Kilmarnock Watershed Assessment Report

April 2013

PREPARED FOR:
Town of Kilmarnock, VA

PREPARED BY:

20 YEARS 1992-2012 Center for Watershed Protection
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SECTION 1. INTRODUCTION

1.1 Executive Summary

The 2158-acre Town of Kilmarnock, Virginia sits at the headwaters of three different watersheds: the Corrotoman River (Norris Prong), Dymer Creek, and Indian Creek. This location places Kilmarnock in a distinctive position: Because no runoff from other jurisdictions enters the town, the health of streams in Kilmarnock is almost entirely dependent on activities and land uses within its boundaries. In this way, Kilmarnock's decision-makers and citizens are in a unique position to influence their own destiny with regard to water resources, as well as have an influence on downstream waterways and communities.

This assessment of Kilmarnock's watershed conditions and restoration opportunities was made possible by the combined efforts of the Town of Kilmarnock ("the town"), Friends of the Rappahannock, Lancaster County, and the Center for Watershed Protection ("the Center"). As the first stage in characterizing the town's watersheds, the Center reviewed available studies and data on stream quality, land cover and land use, geography, soils, geology, and development. In **Section 2** of this report, you will find the results of that research. In general, the town is characterized by erodible soils, variable topography, steep stream valleys, large stands of forest, old and new commercial and residential development, and very little industry. No water quality studies were found to be available for streams within the town.

Using field methods described in **Section 3**, staff from the four partnering organizations documented a range of restoration opportunities in Kilmarnock's uplands and streams. The assessment identified:

- 5 distinct pollution "hotspots";
- Stewardship opportunities in 20 residential neighborhoods;
- 5 severe stream erosion head cuts; and
- Stormwater retrofit or repair concepts on 11 properties.

Section 4 outlines recommendations for using these findings to help direct watershed management and restoration activities in Kilmarnock in the short and long-term future.

This watershed assessment was financially supported by a grant from the Chesapeake Bay Stewardship Fund of the National Fish and Wildlife Foundation.

1.2 Purpose of Assessment

The Town of Kilmarnock has the opportunity to serve as a positive example to other rural localities on the Northern Neck and beyond for improving water quality in the wake of past development and in the face of projected growth. Town staff and environmental partners in the area are particularly interested in ways to reduce non-point sources of pollution such as stormwater runoff.

However, a comprehensive study of Kilmarnock's watershed conditions had never been done. This field-based watershed assessment serves to (1) characterize current conditions within the town's waterways and uplands, with a special focus on its developed areas, (2) locate potential and actual sources of water pollution, and (3) propose specific physical and behavioral solutions to those pollution problems.

With the results of this assessment in hand, the town can forge partnerships with community groups to implement restoration on public and private land, remedy known existing sources of pollution, make informed decisions about natural resources planning and policies, and encourage its citizens to take on stewardship actions specifically needed in the town. In addition, the findings of this watershed assessment should help inform how to work toward Chesapeake Bay TMDL target pollution reductions in the Kilmarnock area, while also addressing local TMDL stream impairments.

1.3 Caveats

It should be noted that this study assessed watershed conditions in the town at one point in time and did not involve any long-term monitoring of conditions. In addition, this "snapshot" approach did not include any water quality testing.

While sites from across the watershed were assessed, not *all* upland and stream areas were visited due to time and budget limits. Also, most of the field assessment was conducted in developed areas in order to gauge human impact near its source. In the future, additional assessments should be conducted in areas of concern to reflect watershed changes and developments.

SECTION 2. WATERSHED CHARACTERIZATION

2.1 Introduction

2.1.1 Town of Kilmarnock and Counties

The Town of Kilmarnock is located on the Northern Neck of Virginia in Lancaster County, with a small portion located in Northumberland County. The Northern Neck peninsula is bordered by the Potomac River to the north and the Rappahannock River to the south. The town is the business and commercial center for Lancaster and neighboring counties, containing 47 percent of the business and service establishments for Lancaster County (Kilmarnock Planning Commission, 2006).

The town comprises 2,158 acres and had a total population of 1,487 people in 2010 (U.S. Census Bureau, American Fact Finder). Except for one major development in the northern section of town, the entire town is served by public water and sewer. The public drinking water for the town is supplied by three deep aquifer wells and stored in water towers for public use (EEE Consulting Inc., 2009). The town's wastewater is treated at the wastewater treatment plant on Mac's Pond Road using an advanced activated sludge system and is then released into Indian Creek (Kilmarnock Planning Commission, 2006).

2.1.2 Watersheds and Tributaries

The town sits at headwaters of three different waterways: the Corrotoman River (Norris Prong), Dymer Creek, and Indian Creek. Figure 1 delineates three subwatershed areas in which most of the town surface is located. The subwatersheds area mapped in Figure 1 is considered the "study area" for this project. However, it should be noted that the watersheds of the full length of Dymer Creek and Indian Creek are more expansive than those delineated in Figure 1.

The Town's three watersheds are roughly divided along the major highways located on the ridge lines between the streams (Kilmarnock Planning Commission, 2006). The Norris Prong subwatershed is located north of Irvington Road and bordered to the north by Goodluck Road, Route 200 to the east and Cox's Farm Road to the west. The Dymer Creek subwatershed drains the area south of Irvington Road, between Harris Road and Main Street. The Indian Creek subwatershed is located in the southeastern section of town, south of Church Street and east of Main Street. The Norris Prong flows into the Eastern Branch of the Corrotoman River which flows into the Rappahannock River and then into the Chesapeake Bay. Dymer and Indian Creeks, however, flow directly to the Chesapeake Bay (Figure 2).

The study area subwatersheds mapped in Figure 1 total 3,659 acres and contain 17.21 stream miles (perennial and intermittent), approximately ten miles of which are within the town's boundaries. Table 1 lists the distribution of these stream miles in each subwatershed and provides the percent of subwatershed area located in Lancaster County, Northumberland County, and the town. GIS mapping analysis also shows that 52% of the town is within the Corrotoman River watershed, 26% in the Dymer Creek watershed, 12% in the Indian Creek watershed, and 10% in other watersheds.

Table 1. Hydrologic Data about Study Area (Kilmarnock GIS, 2013)

Subwatershed	Subwatershed Area (acres)	Stream Length (mi)	Jurisdictions (% of subwatershed in respective jurisdiction)
Corrotoman River (Norris Prong)	2,545.99	12.26	Kilmarnock (44.43%) Lancaster Co. (55.47%) Northumberland Co. (0.09%)
Dymer Creek	605.39	3.40	Kilmarnock (94.18%) Lancaster Co. (5.82%)
Indian Creek	499.47	1.55	Kilmarnock (53.41%) Lancaster Co. (28.58%) Northumberland Co. (18.01%)
Total	**3,650.85**	**17.21**	**Kilmarnock (53.91%)** **Lancaster Co. (43.55%)** **Northumberland Co. (2.52%)**

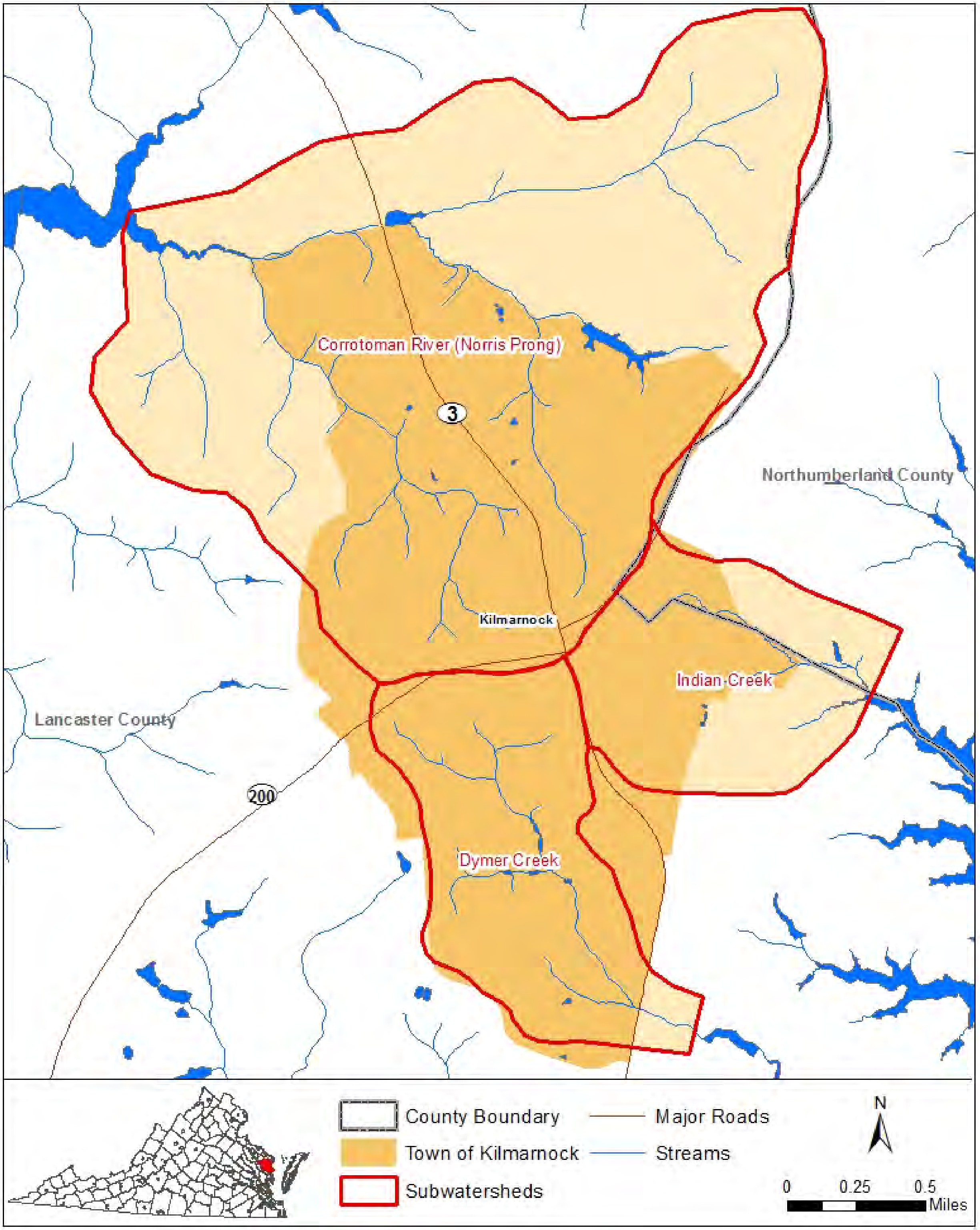

Figure 1. Study area subwatersheds and Kilmarnock town limits.

Figure 2. Vicinity of the Town of Kilmarnock draining to the Chesapeake Bay.

2.1.3 Soils and Geology

Elevations in the town range from 2 to 100 feet above level (Figure 3). The town is located along the upper edge of the Suffolk Scarp, a long elevated geologic formation that runs generally north and south across the Northern Neck and Middle Peninsula. This "terrace" is thought to delineate an ancient shoreline that may have been formed by the Chesapeake Bay Impact Crater (Horton et al., 2005). To the west of the Suffolk Scarp land elevations are above 25 feet above sea level and most land area is above 60 feet. To the east are very flat lowlands of tidal marsh, forest and farmland that all sit below 25 feet.

Approximately 13 percent of the town area is considered "stream basin," i.e., below 50 feet in elevation, and is not usable for development (Kilmarnock Planning Commission, 2006). According to the Northumberland and Lancaster Counties Soil Survey most of the stream corridors in the town are classified in the *Sloping Sandy Land* or *Steep Sandy Land* formation (Figure 4; NRCS, 1963). These soils are highly permeable, commonly have seepage spots, and are droughty, acidic, and not very fertile. These areas are almost solely suited to trees, such as loblolly pine and yellow poplar. These types of soils are also susceptible to erosion. Figure 5 depicts the location of these soil types in the town and shows that these soils are primarily found near streams (NNPDC, 2013).

