash reduction were not recommended.

Since both watersheds are primarily privately-owned, incentive programs for ESD techniques would be a potential management approach to controlling the volume of stormwater being received by the streams in the watershed. Encouraging homeowners or HOAs and commercial properties to implement rain gardens, rain barrels or cisterns, dry wells, green roofs, permeable pavers, or conservation landscaping can be a cost-effective way to provide stormwater quality and quantity control

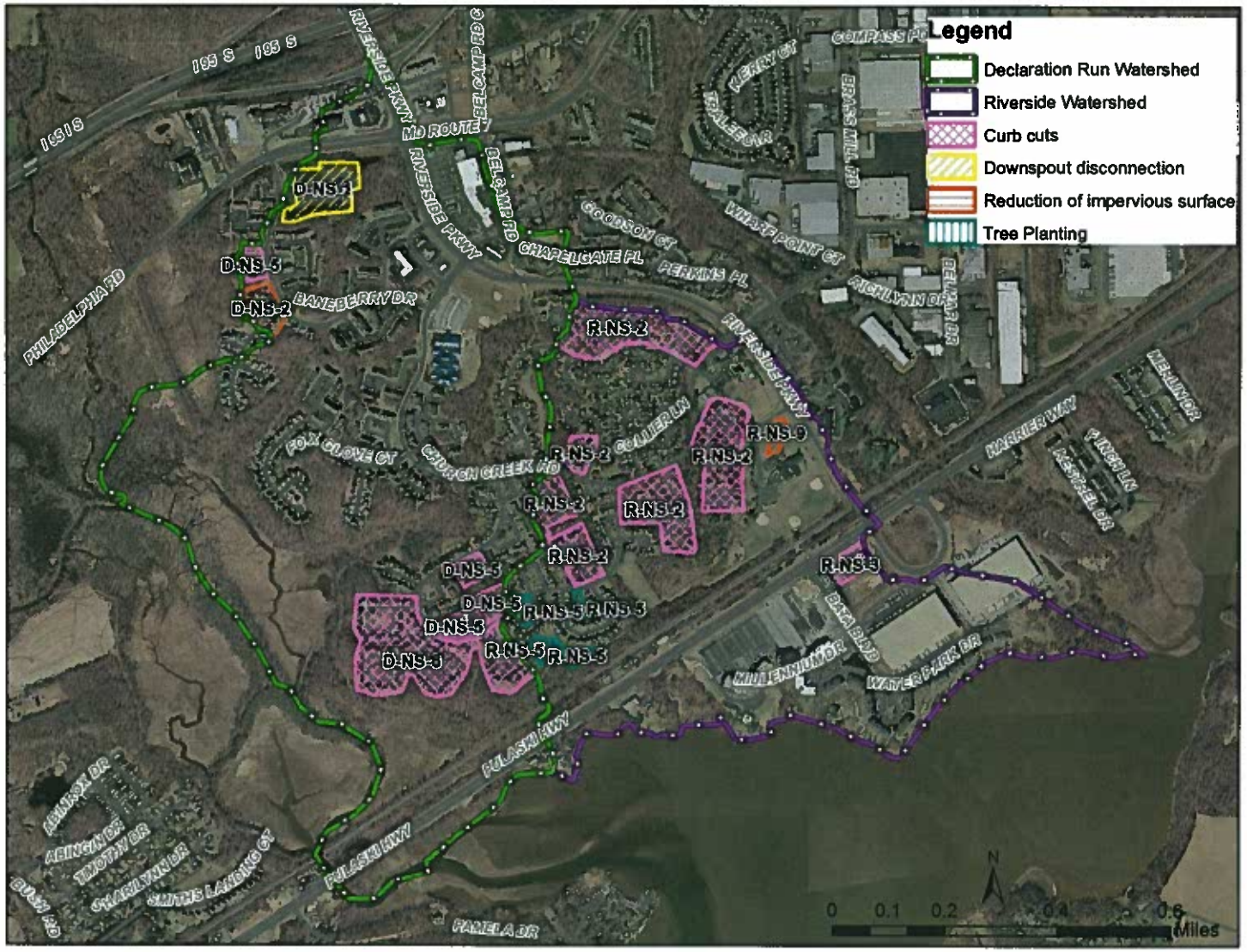


Figure 3-15: Proposed nonstructural stormwater improvements in study watersheds

PAGE INTENTIONALLY LEFT BLANK

3.2.2 Education and Outreach

Public education and outreach are currently available through the "Pollution Prevention" webpage on the County website, which lists various stormwater pollution prevention practices that can be adopted by homeowners and businesses. The pollution prevention practices listed on the website include:

- Use pesticides and fertilizers sparingly
- Repair auto leaks
- Use recycling centers for disposal of household hazardous waste, used auto fluids (e.g., antifreeze, oil) and batteries
- Clean up after pets
- Use a commercial car wash or wash the car on an unpaved surface
- Sweep up yard debris rather than hosing down areas; compost or recycle yard waste when possible

Detailed descriptions of these pollution prevention activities and an explanation of how their adoption by homeowners and businesses will improve the overall water quality are not provided. Additional information is recommended about pollution prevention practices on the County's website to further educate homeowners and businesses. Effective use of existing County communication tools including Facebook, Twitter, and other social media is also recommended to promote public education on good housekeeping practices.

The County's outreach strategy should target the involvement of the residents of watersheds in various restoration activities such as stream cleanup, storm drain stenciling, trash cleanup, and monitoring of stormwater management facilities. This strategy can be achieved by coordinating the HOAs and existing watershed groups.

3.3 IMPROVEMENT BENEFITS

All the proposed structural, nonstructural outreach BMPs, and stream restoration projects were input in WTM to assess their affects in reducing the overall pollutant loads to the surface waters in Declaration Run and Riverside watersheds. Table 3-8 provides the pollutant reductions that would be achieved from the implementation of the proposed improvement projects.

Table 3-8: Pollutant Load Reduction Estimates for Proposed Stormwater Projects

Watershed	Proposed Improvement Measure	Pollutant Load Reductions			
		Total Nitrogen (lbs/year)	Total Phosphorus (lbs/year)	Total Suspended Solids (lbs/year)	Fecal Coliform Bacteria (billion/year)
Declaration Run	Stormwater structural improvements	313	52	15,112	9256
	Stormwater nonstructural improvements and education and outreach	48	9	50	852
	Total	**361**	**61**	**15,162**	**10,108**
Riverside	Stormwater structural improvements	972	206	32,969	34,730
	Stormwater nonstructural improvements and education and outreach	65	13	0	159
	Total	**1037**	**219**	**32,969**	**34,889**

Implementation of proposed structural and nonstructural stormwater management projects will reduce the sediment loads by approximately 8% for Declaration Run watershed, which will help meet the TMDL goal of 14% reduction. Bynum Run does not currently have TMDLs for nutrients; however, the proposed projects in Declaration Run will help to reduce total nitrogen and total phosphorus loads to Bynum Run. The proposed structural and non-structural stormwater management projects will reduce the sediment loads by 20%, total phosphorus loads by 32% and total nitrogen by 28% for the Riverside watershed, which has TMDL goals of 68% reduction in sediment, 81% reduction in total phosphorus and 53% reduction in total nitrogen.

These restoration measures will treat up to 56.2 acres of impervious area in the Declaration Run watershed and 52.8 acres of impervious area in the Riverside watershed. Providing treatment for these impervious areas will help the County meet its Chesapeake Bay TMDL Restoration goals for the upcoming NPDES MS4 permit requirements.

3.4 FUNDING FOR IMPROVEMENTS

Funding for stormwater management improvements in the watersheds is available from a variety of sources. Grants, loans, and cost-share agreements are some ways to obtain short-term funding for improvement projects. A stormwater utility fee is a longer term source of funding. Potential funding sources and their target types of improvements are summarized in Table 3-9.

A potential opportunity for reducing the cost of stormwater management is to converge public outreach with monitoring and maintenance of facilities through volunteer groups and environmental activists. Encouraging local organizations to help monitor or maintain stormwater facilities could reduce the amount of time County staff spend on monitoring and maintenance and help keep the County up-to-date on the status of the improvement projects