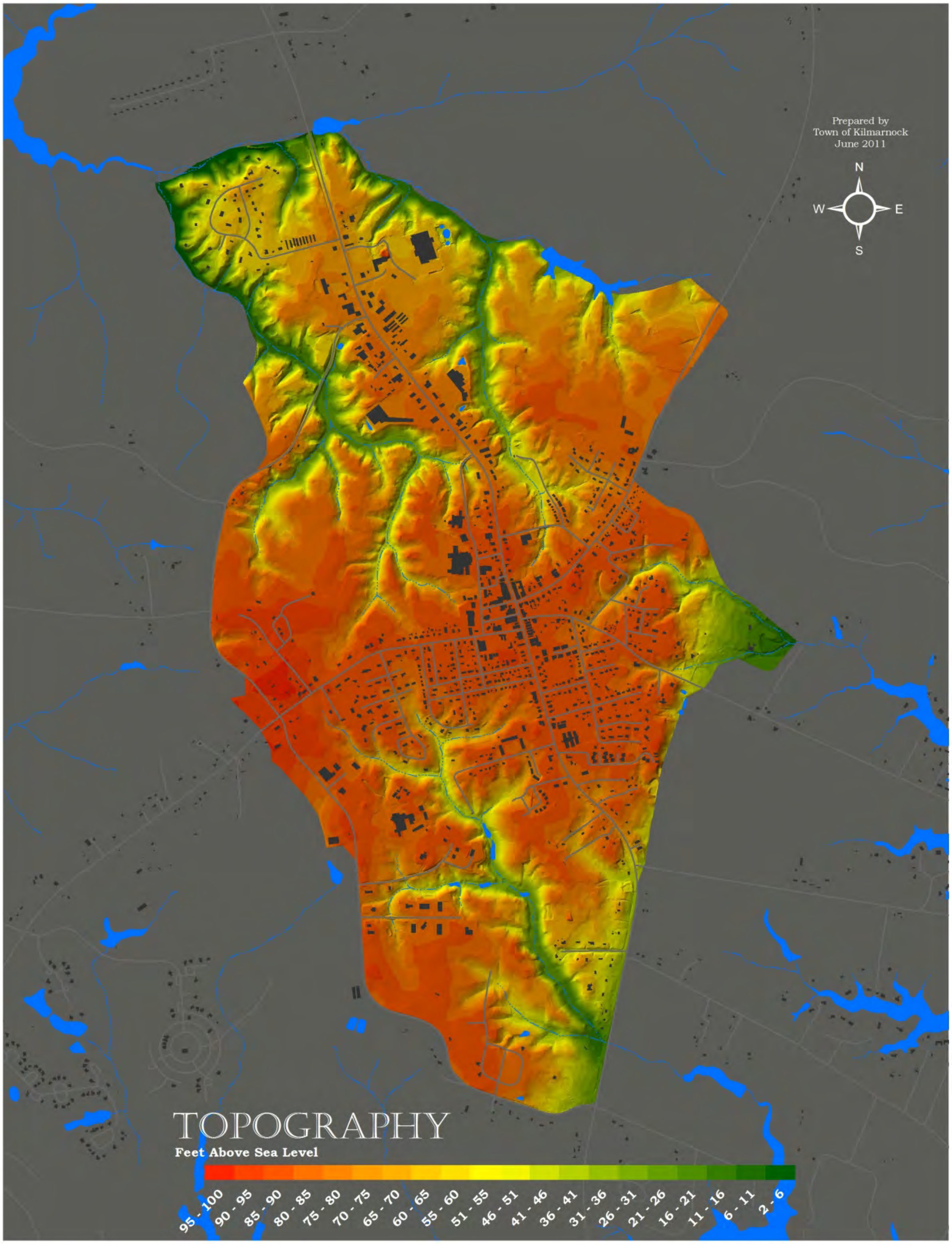

Figure 3. Topography of Kilmarnock (Town of Kilmarnock, 2011).

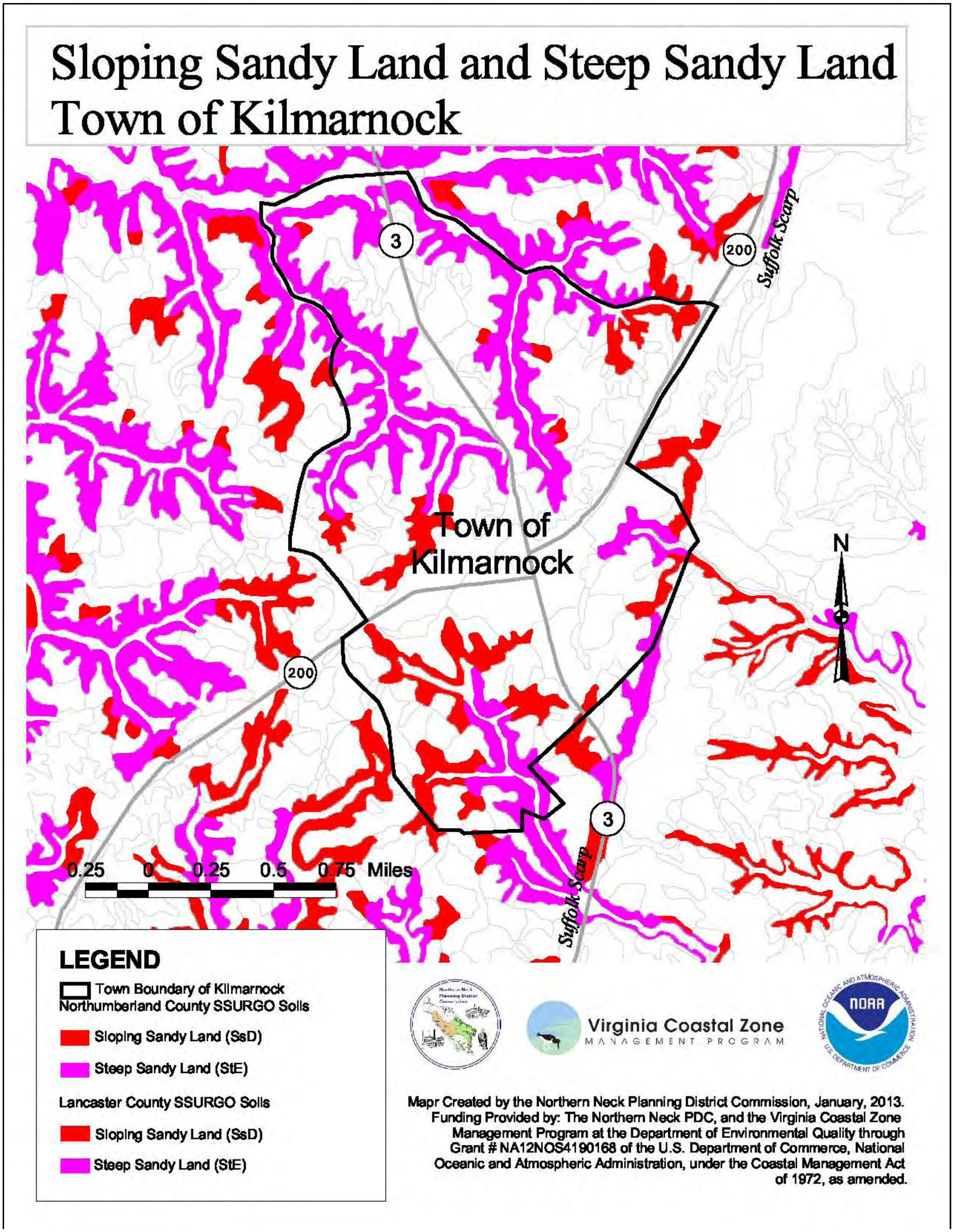

Figure 4. Distribution of *Steep Sandy Land* and *Sloping Sandy Land* in Kilmarnock (NNPDC, 2013).

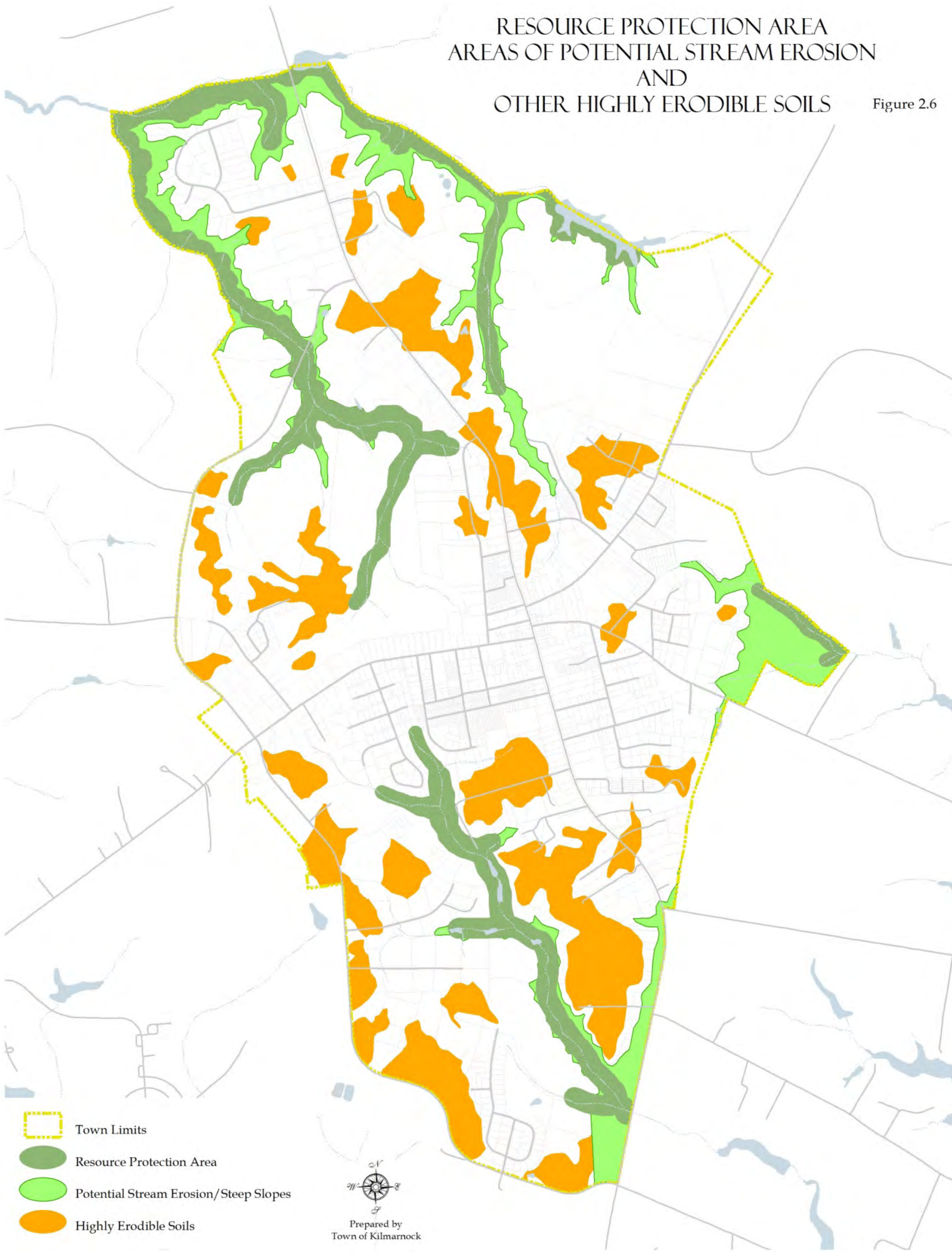

Figure 5. Areas of potential stream erosion and other highly erodible soils (Kilmarnock GIS, 2013)

2.1.4 Land Use

The dominant land uses are vacant land (53.78%), single family residential (28.24%), and commercial (10.89%). Table 2 delineates the land use types in each of the town's three subwatersheds. Note that this table portrays the land use of the *entire* area of each subwatershed, not just the land use within town limits.

Table 2. Land Use in Study Area Subwatersheds (Kilmarnock GIS, 2013)

	Land Use (% of Subwatershed)					
Subwatershed	**Commercial**	**Industrial**	**Multi-Family**	**Office**	**Single Family Residential**	**Vacant (i.e. not developed)**
Corrotoman (Norris Prong)	14.84	1.16	1.64	1.39	15.5	65.47
Dymer Creek	6.24	3.76	3.48	4.2	31.76	50.56
Indian Creek	4.11	3.06	5.6	1.43	74.77	11.04

2.2 Stream Conditions

2.2.1 Total Maximum Daily Loads

In order to fulfill Clean Water Act Section 303(d) requirements, all states are required to maintain and update a list of impaired and threatened waters (stream segments) and submit the list to the U.S. EPA for approval every two years. This list is then used to develop total maximum daily loads (TMDLs), which quantify the maximum amount of a pollutant that a water body can receive and still meet its designated uses. A TMDL also involves a detailed investigation into the sources of the impairment and reductions required to achieve the target loads. TMDLs must be developed for every water body listed as impaired on the 303(d) list of the Clean Water Act.

The scale of watershed for TMDLs varies greatly. The broad-scale TMDL that affects Kilmarnock is the Chesapeake Bay TMDL, which was finalized in 2010 by the U.S. EPA. This TMDL allocates nutrient and sediment reduction targets for each Bay state, including Virginia, to restore the Chesapeake Bay by the year 2025. These reductions were further broken down by major river basin. At the state level, Phase 1 Watershed Implementation Plans (WIPs) were developed to determine how each state will help meet pollutant reductions. The Phase II WIP for Virginia, which was developed by the state with input from many jurisdictions and other entities, outlines a strategy to meet pollutant load allocations.

Several TMDLs are in place at the local level in the vicinity of Kilmarnock. As shown in Table 3, 14% of the stream miles within the study area are listed as impaired. The Virginia DEQ 2010 303(d) list of impaired waters lists 2.41 miles of the Norris Prong as impaired for Dissolved Oxygen, which impacts the aquatic life designated use of the water body. There are also two TMDLs for bacteria (fecal coliform): *Corrotoman River Watershed TMDL Report for Shellfish Condemnation areas listed due to bacteria contamination* (VDEQ, 2007) and *Indian, Tabbs, Dymer and Antipoison Creeks TMDL for shellfish condemnation areas listed due to bacteria pollution* (VDEQ, 2009). Part of the study area is located within the Corrotoman River

Watershed TMDL area, while the TMDL for Indian and Dymer Creeks are for the tidal sections of these watersheds and located downstream of the study area.

Table 3. Study Area Stream Miles on 303(d) Impaired Waters List		
Study Area Subwatersheds	**Stream Length (mi)**	**Impaired Stream Miles (and % Stream Miles)**
Corrotoman River (Norris Prong)	12.26	2.42 (19.73%)
Dymer Creek	3.40	0.00 (00.00%)
Indian Creek	1.55	0.00 (00.00%)
Total	**17.21**	**2.42 (14.06%)**

For both TMDLs, the state bacteria standard used in the development of the TMDL is a 90th percentile geometric mean value of 49 most probable number per 100ml (VA water quality standard 9VAC-25-260-5). Sampling was conducted and evaluated using bacterial source tracking to identify the sources of bacteria. The sampling data was used to model the current pollution load in the stream. This load was compared to the state standard to determine the percent reduction needed to achieve water quality standards. For the East Branch Corrotoman River a 69% reduction in bacteria is needed (VDEQ, 2007). The reductions calculated for Indian and Dymer Creeks are 94% and 92%, respectively (VDEQ, 2009).

2.2.2 Sources of Impairment

Nonpoint and point sources are identified as contributors of pollutants in the TMDLs described above. For the Corrotoman River Watershed TMDL, there were no known point sources associated with bacterial contamination of shellfish areas. Therefore, management strategies in that watershed should be focused on reducing nonpoint sources.

For the East Branch Corrotoman River, the results of the bacteria source tracking indicate the major sources of bacteria are from livestock (34%), humans (32%), and pets (29%) (VDEQ, 2007). In the Indian, Tabbs, Dymer and Antipoison Creeks TMDL, there is one point source: the Kilmarnock Wastewater Treatment Plant located in the non-tidal portion of Indian Creek. For Indian Creek, the results of the bacteria source tracking indicate the major sources of bacteria are from humans (65%), wildlife (23%), and pets (9%). For Dymer Creek, the major sources of bacteria are from pets (41%), humans (26%), and wildlife (22%). Nonpoint source contributions generally arise from failing septic systems and associated drain fields, moored or marina vessel discharges, stormwater retention ponds (from concentration of bird droppings), pump station failures and exfiltration from sewer systems.

Point Sources

Facilities that discharge municipal or industrial wastewater or conduct activities that can contribute pollutants to a waterway are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. Data was obtained from the U.S. EPA Enforcement and Compliance History Online (ECHO) website (http://www.epa-echo.gov/echo/). The Kilmarnock Wastewater Treatment Plant is the only facility in the town with an NPDES permit. Its permit is in the category of a “minor” NPDES permit.

2.3 Natural Resources

2.3.1 Protected Lands

Protected lands are summarized in Table 4 for each of the three study subwatersheds. There are no state or federally-protected lands. However, there are two conservation easements: a 195-acre easement held by the Virginia Outdoors Foundation and a 27-acre easement held by the Northern Neck Land Conservancy. A conservation easement ensures the protection of significant natural resources on a property by removing the development rights of the property. In exchange, placing a property under easement may allow the landowner to receive income, or estate and property tax benefits while still maintaining ownership of the property.

Table 4. Summary of Protected Land

Subwatershed	Protected Land (Acres)	Easement Holder	Percent of Subwatershed Protected (%)
Corrotoman River	195	Virginia Outdoors Foundation	7.6
Dymer Creek	0	None	0
Indian Creek	27	Northern Neck Land Conservancy	5.4
Watershed Total	**222**		**6.1**

2.3.2 Chesapeake Bay Preservation Act Areas

The town is regulated under the Chesapeake Bay Preservation Act, which requires 100-foot riparian buffers along both sides of water bodies with perennial flow including tidal wetlands, non-tidal wetlands and tidal shores. These areas are designated as Resource Protection Areas (Kilmarnock Town Code §54-487). All the remaining land within the town is designated as Resource Management Areas, which is defined in the town Code as “land types that, if improperly used or developed, have the potential for causing significant water quality degradation or for diminishing the functional value of the resource protection area (Kilmarnock Town Code §54-481).”

2.3.3 Rare, Threatened, and Endangered Species

There are no documented rare, threatened or endangered species within the town’s limits based on a review provided by the Virginia Department of Conservation and Recreation Natural Heritage Program (Hypes, 2012).

SECTION 3. WATERSHED ASSESSMENT PROTOCOLS AND FINDINGS

3.1 Introduction to the Watershed Assessment

The Watershed Assessment consisted of a field survey of conditions in both the *upland* sections of Kilmarnock (areas draining to local streams) and the *in-stream* areas. The goals of the field surveys were to identify sources of stormwater pollution and provide management options, develop concepts for managing stormwater runoff from developed areas, and discover other restoration needs and opportunities.

Field work for this watershed assessment was conducted by eight staff members from the Center for Watershed Protection, Friends of the Rappahannock, Lancaster County, and the Town of Kilmarnock. The Center served as the technical lead for each field team. Staff from these organizations was divided into three field teams and completed field work on December 18 and 19, 2012. A variety of watershed assessment methods developed by the Center were used, as described in Section 3.2.

In preparation for field work, town staff created a list of forty-one upland and stream sites for the field teams to visit. These sites included existing stormwater management basins, sites known to have problems (e.g., streams with severe erosion), and properties with greater potential for pollution problems due to the nature of activities at the site (e.g. restaurants, vehicle repair shops).

Prior to field work, the Center used GIS to delineate all the residential neighborhoods in the town. In total, twenty four neighborhoods were included in the list of sites to assess in the field with one additional neighborhood identified in the field. As the need or opportunity arose during the field assessment, the field teams also visited sites not already on the pre-determined list.

3.2 Unified Subwatershed and Site Reconnaissance

The field teams used the Unified Subwatershed and Site Reconnaissance (USSR) method to evaluate pollution-producing behaviors and restoration potential in upland areas of the town. The USSR is a set of visual surveys used to determine specific pollution sources and identify areas outside the stream corridor where pollution prevention possibilities exist. The USSR is a tool for shaping initial subwatershed restoration strategies and locating potential stormwater retrofit or restoration opportunities. The goal of the USSR is to quickly identify source areas that are contributing pollutants to the stream, and suggest ways to reduce these pollutant loads through source controls, outreach and change in current practice, and improved municipal maintenance operations. Additional information on the USSR is found in Wright et al. (2005).

3.2.1 Hotspot Investigations

Pollution source control includes the management of potential stormwater “hotspots” which are certain commercial, industrial, institutional, municipal, and transport-related operations that tend to produce higher concentrations of polluted stormwater runoff and/or have a higher risk for spills. They include auto repair shops, public works yards, restaurants, and other types of commercial, industrial, and institutional sites. Specific on-site maintenance combined with pollution prevention practices can significantly reduce the occurrence of "hotspot" pollution problems.

Assessment Protocol

The Hotspot Site Investigation (HSI) is part of the USSR framework. This survey evaluates commercial, industrial, municipal or transport-related sites that have a high potential to contribute contaminated runoff to the storm drain system or directly to receiving waters. At hotspot sites, field teams investigate vehicle operations, outdoor materials storage, waste management, building conditions, turf and landscaping, and stormwater infrastructure to evaluate potential pollution sources (Table 5). Based on observations at the site, field crews may recommend enforcement measures, follow-up inspections, illicit discharge investigations, stormwater retrofits, or pollution prevention control and education. A wide spectrum of solutions for fixing pollution sources, especially on municipal properties, is described in the manual, *Municipal Pollution Prevention/Good Housekeeping Practices* (Novotney and Winer, 2008).

The overall pollution prevention potential for each hotspot site is assessed using the HSI field form (Appendix A). The assessment identifies observed sources of pollution and the potential of the site to generate pollutants that would likely enter the storm drain network as identified in Table 5.

Table 5. Potential Hotspot Pollution Sources

Activity Type	Description	Examples
Vehicle Operations	Routine vehicle maintenance and storage practices, as well as vehicle fueling and washing operations	• Vehicle storage and repair • Fueling areas • Vehicle washing practices
Outdoor Materials	Exposure of outdoor materials stored at the site	• Loading and unloading • Outdoor material storage • Secondary containment
Waste Management	Housekeeping practices for waste materials generated at the site	• Dumpster practices • Oil and grease disposal
Stormwater Infrastructure	Practices used to convey or treat stormwater, including the curb and gutter, catch basins, and any stormwater treatment practices	• Catch basin cleanout • Stormwater treatment practices

General Findings

Field teams visited 30 potential pollution hotspot sites to conduct the HSI. At two sites, field teams were unable to access the property to conduct an assessment. The vast majority of the hotspot sites visited was located downtown and in the Main Street commercial corridor north of downtown. These consisted of gas stations, restaurants, grocery stores, shopping centers, vehicle maintenance garages, and car washes. Field teams identified active pollution problems at three of the pre-selected sites. In addition, pollution sources were found at two additional locations noted during field work. Table 6 lists the pollution problems found during this HSI. Figure 6 illustrates some of the field findings.

Table 6. Identified Hotspot Pollution Problems

Type of Hotspot	Identified Pollution Problems	Recommendations
Overflowing/Leaking Dumpsters	• Trash around dumpster; over-flowing dumpster at restaurant • Trash accumulation in stormwater basin at shopping center • Significant trash accumulation in pond – mostly plastic bottles • Open, leaking trash dumpster at vehicle maintenance garage	• Ensure dumpsters have lids, keep lids closed • Ensure bottom & corners of container do not have holes • Empty dumpsters on a frequent basis to prevent overflowing • Keep dumpster area clean
Wash water discharge	• Wash water draining to storm drain system from self-service car wash	• Contain wash water within wash bay to prevent spillage into parking lot
Uncovered, leaking outdoor material storage (e.g., grease tanks)	Restaurants: • Uncovered grease tanks, exposed to rain • Grease spills around grease tanks • Open metal drums of liquid with foul odor (unknown substance), exposed to rain Vehicle maintenance garage: • Leaking or over-flowing metal drums of oil at vehicle maintenance garage	• Provide secondary containment around outdoor material • Educate business employees on proper handling, storage and spill clean-up procedures • Empty grease tanks on a frequent basis to prevent overflowing • Keep up-to-date inventory of materials stored outdoors. • Keep spill kit on site to clean up spills
Leaking sewer pipe	• Sewer lateral pipe found leaking at ground level • In turn, town staff found and fixed major sewage block in sewer mains caused by grease and trash accumulation	• Conduct systematic illicit discharge outfall investigations to find and fix other sources of untreated sewage to the stream.

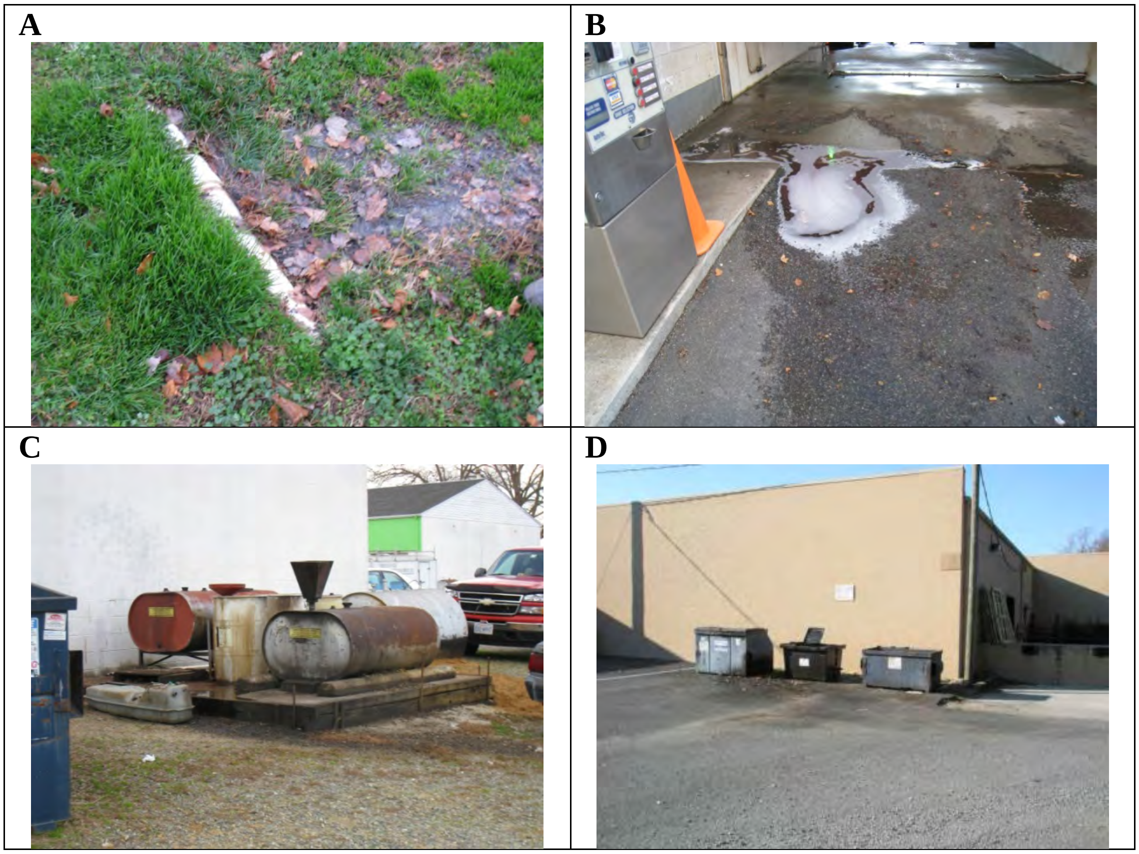

Figure 6. Pollution producing behaviors found during the HSI: A. Leaking sewer lateral pipe; B. Car wash soapy water draining to parking lot; C. Fuel oil containers overflowing; D. Grease and trash containers leaking onto pavement.