Table 3-9: Potential Funding Sources for Watershed Improvements

Sector	Funding Source	Name	Funding Type	Target Improvement Type
Federal	NFWF / EPA	Chesapeake Bay Stewardship Fund: Small Watershed Grants Program	Matching funds / grants	• Stream improvements • Water quality improvements
	NFWF / EPA	Chesapeake Bay Stewardship Fund: Innovative Nutrient and Sediment Reduction Program	Matching funds / grants	• Nutrient / sediment reduction projects
	NFWF / EPA / USFS / USFWS / Southern Company / FedEx / PG&E	2014 Five Star/Urban Waters Restoration Program	Matching funds / grant	• Outreach • Partnerships • Restoration projects • SWM projects • Water quality monitoring
State	MDNR/EPA	Chesapeake Bay Implementation Grants	Grant	• Watershed assistance • Natural filters • Innovative technology • Maryland agriculture cost-share
	MDNR	Natural Filters	Technical assistance / funding	• Forest buffers • Wetlands
	MDE	Water Quality State Revolving Loan Fund	Loan	• Point source pollution prevention • Nonpoint source pollution prevention
	MDE	Stormwater Pollution Control Cost-Share Program	Cost-share	• SWM retrofits
Private/ Non-Profit	Chesapeake Bay Trust	Chesapeake Bay Trust Grants	Grants	• Environmental education • Restoration and retrofits • Outreach

EPA = Environmental Protection Agency
MDE = Maryland Department of the Environment
MDNR = Maryland Department of Natural Resources
NFWF = National Fish and Wildlife Foundation
PG&E = Pacific Gas and Electric Company
SWM = stormwater management
USFS = U.S. Forest Service
USFWS = U.S. Fish and Wildlife Service

PAGE INTENTIONALLY LEFT BLANK

SECTION FOUR: IMPLEMENTATION SCHEDULE

A strategy for placing BMPs in-ground will be helpful in the planning processes of the stormwater management program. The strategy would include a process for prioritizing improvements. Some funding sources require a description of the prioritization process. The proposed improvements in the study watershed were prioritized based on existing conditions, feasibility, and opportunity for water quality benefits.

The implementation schedule provided in Table 4-1 will be useful for permit-required stormwater management strategy documentation.

As shown in Table 4-1, a phased approach is used for the project implementation schedule. Subdividing the milestones is recommended to make implementation more achievable, given limited budgets. For example, the eight Declaration Run watershed projects due in 2017 could be subdivided into a goal of implementing two projects per year. In the Riverside watershed, one high-priority project could be implemented every year through 2017. The milestones in the table were chosen to mirror the interim and final milestones of the Chesapeake Bay TMDL.

Implementation of projects is dependent on the availability of funding, and because of this restriction, the implementation timeline can vary from months to years. It is important to regularly re-evaluate project priorities as implementation timelines shift and watershed characteristics change over time. Regularly re-evaluating projects will allow for the introduction of future innovations in stormwater technology that may be a better fit for the conditions in each site than previously suggested. Additionally, if the priorities of residents, local government, or watershed use change, other project or planning management items may provide for better stormwater management and result in better water quality in the study watersheds.

PAGE INTENTIONALLY LEFT BLANK

Table 4-1: Implementation Schedule for Stormwater Improvement Projects

Watershed	Project	Location	Development (acres)	Existing	Proposed	Priority	Completion Milestone
Declaration Run	D-SWM0110 (ES-1)	Church Creek Elementary School	8.2	Infiltration basin	Wetland plantings	High	2017
	D-ES-2	End of Oreganum Court	11.3	Water quality trap	Retrofit to wetland	High	2017
	D-ES-7	Germander Drive & Church Creek Road	2.8	Water quality trap	Bioswale and Bioretention	High	2017
	D-ES- 8	Baneberry Drive	7.8	Water quality trap	Step Pool Conveyance System	High	2017
	D-ES-15	Procedure Way	3.3	Dry Pond	Bioretention	High	2017
	D-NS-8	Dalmation Place	4.6	Outfall	Bioretention	High	2017
	D-NS-12	Church Creek Elementary School	0.9	Traditional storm drain	Bioretention and Tree box filters	High	2017
	D-NS-13	Church Creek Road	0.8	Impervious right-of-way	Green street bump out	High	2017
	D-ES-6	Germander Drive	3.4	Water quality trap	Bioretention	Medium	2021
	D-ES-12	End of Marigold Lane	1.8	Water quality trap	Micropool and wetland	Medium	2021
	D-NS-4	Church Creek Road	2.1	Wide sidewalks	Green street bump out	Medium	2021
	D-ES-5	North end of Foxglove Court	8.9	Extended detention basin	Bioretention	Low	2025
	D-NS-3	Liriope Court	0.1	Sloped impervious roofs	Green roofs	Low	2025
	D-NS-7	Foxglove Court	6	Outfall	Step Pool Conveyance System	Low	2025
	D-NS-9	Golden Rod Court	6.3	Traditional storm drains	Tree box filters	Low	2025
Riverside	R-ES-1	Halls Chance Road	130.4	Grass swale	Bioswale and check dams	High	2017
	R-NS-1	Belcamp Park	5.5	Traditional storm drain	Bioretention	High	2017
	R-NS-7	Caldwell Court South	64.3	Grass swale	Bioswale and check dams	High	2017
	R-NS-8	Carlyle Garth	1.9	Grass swale	Bioswale and check dams	High	2017
	R-NS-6	Winners Circle	1.3	Open space	Rain garden	Low	2025
	R-SWM0491	West end of Millennium Drive	4.9	Grass swales	Filter strips	Low	2025
	R-SWM0627	Millennium Drive	4.6	Grass swales	Filter strips	Maintain Existing Facility Instead	2015

PAGE INTENTIONALLY LEFT BLANK

SECTION FIVE: MONITORING PLAN

After an improvement project has been completed, monitoring the improvement project is an important part of the stormwater management program because the monitoring provides information on the effectiveness of the improvement project and its effect on the watershed and stream health.

The location of monitoring sites should reflect the level of understanding of the watershed that is needed. Examples of locations are a point right before the stream leaves a jurisdiction or watershed and upstream and downstream of the improvement project. Information obtained from monitoring stream sites provides an understanding of how improvement projects throughout the watershed have cumulatively increased or decreased water health. Monitoring upstream and downstream of structural improvement sites provides information on how effectively that type of improvement is reducing pollutants. Monitoring information can help the stormwater management program focus time and efforts on the parts of the program that are providing the most benefits to the goal—improving stream and watershed health through improved water quality.

Federal agencies conduct occasional compliance monitoring at point source locations in the study watersheds. Monitoring has been conducted on receiving streams, Bynum Run, and Bush River for the existing TMDLs. These sites are not maintained regularly, and the results from these sites would not adequately represent the stormwater management in the Declaration Run or Riverside watersheds. However, the compliance and TMDL monitoring may provide an opportunity to compare and gain a big-picture understanding of watershed effects.

Currently, there are no maintained monitoring sites or monitoring programs in the Declaration Run or Riverside watersheds. Based on the discussion with the County staff, it is recommended that monitoring stations be installed in the upper reaches of Declaration Run to assess physical stream parameters such as BEHI and cross section measurement. Since field reconnaissance in the Riverside watershed indicated that streams with defined channel were not present in the watershed contradicting the County hydrology GIS data, physical assessment sites were not proposed in the watershed. Physical assessment can be conducted throughout the year, however if the County plans to include assessment for macro-invertebrates and habitat at these sites, spring and summer are the recommended sampling seasons.

Figure 5-1 shows the potential monitoring stations for physical assessment in the Declaration Run watershed.