3.2.2 Neighborhood Source Assessment

Everyday activities and behaviors conducted within residential neighborhoods can be a source of pollution that influences stream water quality. Some behaviors that negatively influence water quality include over-fertilizing lawns, using excessive amounts of pesticides, and inappropriate trash disposal or storage. Alternatively, positive behaviors such as tree planting and using native plants, disconnecting rooftop downspouts from storm drains, and picking up pet waste can help improve water quality. These residential activities and behaviors were assessed within the town.

Assessment Protocol

The Neighborhood Source Assessment (NSA) was conducted to evaluate pollution source areas within individual residential neighborhoods. It is also part of the USSR framework. This “windshield survey” focuses specifically on yards and lawns, rooftops, driveways and sidewalks, curbs, and common areas. The NSA field form (Appendix A) was used to assess neighborhoods in terms of existing tree cover, stormwater management, fertilizer use on lawns, evidence of pollution sources, and evidence of resident stewardship (e.g., storm drain stenciling, pet waste management signage). In turn, the field teams considered potential restoration and education opportunities for each neighborhood, as identified in Table 7.

Table 7. Typical Projects Identified during a Neighborhood Source Assessment		
Project Type	**Description**	**Examples**
On-site Retrofits	Homeowners reduce/manage stormwater runoff generated by their lots	• Rain gardens • Rain barrels • Downspout disconnection
Lawn and Landscaping Practices	Better lawn and landscaping practices to minimize the use of chemicals and encourage the use of native landscaping, particularly in neighborhoods where lawns are prevalent and highly managed	• Improved stream buffer protection • Native plantings • Turf reduction • Reduced fertilizer and pesticide application • Reduce ditch erosion
Open Space Management	Management of neighborhood common areas or courtyards	• Landscaping • Tree planting • Pet waste signage and containers • Stream buffer restoration • Trash removal
Education and Outreach	Providing homeowners with additional information to better manage pollution in their residential lots	• Lawn and nutrient management outreach • Pet waste education • Septic system education • Storm drain stenciling

General Findings

Field teams visited 25 residential neighborhoods to conduct the NSA. Most of the town's residential neighborhoods are located south of Route 200 and south of downtown, within the Dymer Creek and Indian Creek subwatersheds (Figure 7). The majority of the neighborhoods assessed have single family homes on quarter-acre or smaller lots. No egregious pollution problems were found, but the field crews identified several opportunities for soil restoration, stewardship projects, and homeowner education. Examples of neighborhood conditions are shown in Figure 8, and Table 8 provides a summary of opportunities for each neighborhood. A general description of these opportunities is provided below.

- *Lack of tree cover* – Most of the homes seen in these neighborhoods have expansive lawns. Trees help catch rainfall before it can turn to runoff. Increasing the tree cover in a watershed is an effective way of reduce runoff and peak flows, promote infiltration to ground water, provide filtration for water quality, moderate the effect of summer heat spikes on stream temperature, and supply food in the way of leaf litter for organisms at the base of the stream food web.
- *Intensely mowed yards* – Too much mowing can compact the soil which reduces the amount of rainfall that can soak into the ground. Also, taller grass reduces runoff more efficiently than very short grass. A recommended practice includes setting mower decks to a higher setting to avoid cutting grass too short. Taller grass produces stronger roots, will reduce stormwater runoff from the site, and will expose less soil to erosion. If possible, also try to reduce frequency of mowing to lessen soil compaction over time.
- *Heavy use of lawn fertilizer* – Several neighborhoods exhibited bright green lawns (in December) which are a likely sign of heavy fertilization. Excessive fertilization can cause nutrients to run off into local streams during storms.
- *Soil erosion problems* – Several neighborhoods had poorly established vegetation due to poor quality topsoil and compaction from over-mowing. Several landscaping changes

could help reduce the amount of bare soil and erosion seen in some of Kilmarnock's neighborhood. To increase the organic matter content of the soil, consider tilling in compost amendments in the fall. Where turf area is still needed, re-seed and straw following the addition of compost. Otherwise, replace turf grass with other perennial ground cover that is better suited to sandy soils and does not need to be mowed as frequently.

- *Roof downspouts connected to storm drain pipes* – This roof drainage design does not allow roof water to soak into the ground. Residential roof downspouts that are connected directly to storm drain pipes can be disconnected and re-routed to an adequately sized lawn or pervious area (disconnection), a rainwater cistern/rain barrel for use in outside irrigation, or a rain garden to filter pollutants.
- *Swimming pools* (only a problem if homeowners drain their chlorinated pool water to the street and/or storm drain network)

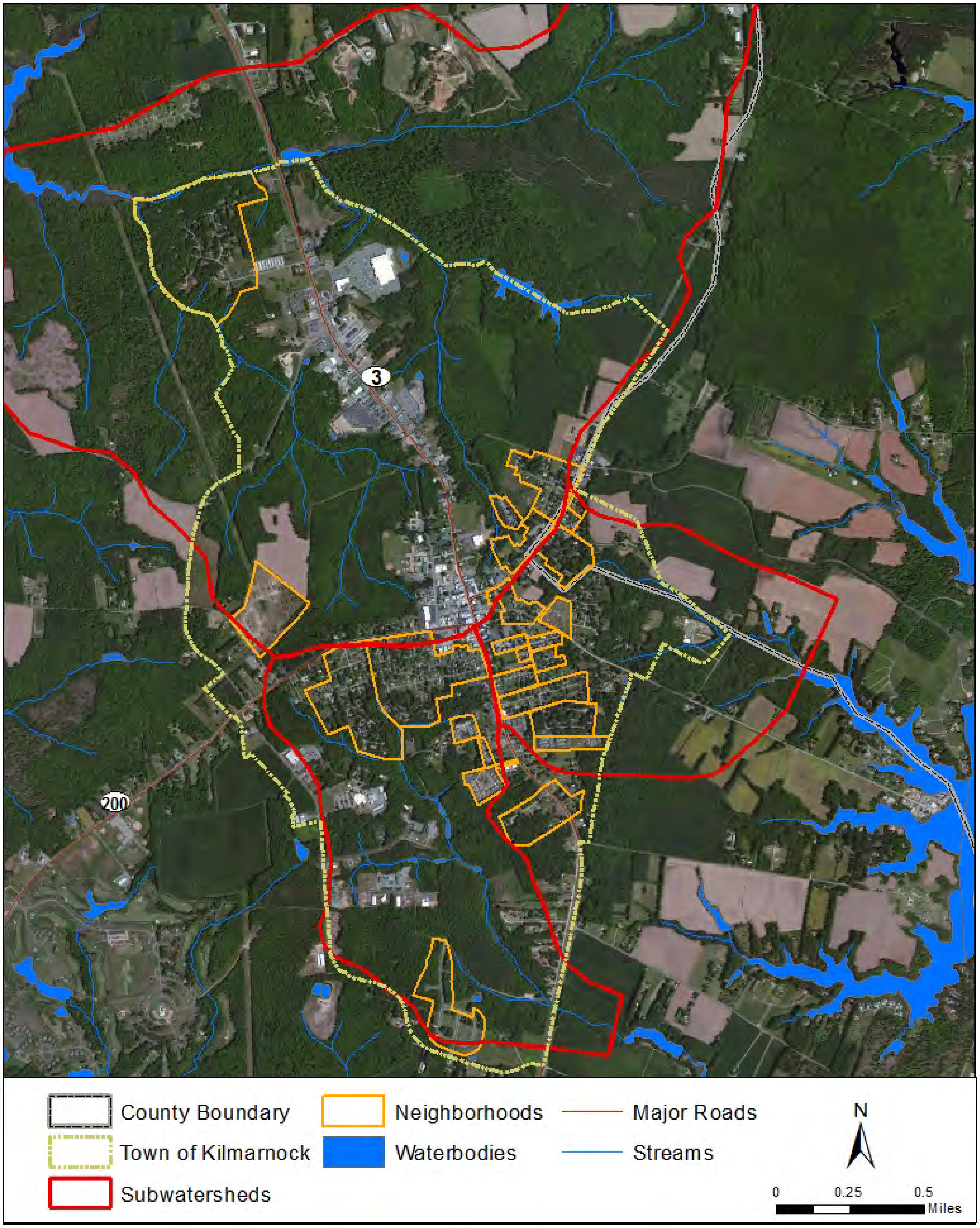

Figure 7. Location of neighborhoods assessed.

Figure 8. Examples of neighborhood conditions: A & B. Heavy fertilizer use (Sites N-103 & N-111); C. Lack of trees (Site N-121); D. Opportunity for rain garden (Site N-106); E. Establish better topsoil, plant trees and ground cover (Site N-113); F. Control erosion and reduce mowing, plant trees (Site N-112).

Table 8. Neighborhood Restoration Opportunities

Site ID	Street Location	Comments	Restoration Opportunities				
			Plant Trees/ Ground Cover	Rainwater Harvesting	Rain Gardens	Disconnect Downspouts	Fix Erosion Problem
N-100	Corrotoman Circle, Hawthorne Avenue	Potential to treat stormwater at outfalls (e.g., rain gardens)			X		
N-101	Venable Drive, Gilbert Street	None.	X				
N-102	Bayridge Avenue, Avonne Avenue	None.	X	X			
N-103	Clifton Avenue, Oak Ridge Drive	Let grass grow taller	X				
N-104	Fox Hill Drive	None.					
N-105	Waverly Avenue, East Church Street	Educate on proper disposal of pool water.					
N-106	Heatherfield Court	None.			X		
N-107	Lloyd Lane	None.	X				
N-108	Dogwood Lane	None.					
N-109	Hatton Avenue	None.	X		X		
N-110	Cedar Lane	None.	X				
N-111	Kamps Lane, Lawler Lane	Reduce use of lawn fertilizer					
N-112	Baywalk Drive	Erosion due to over-mowing	X				X
N-113	Shamrock Court, Tartan Village Drive	Multiple restoration needs	X				X
N-114	Southport Lane	Disconnect downspouts on back on buildings				X	
N-115	Wiggins Avenue	None.					
N-116	Dilvers Road, Dennisville Drive	None.	X				
N-117	Braxton Way, Pleasants Lane	None.					

Site ID	Street Location	Comments	Restoration Opportunities				
			Plant Trees/ Ground Cover	Rainwater Harvesting	Rain Gardens	Disconnect Downspouts	Fix Erosion Problem
N-118	First Avenue, Second Avenue, Third Avenue, Roseneath Avenue, Claybrook Avenue	Reduce fertilizer use	X				
N-119	Chase Street	None.	X				
N-120	Walnut Street	None.	X		X		
N-121	Byway Drive, Byway Circle	None.	X				
N-122	Town Center Drive, East Church Street	None.		X	X		
N-123	Dixie Avenue	None.					
N-301	Purcell Drive, Waverly Avenue	Town Carnival property	X				X

3.3 Stream Head Cuts

Stream head cutting is a process of active erosion in a channel caused by an abrupt change in slope. Head cuts occur when the turbulence in the water undercuts substrate material resulting in collapse of the upper level. This undercut-collapse process advances up the stream channel.

Assessment Protocol

Town staff identified thirteen headwater channels with existing head cuts for the field teams to investigate, of which two were inaccessible. These channels consist of storm drain outfalls that feed natural ravines, as well as channels that receive very little runoff from developed areas yet still are undergoing considerable erosion. In total, the field teams visited twelve stream channels (one extra head cut was found in the field) for a preliminary investigation. Out of these, seven were identified for a more extensive evaluation based on the potential threat to existing infrastructure, and the potential for ongoing erosion and impacts to receiving waters. Table 9 provides a list and location of the seven head cuts evaluated, and Figure 9 provides a corresponding map.

Table 9. Investigated Channels with Head Cuts

Map ID	Site Location	Subwatershed
S-100	School Street Pump Station	Corrotoman River (Norris Prong)
S-101	School Street at intersection with North Main Street	Corrotoman River (Norris Prong)
S-102	Behind vacant structure north of Food Lion	Corrotoman River (Norris Prong)
S-103	Walmart Access Road	Corrotoman River (Norris Prong)
S-104	Municipal Parking Lot	Corrotoman River (Norris Prong)
S-108	Food Lion/McDonalds	Corrotoman River (Norris Prong)
S-401	Lancaster Middle School	Corrotoman River (Norris Prong)

A follow-up visit was made to assess the physical conditions and dimensions of head cut S-102 as well as to do a more thorough visual survey of S-103 and S-401. These sites were chosen as representative and high priority in consultation with town officials. Simple transit level and rod measurements were conducted along the length and width of the head cut. These measurements allowed a very preliminary assessment of the total volume of sediment that has mobilized downstream. It is important to note that the measurements are not adequate for a final design, nor were they benchmarked into any horizontal or vertical datum.

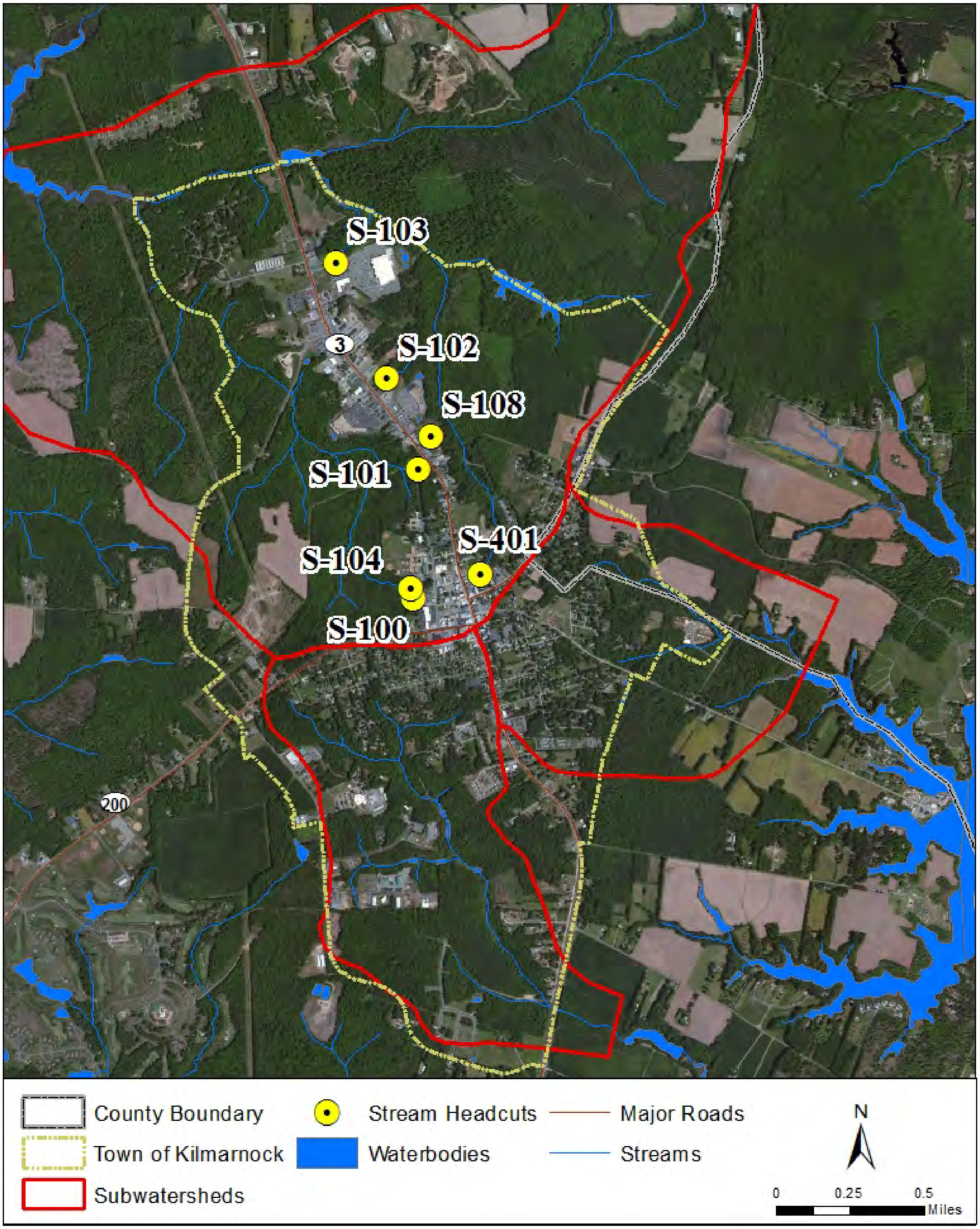

Figure 9. Location of channel head cuts investigated in the field.

General Findings

Most of these channels are not flowing streams; rather they are drainage channels that are generally dry in the upper reaches and drop down a relatively steep vertical grade over a variable distance to the floodplain. The cause of the head cuts may include an increase in impervious cover and stormwater runoff from the contributing drainage area, or channelization within the contributing drainage area that concentrates the runoff into the channel, thereby increasing the erosive energy (with or without an increase in impervious cover). The consistent factors in all the channels are the presence of highly erodible soils at or near the lower elevations of the channel, and an erratic meandering of the newly scoured channel.

The typical evolution of a head cut is a gradual up-gradient migration of the erosion of the underlying soils, causing the topsoil to cave in over top of the scour and be washed downstream. The initial erosion occurs where the gradient of the channel flow intercepts the exposed horizontal layer of erodible soils – this initial exposure can be the result of a single large storm that uproots vegetation, or a long-term increase in flow resulting from changes in the upstream hydrology. In either case, once the process has begun, it becomes very difficult to stop the steady upstream migration due to the highly erodible nature of the soils. Once exposed, even small amounts of runoff can mobilize enough of these soil particles to accelerate the erosion. Eventually, the head cut reaches the upstream drainage system or other infrastructure and must be stabilized or it can damage existing infrastructure.

Of the seven head cuts evaluated, the following five head cuts were identified as the most problematic in Kilmarnock. These are the deepest and longest head cuts, and/or have the potential to put infrastructure at-risk.

Head Cut S-401: Lancaster Middle School

The most immediate impact to infrastructure is at the Lancaster Middle School (S-401). The outlet of the storm drainage pipe system that drains the visitor entrance driveway, the entire teacher parking lot, and the bus loop discharges into the adjacent woods southwest of the school building. The pipe outlet is suspended above a scour hole more than 5 feet deep and only 6 feet from the edge of the service drive to the School Street Pump Station (Figure 10). The outlet channel meanders through the wooded area and eventually meets the main stream channel.

Figure 10. Head cut S-401

The geomorphology of this channel includes a clay layer (blue marl, or marlstone, or other very stable clay-based material) that appears to have stopped the down-cutting of the channel at the elevation of the top of the layer. The channel may continue to erode by widening, but the particular geology of this channel appears to be holding the channel geometry relatively constant. Likewise, the head cut has reached the upstream limit (which has been armored with concrete).

However, the head cutting may continue and eventually undermine the armoring, threatening the drainage pipe and the subgrade of the school's service drive.

Head Cut S-102: Behind vacant structure north of Food Lion

The potential for ongoing erosion and impact to receiving waters appears to be very significant at the outfall channels S-102 and S-103. The outfall channel at S-102 shows evidence of a head cut with an up-gradient extent of between 50 and 90 linear feet from the culvert outlet under North Main Street. The drainage system is a concrete pipe culvert that drains the commercial frontage on the west side of North Main Street for an indeterminate distance along North Main Street (the grades are very flat, and the extent of drainage area from the commercial properties is difficult to determine).

The head cut initially appears as a sunken area of grass that quickly drops into a gully (eighteen inches wide, two feet deep) with exposed soil on the sides and bottom. It then drops into a large cavernous channel (top width of 13 feet, bottom width of 6 feet, and approximately 6 feet deep) within a channel length of 50 feet (Figure 11). This eroded gully cross section continues to increase in size with sharp grade drops at intermediate locations as the channel erodes from the upper elevation down to the floodplain. Figure 12 shows a schematic profile of the channel as measured in the field.

Figure 11: Head cut S-102

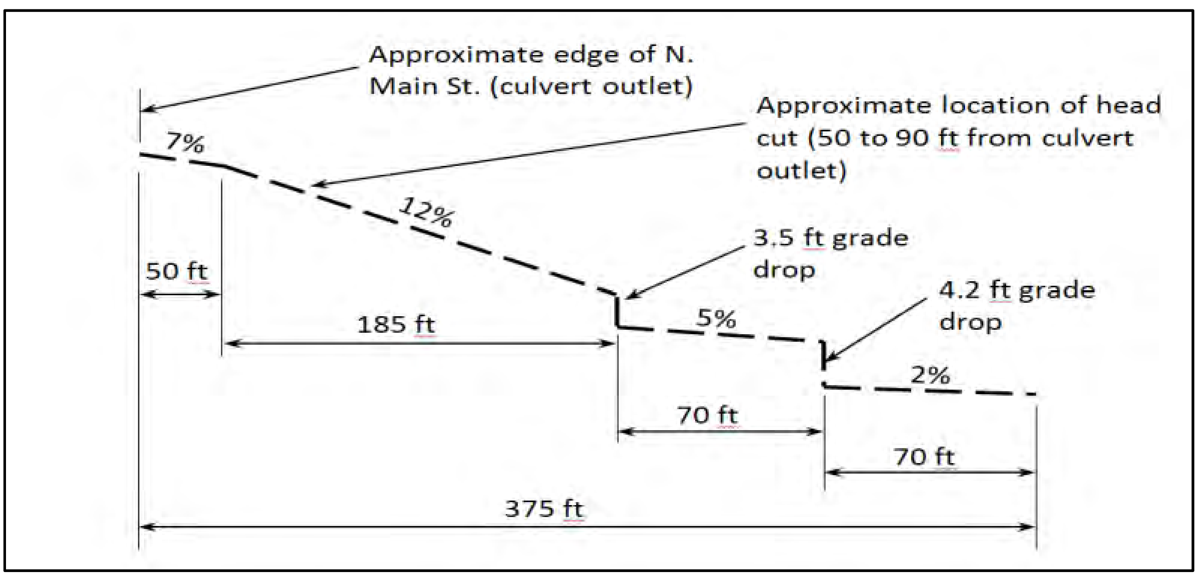

Figure 12. Schematic profile of head cut S-102

The profile of head cut S-102 is consistent with the geomorphologic process of a channel eroding and creating a meander to establish equilibrium between the channel grade and the soil structure.

In the case of the head cuts at S-102 and S-103, the highly erodible soils are being scoured from the upstream channel to fill in the lower channel and create a flatter grade. The 2% grade at the downstream end of the S-102 profile is approaching the relatively flat floodplain grade as the channel travels an additional 1,000 feet to the floodplain of the Corrotoman River (Norris Prong).

The quantity of sediment scoured from the channel can be approximated from the measured cross sections (approximately 3 ft^2 near the top of the head cut, to approximately 230 ft^2 at the bottom) and the total length of scour above the floodplain. The total length of scour was measured in a straight line, while the actual distance is considerably longer due to the meandering alignment of the erosion process. An inspection of the wide flat floodplain area (approximately 500 feet from the start of the head cut) reveals the stream's base flow braiding through a thick mat of sediment covering the entire width (Figure 13).

Figure 13: Floodplain below S-102

A very rough and conservative estimate is that approximately 1,650 cubic yards of soil has eroded into the floodplain below this outfall channel. Considering an average dump truck hauling capacity of 10 yd^3, approximately 165 truckloads of sediment from S-102 have covered the flood plain and are slowly migrating towards Norris Pond (Figure 14). Unlike the outfall at S-401 there is no apparent clay layer to slow or limit the channel erosion in terms of the depth of the scour. The channel bottom may continue to down-cut with additional grade drops, the channel width may increase as the meander pushes against the near vertical side walls, and the upstream edge of the head cut will undoubtedly continue to migrate up-gradient. The amount of time before the head cut erosion reaches the edge of North Main Street is dependent on the amount and intensity of rainfall.

Figure 14: Sediment from S-102 fills downstream channel

Head Cut S-103: Walmart access road – Old Fairgrounds Way

Figure 15: Concrete headwall above S-103

The head cut in the outfall channel at S-103 is similarly moving upstream. Although the head cut is not visible from Old Fairgrounds Way, there is evidence of soil instability and erosion in the vicinity of the Old Fairgrounds Way concrete retaining wall and the adjacent drainage system headwall (Figure 15). The overall condition of this head cut is very similar to that of S-102. A quick investigation of the downstream edge of the floodplain (where the outfall channel meets the main channel) as observed from the terminal point of the Baylor Park Nature Trail may indicate that the total volume of sediment that has moved downstream into the floodplain is greater than that of S-102. The sediment appears to be deeper with no evidence of vegetation being able to emerge.