PAGE INTENTIONALLY LEFT BLANK

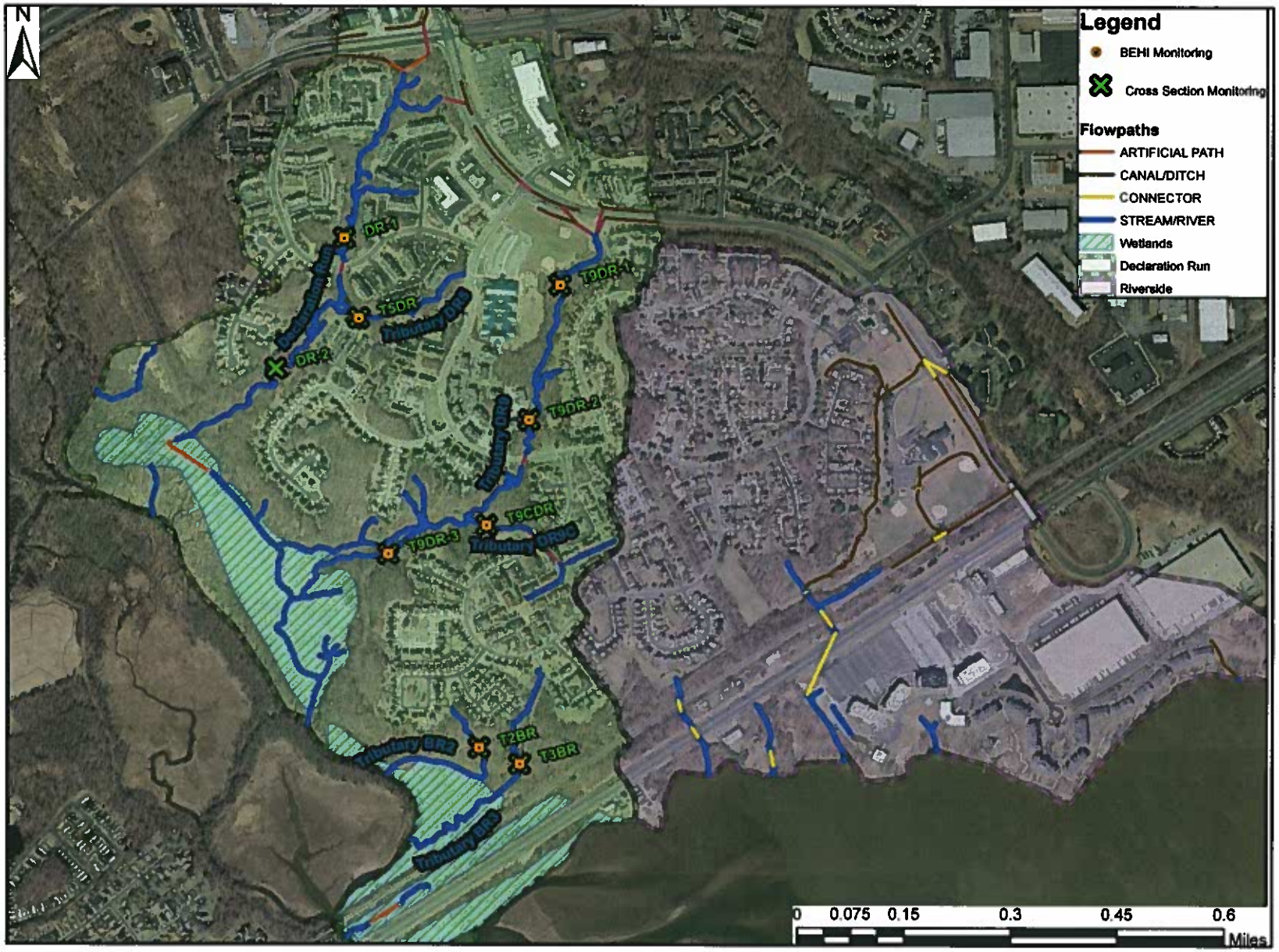


Figure 5-1: Proposed stream monitoring sites for physical assessments

PAGE INTENTIONALLY LEFT BLANK

In addition, the NPDES reporting requirements specify that triennial inspection of all stormwater management facilities, including ESD facilities is required and that inspection forms must be kept for 3 years post inspections. The records must be made available to the public and MDE up on request.

To comply with this requirement, the County could monitor upstream and downstream of the implemented stormwater improvements to determine actual pollutant removal efficiencies and/or volume reduction rates and to see how their function is affecting the overall health of the watershed

5.1 ANNUAL REPORTING REQUIREMENTS

The County must submit a report to MDE annually, and the report must include:

- Progress toward meeting identified measurable goals
- Results of information collected and analyzed including monitoring data
- Summary of planned stormwater activities for the upcoming year
- Coordination efforts regarding minimum control measures
- Fiscal analysis of expenditures needed to implement minimum control measures for the general permit

Monitoring, documenting and reporting the efficiency and maintenance needs of the County stormwater management facilities will help the County in understanding the most cost efficient restoration measures to improve the overall water quality of the study watersheds.

SECTION SIX: SUMMARY

The County's goals for this SWAP is to understand existing conditions of the Declaration Run and Riverside watersheds, identify problem areas, and recommend water quality improve measures that will improve overall health of the watersheds. Due to the timing of development in both watersheds, the majority of neighborhood areas were erected prior to current stormwater standards. These areas do not have water quality control and have limited water quantity control. The existing conditions of both watersheds show deterioration to streams due to limited control of upland stormwater runoff volumes. The proposed projects include structural, non-structural, stream restoration and education and outreach BMPs that can become a part of the County Capital Improvement Program for compliance with TMDL and NPDES permitting requirements. Table 6-1 shows the potential percent load reduction of nutrients, sediment, and bacteria that could occur if all of the recommended improvement measures are implemented.