Head Cut S-108: Food Lion/McDonald's

The head cut at S-108 has worked its way upstream to the existing stormwater basin that drains the McDonald's Restaurant and the Food Lion Shopping Center (and adjacent outparcels) on North Main Street. The embankment of the basin has been scoured away, although it is uncertain if this was the result of the up-gradient migration of the head cut or the result of a dam failure during a storm event. In either case, the channel draining this highly impervious area is scoured very similarly to S-102 and S-103 – the only difference being the relatively short distance to the downstream flood plain. The flood plain channel is braided through a thick mat of sediment that is gradually moving downstream.

Head Cut S-104: Municipal Parking Lot

The outfall channel at S-104 drains a municipal parking lot and other impervious areas adjacent to Main Street. The parking lot has a small BMP (see R-400 Site Summary in Appendix B) that treats the water quality volume from the parking lot. The impervious cover and the outfall channel are in the headwaters of the watershed, so the head cut may not be scoured all the way to the floodplain. However, the head cut may continue upstream to the parking lot and commercial property on Main Street.

Remedying these head cuts and the associated erosion and sediment delivery is very complex. Section 4 provides several recommendations for remedies. Given that sediment delivery from head cuts likely exceeds other sources by orders of magnitude, they may be a high priority for restoration as part of an overall plan.

3.4 Stormwater Retrofit Inventory

Stormwater retrofits are structural stormwater management practices that can be used to regulate the volume, duration, frequency, and rate of stormwater runoff. These practices can be installed in upland areas to capture and treat stormwater runoff before it is delivered to the storm drainage system and, ultimately, creeks and ponds in the town. They are an essential element of a holistic watershed restoration program because they can help improve water quality, increase groundwater recharge, and reduce erosion. Without using stormwater retrofits to help establish a stable, predictable hydrologic regime, the effectiveness of many other watershed restoration strategies – such as stream stabilization, erosion control, and aquatic habitat enhancement – will be diminished. Stormwater retrofits can also serve as local demonstration projects of a new generation of stormwater controls, and can help educate residents and build their interest in watershed restoration.

Assessment Protocol

Potential stormwater retrofit opportunities at a number of candidate project sites within the town were assessed. A Retrofit Reconnaissance Inventory (RRI) field form (Schueler, et al., 2007) was used to evaluate retrofit opportunities at candidate sites (Appendix A). Field teams looked specifically at drainage patterns, the amount of impervious cover, available space, and other site constraints when developing concepts for a site. In the town, retrofit opportunities were identified during field work as field teams visited the pre-identified hotspot, neighborhood, and stream head cut sites. Candidate retrofit sites generally had one or more of the following characteristics:

- Located on publicly-owned or operated lands or open spaces (e.g. school sites and parks)
- Located on commercial and industrial sites with large areas of impervious cover
- Potential to serve as a demonstration project; and
- Located at an existing stormwater best management practice (BMP)

It should be noted that the retrofit sites identified in the field represent only a portion of the potential retrofit opportunities in the town. A second field investigation would likely yield more retrofit opportunities.

General Findings

The list of projects provided in this report should not be considered a ranking but rather the basic information on which a ranking system can be based. The ultimate criteria for selecting any one of these retrofit projects should be developed by the town after considering the numerous water quality initiatives and regulatory drivers being developed and implemented in the region, as well as community needs such as protecting infrastructure and recreational amenities. Table 10 provides a list of the retrofit concepts identified in the field, listed in order of their site ID (not a ranking). A project write-up for each retrofit site, including photographs and a detailed description, is provided in Appendix B.

In addition to stormwater retrofit opportunities, three existing BMPs were identified as having experienced an embankment failure. The embankment of the WalMart stormwater pond failed either during construction of the shopping center or shortly thereafter, and has since been repaired. The Bowling Alley and the Food Lion (south) ponds have breached embankments that have not been repaired. (In addition, a potential future embankment failure was identified at a wet pond behind CVS where the corrugated metal spillway pipe has started to corrode.) The cause of the embankment failures was not confirmed, however, four common causes are suspected:

1. Inappropriate embankment construction material (too sandy or otherwise unsuitable soil);
2. Improper construction techniques:
    - Inadequate seepage controls
    - Failure to adequately compact embankment soil
3. Reduced storage volume due to the accumulation of sediment in the basin; and
4. Embankment undermined from a downstream outfall channel head cut.

These observations are noted because the excessive sediment loading associated with an embankment failure are comparable to the loads associated with the stream head cuts described in Section 3.3. The sediment loads from an embankment failure are more readily addressed through prevention. Due to the highly erodible soils in Kilmarnock, embankments on all impoundment BMPs should be given careful scrutiny during and after construction.

Table 10. Stormwater Retrofit Inventory

Site ID	Location	Proposed Retrofit
R-300	WalMart Parking Lot	Parking lot bioretention, existing wet pond (embankment failure during construction)
R-301A/B	Holiday Inn Express	Existing BMP retrofit
R-302	Walgreens Detention Pond	Existing BMP retrofit
R-303	CVS Wet Pond	Existing wet pond maintenance (corrosion of spillway pipe)
R-304	Bowling Alley Retention Pond	Existing wet pond repair (embankment failure)
R-400	Municipal Parking Lot	Existing BMP repair
R-401	Lancaster Middle School	Parking lot and adjacent area bioretention and outfall repair (see S401)
R-402	Boys and Girls Club	Impervious disconnection
R-403	Peebles Shopping Center	Parking lot bioretention
H-105, 120, & 121	McDonalds Restaurant and Food Lion Shopping Center	Existing BMP Repair and parking lot bioretention Two wet ponds at Food Lion (south pond, embankment failure)
R-110	Technology Park	Existing BMP repair

SECTION 4. RECOMMENDATIONS

4.1 Recommendations

1. *Encourage restoration in residential neighborhoods.*

Several opportunities were noted in the residential neighborhoods that include increased tree canopy, reduced use of fertilizer and pesticides, and downspout disconnection (Section 3.2.2). During the neighborhood assessment, large lawns were noted with the potential for increased tree canopy. The town should work with the local soil and water conservation district to provide free tree giveaways to residential homeowners, or similar types of efforts. This program could be incorporated into meeting a tree canopy goal. Additionally, education should be provided to the homeowners and maintenance companies on proper lawn fertilization. An example program is the James City County, VA *Turf Love* program in cooperation with the Virginia Cooperative Extension. This program provides lawn analysis and workshops to educate residents on how to produce a healthy turf while not polluting local waterways. For more information on this program visit http://offices.ext.vt.edu/james-city/programs/anr/Turf_Love.html

Downspout disconnection opportunities were noted in the neighborhoods. This includes simple disconnection to the lawn, a rain barrel or rain gardens. The town should consider providing cost share funding to offset the cost of a rain barrel or rain garden. Additionally, the Friends of the Rappahannock have a program called ‘Livable Neighborhoods’. This program develops leaders for neighborhood projects that build a safer and healthier watershed. The goal of the Livable Neighborhood Program is to reach all stakeholders in the watershed, serve as a forum for discussion of the stormwater concerns of the town and its citizens, and educate citizens on simple practices they can take to reduce pollution from their homes. The results from the neighborhood assessment provide a list of restoration and protection projects that can be integrated into the existing Livable Neighborhood Program.

2. *Mitigate Hotspot Pollution Problems*

At the five sites where pollution problems were found, town staff and/or Lancaster County staff should work with property owners to correct these problems. Town staff has been briefed on the location of these sites.

If an illicit discharge ordinance does not already exist, the Town should consider establishing one in order to have the authority to remedy these types of point source pollution.

In addition, the town could consider establishing a business-oriented clean water incentive program, whereby local businesses are encouraged to adopt a set of clean water practices based on standards or a checklist. The program could be set up to offer signage or other promotion of businesses that “pass the test.” The program could feature some type of logo or branding, such “Clean Water Kilmarnock.”

3. *Address Stormwater Basin Embankment Failures*

Several stormwater basin embankment failures were noted during field work (Section 3.4). It is the responsibility of the property owner or developer (if construction permit still active) to fix these embankments, however they may not be aware of the problem. Town staff should work with Lancaster County to inform the property owners of the need to fix these damaged stormwater basin embankments.

Several recommendations are provided to avoid future problems with basin embankments:

1. For new basins, inspections during construction should ensure that embankments are constructed in accordance with the plan specifications and built with the specified materials. In general, basins should not be placed next to streams, so as to avoid erosion of the embankment from the streams' flow.

2. For existing basins, on-going operation and maintenance inspections should ensure that:
   a. The outlet pipe does not exhibit signs of seepage or excessive corrosion;
   b. The embankment does not have woody vegetation, or show evidence of animal burrows or sink holes; and
   c. The sediment forebays and main pool areas have less than one-half of the storage depth filled with sediment.

4. Address Stream Head Cuts

The potential solutions to stabilize and prevent channel head cutting are neither simple nor inexpensive. The primary objectives of any proposal to address these head cuts is to stop the up-gradient migration of the erosion, stabilize the channel itself, and remove or stabilize the sediment that is already in the floodplain. One option is to reduce the amount of runoff from the upstream drainage areas through stormwater retrofitting (Section 3.4, Appendix B). However, given the highly erodible soils that characterize these outfall channels, even the implementation of an aggressive stormwater retrofit strategy to reduce the volume, velocity, and peak flow rate of stormwater runoff may only succeed in slowing the rate of erosion. Similarly, implementing stringent stormwater controls on new development in these watersheds will not eliminate the erosion. The channels will continue to erode to establish the equilibrium of a low gradient channel.

Each head cut investigated will require a detailed assessment to determine the practicality and cost estimate for any proposed solutions. The five head cuts described in Section 3.3 all drain towards Norris Pond which is currently serving as a large sediment basin. The costs for addressing the head cuts should be compared against the cost savings from not having to dredge Norris Pond and not having to repair damage to infrastructure (buildings, utilities) eventually caused by the head cuts.

Three approaches to address these head cuts are discussed below:

1. Stop the up-gradient migration of the head cut by installing a drop structure such as a manhole and pipe, a slope drain, or other means of conveying the stormwater to the appropriate lower elevation. The drop structure can be placed above the highest point of the head and a pipe installed within the existing scoured channel. (Some minor

grading would be required to create suitable pipe bedding. This also assumes that the existing soil material is suitable for the proposed structural improvements.) Careful alignment of the pipe along with suitable soils for backfilling over the pipe can minimize the need to bring in significant amounts of fill material or to excavate and haul material away

2. Stabilize the channel with channel restoration practices such as Regenerative Stormwater Conveyance (RSC) (Figure 16). This is a system of step pools that is designed to bring stormwater down to the bottom elevation and can incorporate water quality treatment. The design of a RSC is somewhat unique for each outfall channel. In general, RSC will include earthwork to create the step pool geometry and large to medium sized rock to create the pools and to withstand the energy of large flows.

   Stabilizing the channel can also include different scales of stream restoration or stabilization techniques below a drop structure as previously described. Stabilization techniques can be as simple as laying back the vertical eroded slopes of the channel and installing check dams or other forms of energy dissipation at the appropriate elevations within a newly created (armored or otherwise stabilized) channel. Any remedy should be analyzed carefully to ensure that structures (such as check dams or energy dissipation devices) won't be undermined by continued head cutting of the channel.

3. Removal of sediment may be beyond the reach or capacity of traditional equipment as the floodplains are not easily accessible with heavy equipment. Further, the volume of sediment is such that the excavation and hauling would likely cause more damage than already exists. A possible solution is to establish a traditional floodplain configuration by creating a stable primary low flow channel within the floodplain and stabilize the sediment in flood fringe with native grasses and other vegetation.

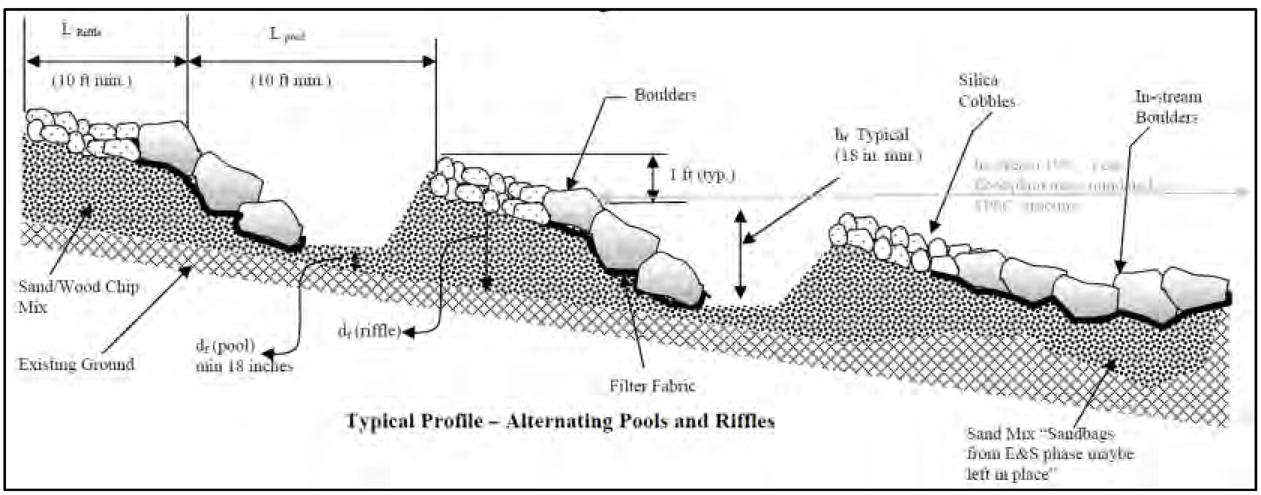

Figure 16. Regenerative Stormwater Conveyance profile (Anne Arundel County, MD, 2012.)

5. *Town to provide leadership role in stormwater management*

Kilmarnock's Comprehensive Plan (2006) states that, "The focus of policies will be on ways to reduce or minimize the amount of pollutants in the runoff water as well as minimizing the amount of such water that reaches the Chesapeake Bay tributaries." Using the retrofit concepts identified in this report, the town can install runoff reduction practices that not only achieve this goal outlined in the Comprehensive Plan, but that also serve as a showcase for the region.

The town and its partners should look for future project funding to install these projects (e.g., National Fish and Wildlife Foundation, Chesapeake Bay Restoration Fund). The projects should have signage installed that describes the benefits of the project and serves to educate town residents. For example, a demonstration retrofit could be installed at the Lancaster Middle School (R-401) where several biofilter systems are proposed in the parking lot. This is a highly visible area and could engage the students by incorporating stormwater and the environment into the school's science curriculum.

Other stormwater retrofit projects should be prioritized using criteria important to the town. Typical stormwater retrofit ranking criteria include cost, community education and involvement, water quality improvement, and ecological objectives. Once the projects are prioritized, the town should focus efforts on the implementation of the high priority projects.

6. Establish Strong Partnerships for Implementation

Restoring a watershed is most successful through partnerships with organizations that bring together different strengths and resources. Several local organizations that may serve as good partners include Friends of the Rappahannock, Lancaster County, Northern Neck Soil and Water Conservation District, and Lancaster County Cooperative Extension Service. Local partners could meet once a month or quarterly to discuss progress on implementing restoration projects identified in this report. This report should act as a living document to be updated every five years to include additional data on the subwatersheds and restoration progress.

7. Conduct additional watershed assessments

While the scope of this project was limited to the assessments provided, several additional assessments may be useful for watershed restoration. A more extensive stream assessment that involves walking the entire length of streams within Kilmarnock would paint a clearer picture of the physical impacts of the town's upland areas on the streams. No water quality data is known to exist for streams in Kilmarnock, so this is a gap that would be very useful to fill, perhaps with the help of citizen volunteers.

An assessment of illicit discharges, especially to identify and fix any existing sewer leaks, could reduce a potentially significant source of nutrients and bacteria to local streams. As an example, a leaking sewer lateral pipe was discovered just by chance during this watershed assessment (Section 3.2.1) – other leaks are almost certainly out there.

With a significant amount of undeveloped lands in the town, it would be useful to inventory the extent and type of existing ecological communities, wetlands, contiguous forests, and additional stream assessments. This information would inform Kilmarnock's decision-makers about the areas of town with the most valuable ecosystems that should be preserved.

4.2 Summary of Proposed Actions

This study proposes a wide variety of actions to improve watershed conditions in the Town of Kilmarnock. Table 11 below summarizes the types of actions proposed and assigns each a relative ranking of (1) the complexity of implementing the practice and (2) the water quality benefit of that practice.

Table 11. Relative Ease and Benefit of Proposed Watershed Actions for Kilmarnock

Concept	Sites	Complexity*	Water Quality Benefit**
Neighborhoods			
Plant trees and/or ground cover	N-101, N-102, N-103, N-107, N-109, N-110, N-112, N-113, N-116, N-118, N-119, N-120, N-121, N-301	Low	Medium
Disconnect downspouts	N-114	Low	Medium
Fix erosion	N-112, N-113, N-301	Medium	High
Reduce fertilizer use	N-111, N-118	Low	High
Rain gardens	N-100, N-106, N-109, N-120, N-122	Medium	Medium
Rainwater harvesting	N-102, N-122	High	High
Proper pool water disposal	N-105	Low	Low
Basin Repairs			
Repair embankment/dam	R-304, H-105/120/121	Medium	High
Other maintenance	R-303, R-110	Medium	Medium
Retrofits			
Retrofit existing BMP	R-301A &B, R-302	Medium	Medium
New bioretention	H-105/120/121, R-300, R-401, R-403	High	High
Disconnection	R-402	Low	high
Hotspots			
Proper dumpster maintenance		Low	Medium
Wash water containment at car wash		Medium	Medium
Proper outdoor materials storage		Medium	Medium
Fix leaking sewer pipes		Medium	High
Head Cuts			
Stop up-gradient head cut migration		Medium	Medium
Stabilize & restore channel		High	High
Remove sediment from floodplain		High	High
Stabilize floodplain		High	High

* “Complexity” of implementing practice refers primarily to the technical aspects of implementation. Programmatic (e.g., outreach or enforcement) elements may be more difficult.
** “Water Quality Benefit” of practice is based on pollutant and runoff reduction values described by the Virginia Runoff Reduction Method, EPA Chesapeake Bay Program, and based on best professional judgment.

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APPENDIX A: FIELD FORMS

This appendix includes the field forms used during Kilmarnock's watershed field assessment:

- Retrofit Reconnaissance Inventory form
- Hotspot Site Investigation form
- Neighborhood Source Assessment form
- Severe Bank Erosion form

WATERSHED:		**SUBWATERSHED:**		**UNIQUE SITE ID:**
DATE:	**ASSESSED BY:**	**CAMERA ID:**	**PICTURES:**	
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**	

SITE DESCRIPTION

Name:____
Address:____

Ownership: ☐ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:________________________

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:_________________

Proposed Retrofit Location:

Storage
☐ Existing Pond ☐ Above Roadway Culvert
☐ Below Outfall ☐ In Conveyance System
☐ In Road ROW ☐ Near Large Parking Lot
☐ Other:________________________________

On-Site
☐ Hotspot Operation ☐ Individual Rooftop
☐ Small Parking Lot ☐ Small Impervious Area
☐ Individual Street ☐ Landscape / Hardscape
☐ Underground ☐ Other:______________
____

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ _________________
Imperviousness ≈ ________________%
Impervious Area ≈ _______________

Notes:

Drainage Area Land Use:
☐ Residential
  ☐ SFH (< 1 ac lots)
  ☐ SFH (> 1 ac lots)
  ☐ Townhouses
  ☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☐ Other:______________

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☐ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width (if applicable):________

Existing Head Available:

Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)

PROPOSED RETROFIT

Purpose of Retrofit:

☐ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☐ Demonstration / Education ☐ Repair ☐ Other:______________________________

Retrofit Volume Computations - Target Storage:

Retrofit Volume Computations - Available Storage:

Proposed Treatment Option:

☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☐ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other:______________________

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

Available Width: __________
Available Length: __________
Available Area: __________
Ponding Depth: __________
Soil Depth: __________

SITE CONSTRAINTS

Adjacent Land Use:

☐ Residential ☐ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:__________________

Possible Conflicts Due to Adjacent Land Use? ☐ Yes ☐ No
If Yes, Describe:

Access:

☐ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:__________________

Conflicts with Existing Utilities:

	Yes	**Possible/ Modifiable**	**No**	**Unknown**
Sewer:	☐	☐	☐	☐
Water:	☐	☐	☐	☐
Gas:	☐	☐	☐	☐
Electric to Streetlights:	☐	☐	☐	☐
Other:	☐	☐	☐	☐

____
____

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☐ Not Probable
Impacts to Wetlands	☐ Probable	☐ Not Probable
Impacts to a Stream	☐ Probable	☐ Not Probable
Floodplain Fill	☐ Probable	☐ Not Probable
Impacts to Forests	☐ Probable	☐ Not Probable
Impacts to Specimen Trees	☐ Probable	☐ Not Probable

How many?____________
Approx. DBH____________

Other factors:______________________________
____

Soils:

Soil auger test holes:	☐ Yes	☐ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☐ No
Evidence of shallow bedrock:	☐ Yes	☐ No
Evidence of high water table (gleying, saturation):	☐ Yes	☐ No

SKETCH

Design or Delivery Notes

Follow-up Needed to Complete Field Concept

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☐ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☐ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☐ Other:____

Initial Feasibility and Construction Considerations

Site Candidate for Further Investigation:	☐ Yes	☐ No	☐ Maybe
Is Site Candidate for Early Action Project(s):	☐ Yes	☐ No	☐ Maybe
If no, site candidate for Other Restoration Project(s):	☐ Yes	☐ No	☐ Maybe

If yes, type(s):____

WATERSHED:	**SUBWATERSHED:**		**UNIQUE SITE ID:**	
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**	**PIC#:**	
MAP GRID:	**LAT** ___°_____'_____" **LONG** ___°_____'____"		**LMK #**	

A. SITE DATA AND BASIC CLASSIFICATION

Name and Address: ___________________

____

____

SIC code (if available): ___________

NPDES Status: ☐ Regulated ☐ Unregulated ☐ Unknown

Category: ☐ Commercial ☐ Industrial Miscellaneous ☐ Institutional ☐ Municipal ☐ Golf Course ☐ Transport-Related ☐ Marina ☐ Animal Facility

Basic Description of Operation:

____

	INDEX*
B. VEHICLE OPERATIONS ☐ **N/A** *(Skip to part C)*	**Observed Pollution Source?** ☐
B1. Types of vehicles: ☐ Fleet vehicles ☐ School buses ☐ Other: ____________	
B2. Approximate number of vehicles: _______	
B3. Vehicle activities *(circle all that apply)*: **Maintained Repaired Recycled Fueled Washed Stored**	○
B4. Are vehicles stored and/or repaired outside? ☐ Y ☐ N ☐ Can't Tell Are these vehicles lacking runoff diversion methods? ☐ Y ☐ N ☐ Can't Tell	○
B5. Is there evidence of spills/leakage from vehicles? ☐ Y ☐ N ☐ Can't Tell	○
B6. Are uncovered outdoor fueling areas present? ☐ Y ☐ N ☐ Can't Tell	○
B7. Are fueling areas directly connected to storm drains? ☐ Y ☐ N ☐ Can't Tell	○
B8. Are vehicles washed outdoors? ☐ Y ☐ N ☐ Can't Tell Does the area where vehicles are washed discharge to the storm drain? ☐ Y ☐ N ☐ Can't Tell	○
C. OUTDOOR MATERIALS ☐ **N/A** *(Skip to part D)*	**Observed Pollution Source?** ☐
C1. Are loading/unloading operations present? ☐ Y ☐ N ☐ Can't Tell If yes, are they uncovered *and* draining towards a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell	○
C2. Are materials stored outside? ☐ Y ☐ N ☐ Can't Tell If yes, are they ☐ Liquid ☐ Solid Description: _______ Where are they stored? ☐ grass/dirt area ☐ concrete/asphalt ☐ bermed area	○
C3. Is the storage area directly or indirectly connected to storm drain (circle one)? ☐ Y ☐ N ☐ Can't Tell	○
C4. Is staining or discoloration around the area visible? ☐ Y ☐ N ☐ Can't Tell	○
C5. Does outdoor storage area lack a cover? ☐ Y ☐ N ☐ Can't Tell	○
C6. Are liquid materials stored *without* secondary containment? ☐ Y ☐ N ☐ Can't Tell	○
C7. Are storage containers missing labels or in poor condition (rusting)? ☐ Y ☐ N ☐ Can't Tell	○
D. WASTE MANAGEMENT ☐ **N/A** *(Skip to part E)*	**Observed Pollution Source?** ☐
D1. Type of waste *(check all that apply)*: ☐ Garbage ☐ Construction materials ☐ Hazardous materials **any of these**	○
D2. Dumpster condition (*check all that apply)*: ☐ No cover/Lid is open ☐ Damaged/poor condition ☐ Leaking or evidence of leakage (stains on ground) ☐ Overflowing **any of these**	○
D3. Is the dumpster located near a storm drain inlet? ☐ Y ☐ N ☐ Can't Tell If yes, are runoff diversion methods (berms, curbs) lacking? ☐ Y ☐ N ☐ Can't Tell **if both are yes**	○
E. PHYSICAL PLANT ☐ **N/A** *(Skip to part F)*	**Observed Pollution Source?** ☐
E1. Building: Approximate age: ________ yrs. Condition of surfaces: ☐ Clean ☐ Stained ☐ Dirty ☐ Damaged Evidence that maintenance results in discharge to storm drains (staining/discoloration)? ☐ Y ☐ N ☐ Don't know	○ ○

*Index: ○ denotes potential pollution source; ☐ denotes confirmed polluter (evidence was seen)