Table 6-1: Effect of Recommended Projects on Pollutant Loads if Implemented

Watershed	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Bacteria	Runoff Volume
Declaration Run	12%	12%	8%	6%	6%
Riverside	28%	32%	20%	19%	14%

Approximate total implementation costs of $3,829,400 will be required for Declaration Run watershed and $3,513,300 will be required for Riverside watershed to achieve the above-mentioned pollutant load reductions by implementing the stormwater management recommendations. The recommendations provided will help provide water quality control that will limit the amount of pollutants from Declaration Run and Riverside watersheds transported from upland areas to Bynum Run and Bush River, respectively. In addition, stream restoration opportunities can help to stabilize eroded areas thereby enhancing ecological habitats. These opportunities will provide Harford County with credits towards its NPDES, Chesapeake Bay TMDL regulatory requirements and promote healthier living space for the residents in the watersheds.

SECTION SEVEN: REFERENCES

EPA (Environmental Protection Agency). 2010. *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment.*

Center for Watershed Protection. 2003. *Bush River Watershed Management Plan*. Available at http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=2&ved=0CC4QFjAB&url=http%3A%2F%2Fwww.dnr.state.md.us%2Firc%2Fdocs%2F00013859.pdf&ei=A7oHU8azFIyM1AHVz4BA&usg=AFQjCNE6AU1VtatBDW5CsIqR70uo0K7A1Q&bvm=bv.61725948,d.dmQ. Accessed February 23, 2014.

Center for Watershed Protection. [2013]. Water Treatment Model. Available at http://www.cwp.org/online-watershed-library/cat_view/65-tools/91-watershed-treatment-model

EPA. [2013]. My WATERS Mapper. Available at http://watersgeo.epa.gov/mwm/?layer=LEGACY_WBD&feature=02050306&extraLayers=null

EPA Storet http://iaspub.epa.gov/storpubl/storet_wme_pkg.Display_Station?p_org_id=MDEDAT04_WQX&p_station_id=BUS0009

Harford County. 2012. *Harford County, Maryland: Phase II Watershed Implementation Plan.* Available at http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Documents/FINAL_PhaseII_Report_Docs/Final_County_WIP_Narratives/Harford_WIPII_2012.pdf. Accessed February 23, 2014.

Harford County. 2013. *Belcamp, Maryland 21017 Zip Code 2013 Profile.* http://www.harfordcountymd.gov/services/stimulus/download/Belcamp21017.pdf

Harford County Population. http://www.harfordcountymd.gov/services/Stimulus/download/population.pdf

Harford County Government Watershed Management Program. http://www.harfordcountymd.gov/dpw/engineering/waterresources_hold/index.cfm?ID=999

Maryland Atlas of Greenways, Water Trails, and Green Infrastructure. 2000 Edition Maryland Greenways Commission. Harford County. http://www.dnr.state.md.us/greenways/counties/harford.html

MDE (Maryland Department of the Environment). 2003. National Pollutant Discharge Elimination System General Permit for Discharges from Small Municipal Separate Storm Sewer Systems.

MDE. 2006. Water Quality Analysis of Eutrophication for Bynum Run, Harford County, Maryland. Available at http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Pages/Programs/WaterPrograms/TMDL/approvedfinaltmdl/wqa_final_bynum_run_eutro.aspx. Accessed February 23, 2014.

MDE. 2010. *Phase I Watershed Implementation Plan for the Chesapeake Bay Watershed.* Available at http://www.mde.state.md.us/programs/Water/TMDL/TMDLHome/Pages/Final_Bay_WIP_2010.aspx. Accessed February 23, 2014.

MDE. 2011a. Total Maximum Daily Load of Sediment in the Bynum Run Watershed, Harford County, Maryland. http://www.mde.state.md.us/programs/Water/TMDL/ApprovedFinalTMDLs/Documents/www.mde.state.md.us/assets/document/Bynum_Sed_TMDL_093011_Final.pdf

MDE. 2012. *Phase II Watershed Implementation Plan for the Chesapeake Bay Watershed.* Available at http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/FINAL_PhaseII_WIPDocument_Main.aspx. Accessed February 23, 2014.

MDE. 2011b. *Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for National Pollutant Discharge Elimination System Stormwater Permits.* Draft. Available at http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/Documents/NPDES%20Draft%20Guidance%206_14.pdf. Accessed January 2013

MDE. 2011c. *Cost of Stormwater Management Practices in Maryland Counties.* Draft, Available at http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Documents/King_Hagan_Stormwater%20Cost%20Report%20to%20MDE_Final%20Draft_12Oct2011.pdf. Accessed January 2013

Rosgen, Dave. *Applied River Morphology*. Wildland Hydrology. Pogosa Springs, Colorado. 1996.