E2. Parking Lot: Approximate age _____ yrs. Condition: ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up Surface material ☐ Paved/Concrete ☐ Gravel ☐ Permeable ☐ Don't know	○
E3. Do downspouts discharge to impervious surface? ☐ Y ☐ N ☐ Don't know ☐ None visible Are downspouts directly connected to storm drains? ☐ Y ☐ N ☐ Don't know	○
E4. Evidence of poor cleaning practices for construction activities (stains leading to storm drain)? ☐ Y ☐ N ☐ Can't Tell	○
E5. Evidence of poor cleaning practices for washing activities (observed washwater dumping, stains leading to storm drain)? ☐ Y ☐ N ☐ Can't Tell	○
F. TURF/LANDSCAPING AREAS ☐ **N/A** *(skip to part G)* **Observed Pollution Source?**	☐
F1. % of site with: Forest canopy ____% Turf grass _____ % Landscaping ____% **Bare Soil 20 %**	○
F2. Rate the turf management status: ☐ High ☐ Medium ☐ Low **40% medium to high**	○
F3. Evidence of permanent irrigation or "non-target" irrigation ☐ Y ☐ N ☐ Can't Tell	○
F4. Do landscaped areas drain to the storm drain system? ☐ Y ☐ N ☐ Can't Tell	○
F5. Do landscape plants accumulate organic matter (leaves, grass clippings) on adjacent impervious surface? ☐ Y ☐ N ☐ Can't Tell	○
G. STORM WATER INFRASTRUCTURE ☐ **N/A** *(skip to part H)* **Observed Pollution Source?**	☐
G1. Are storm water treatment practices present? ☐ Y ☐ N ☐ Unknown If yes, please describe: __________________	○
G2. Are private storm drains located at the facility? ☐ Y ☐ N ☐ Unknown **> 25 %** Is trash, sediment and/or organic material present in gutters leading to storm drains? *(circle appropriate)*	○

H. INITIAL HOTSPOT STATUS - INDEX RESULTS

☐ Not a hotspot (fewer than 5 circles and no boxes checked) ☐ Potential hotspot (5 to 10 circles but no boxes checked)
☐ Confirmed hotspot (10 to 15 circles and/or 1 box checked) ☐ Severe hotspot (>15 circles and/or 2 or more boxes checked)

Follow-up Action:

Immediate (1 week)

☐ Refer for immediate enforcement
☐ Test for illicit discharge
☐ Check to see if hotspot is an NPDES non-filer

Mid-term (2-3 months)

☐ Schedule a review of storm water pollution prevention plan
☐ Suggest follow-up on-site inspection

Long-term (1 year)

☐ Onsite non-residential retrofit
☐ Suggest pollution prevention training for employees
☐ Other:____

Identified Opportunities:

General

☐ Include in future education effort (add specifics to Notes)
☐ Stencil or mark storm drain inlets
☐ Signage opportunities (buffer, wetland, bacteria, etc.)
☐ Other:____

Rooftop

☐ Evaluate feasibility of cistern or water reuse (roof area:____sf)
☐ Downspout disconnection (#: ____________)

Loading Areas

☐ Sweep loading areas
☐ Cover loading docks or redesign drainage (area: ________sf)

Fueling Islands

☐ Cover fueling islands (covered area: ___________sf)
☐ Install dry spill response kits (#: _____________)

Landscaping / turf

☐ Turf conversion to landscaping / Bayscaping (area: _______sf)
☐ Pervious area restoration (turf area: ____________sf)
☐ Tree planting (# or area: ______________)
☐ Reduce maintenance (mowing, herbicides, fertilizers)

Vehicle repairs

☐ Plumb indoor shop drains to sanitary
☐ Store fluids/batteries inside or under cover

Outdoor materials

☐ Provide cover or secondary containment (area: __________sf)
☐ Place materials on pallets

Dumpster management

☐ Cover or add/repair lids (#: ___________)
☐ Move dumpsters away from storm drains or streams

Parking lots

☐ Find and fix fluid leaks
☐ Trash and litter pick-up, sweeping
☐ Identify retrofit projects
☐ Reduce salt application

Stormwater Infrastructure

☐ Clean out storm drain inlets
☐ Perform maintenance inspection

Notes:

Neighborhood Source Assessment **NSA**

WATERSHED:	**SUBWATERSHED:**	**UNIQUE SITE ID:**	
DATE: ___/___/_____	**ASSESSED BY:**	**CAMERA ID:**	**PIC#:**

A. NEIGHBORHOOD CHARACTERIZATION

Neighborhood/Subdivision Name: ____ Neighborhood Area (acres) _______

If unknown, address (or streets) surveyed:

____

Homeowners Association? ☐ Y ☐ N ☐ Unknown If yes, name and contact information: __________________________

Residential *(circle average single family lot size):* __________________________

☐ Single Family Attached (Duplexes, Row Homes) <⅛ ⅛ ¼ ⅓ ⅓ acre ☐ Multifamily (Apts, Townhomes, Condos)

☐ Single Family Detached <¼ ¼ ½ 1 >1 acre ☐ Mobile Home Park

Estimated Age of Neighborhood: _____ years	Percent of Homes with Garages: _____% With Basements ____%		**INDEX***
Sewer Service? ☐ Y ☐ N			○
Index of Infill, Redevelopment, and Remodeling ☐ No Evidence ☐ <5% of units ☐ 5-10% ☐ >10%			○
Record percent observed for each of the following indicators, depending on applicability and/or site complexity	**Percentage**	**Comments/Notes**	
B. YARD AND LAWN CONDITIONS			
B1. % of lot with impervious cover			
B2. % of lot with grass cover			○
B3. % of lot with landscaping (e.g., mulched bed areas)			◇
B4. % of lot with bare soil			○
**Note: B1 through B4 must total 100%*			
B5. % of lot with forest canopy			◇
B6. Evidence of permanent irrigation or "non-target" irrigation			○
B7. Proportion of *total neighborhood* turf lawns with following management status:	High: ____		○
	Med: ____		
	Low: ____		
B8. Outdoor swimming pools? ☐Y ☐N ☐ Can't Tell Estimated # ____			○
B9. Junk or trash in yards? ☐ Y ☐ N ☐ Can't Tell			○
C. DRIVEWAYS, SIDEWALKS, AND CURBS			
C1. % of driveways that are impervious ☐ N/A			
C2. Driveway Condition ☐ Clean ☐ Stained ☐ Dirty ☐ Breaking up			○
C3. Are sidewalks present? ☐ Y ☐ N If yes, are they on one side of street ☐ or along both sides ☐			
☐ Spotless ☐ Covered with lawn clippings/leaves ☐ Receiving 'non-target' irrigation			○
What is the distance between the sidewalk and street? _____ ft.			◇
Is pet waste present in this area? ☐ Y ☐ N ☐ N/A			○
C4. Is curb and gutter present? ☐ Y ☐ N If yes, check all that apply:			
☐ Clean and Dry ☐ Flowing or standing water ☐ Long-term car parking ☐ Sediment			○
☐ Organic matter, leaves, lawn clippings ☐ Trash, litter, or debris ☐ Overhead tree canopy			◇

* INDEX: ○ denotes potential pollution source; ◇ denotes a neighborhood restoration opportunity

D. ROOFTOPS			
D1. Downspouts are directly connected to storm drains or sanitary sewer			◇ ○
D2. Downspouts are directed to impervious surface			
D3. Downspouts discharge to pervious area			
D4. Downspouts discharge to a cistern, rain barrel, etc.			
**Note: C1 through C4 should total 100%*			
D5. Lawn area present downgradient of leader for rain garden? ☐ Y ☐N			◇

E. COMMON AREAS	
E1. Storm drain inlets? ☐ Y ☐ N If yes, are they stenciled? ☐ Y ☐ N Condition: ☐ Clean ☐ Dirty	◇
Catch basins inspected? ☐ Y ☐ N If yes, include Unique Site ID from SSD sheet: ________________	○
E2. Storm water pond? ☐ Y ☐ N Is it a ☐ wet pond or ☐ dry pond? Is it overgrown? ☐ Y ☐ N What is the estimated pond area? ☐ <1 acre ☐ about 1 acre ☐ > 1 acre	◇
E3. Open Space? ☐ Y ☐ N If yes, is pet waste present? ☐ Y ☐ N dumping? ☐ Y ☐ N	○
Buffers/floodplain present: ☐ Y ☐ N If yes, is encroachment evident? ☐ Y ☐ N	

F. INITIAL NEIGHBORHOOD ASSESSMENT AND RECOMMENDATIONS	
Based on field observations, this neighborhood has significant indicators for the following: (*check all that apply*) ☐ Nutrients ☐ Oil and Grease ☐ Trash/Litter ☐ Bacteria ☐ Sediment ☐ Other ___________________	○

Recommended Actions

Specific Action

- ☐ Onsite retrofit potential?
- ☐ Better lawn/landscaping practice?
- ☐ Better management of common space?
- ☐ Pond retrofit?
- ☐ Multi-family Parking Lot Retrofit?
- ☐ Other action(s) ___________________________

Describe Recommended Actions:

Initial Assessment

NSA Pollution Severity Index

- ☐ Severe (More than 10 circles checked)
- ☐ High (5 to 10 circles checked)
- ☐ Moderate (Fewer than 5 circles checked)
- ☐ None (No circles checked)

Neighborhood Restoration Opportunity Index

- ☐ High (More than 5 diamonds checked)
- ☐ Moderate (3-5 diamonds checked)
- ☐ Low (Fewer than 3 diamonds checked)

NOTES:

ER

WATERSHED/SUBSHED:		DATE: ___/_____/___	ASSESSED BY:
SURVEY REACH:	TIME:___:____AM/PM	PHOTO ID (CAMERA-PIC #): /#	
SITE ID: (*Condition-#*) ER-_____	*START* LAT ____°____'____" LONG ____°____'____" LMK _____ *END* LAT ____°____'____" LONG ____°____'____" LMK _____		GPS: (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream)*
LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS)*	LT_______ft	and/or RT_________ft	Bottom width _______ft	
Bank Ht	LT_______ft	and/or RT__________ft	Top width __________ft	
Bank Angle	LT________°	and/or RT________°	Wetted Width _______ft	

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY(*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5 4	3	2 1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5 4	3	2 1

NOTES/CROSS SECTION SKETCH:

REPORTED TO AUTHORITIES ☐ YES ☐ NO

APPENDIX B: STORMWATER RETROFIT CONCEPT SUMMARIES

This appendix contains the following twelve concept summaries of stormwater retrofits, repairs, and/or maintenance actions on eleven different properties in Kilmarnock:

- H-105, 120 & 121: Lancaster Square Shopping Center (Foodlion)
- R-110: Technology Park Drive
- R-113: Tartan Village – elderly independent living neighborhood
- R-300: WalMart Parking Lot
- R-301A: Holiday Inn Express - front
- R-301B: Holiday Inn Express - back
- R-302: Walgreens Detention Pond
- R-303: CVS Wet Pond
- R-304: Bowling Alley Retention Pond
- R-400: Municipal Parking Lot
- R-401: Lancaster Middle School
- R-402: Boys and Girls Club
- R-403: Peebles Shopping Center

H-105, 120 & 121: Lancaster Square Shopping Center (Foodlion)

Figure 1: Existing stormwater basin

Figure 1: Inflow from McDonald's parking lot

Description: Site H-105 is a gas station, H-120 is a McDonald's restaurant, and a third outparcel, a bank, all combine with the main parking lot of the Lancaster Square Shopping Center anchor building, H-121 (Food Lion and several other smaller stores) and drain to an existing stormwater BMP on the southern edge of the parking lot. The BMP is a small basin that could be considered a constructed wetland, extended detention pond with a clogged orifice, or a wet pond with an undersized permanent pool. The site visit noted 3 important observations about the basin:

1. The basin appears to be significantly undersized (Figure 1). The drainage area to the basin is 6.3 acres (which does not include the main building roof drains; it was unclear where those are directed – front or rear of the building. The drainage area is almost 90% impervious.
2. The basin outlet appears to have been a rip-rap weir over the embankment that has been damaged by high flows. The outlet is now is an eroded gully through the embankment and provides little or no detention or retention of the storm flows.
3. A significant amount of debris and trash is mobilized into the site through the existing surface conveyance system (Figure 2).

The total drainage area to the basin is approximately 6.3 acres (90% impervious). This does not include the roof runoff of the grocery store and adjacent businesses (1.5 acres – it is not clear where the roof drains discharge. If they go to the rear of the building they would drain to the basin on the north end of the parcel, behind the shopping center).

Proposed Retrofit: This retrofit includes the following actions:

1. Verify the location of the roof drain discharge, and conduct an "as-built" survey to verify the existing basin volume. Re-grade the basin to provide adequate storage and repair the embankment and outlet structure.

(The basin on the north side of the property is significantly bigger with a much smaller drainage area. If it is assumed that the entire rooftop goes to the north basin, including all the impervious cover associated with the rear access road and loading dock, the total drainage area to the north basin is approximately 2.3 acres, 100% impervious.)

The repair of the basin should also include some form of pre-treatment at the inflow from the McDonald's site. Ideally, a screen or trash rack keeping the trash in or adjacent to the McDonald's parking lot will be much simpler to maintain than having to access the BMP at the bottom of a hill to remove trash.

2. Investigate the existing grass strip and possible BMP on the eastern edge of H-105. This strip divides H-105 from the H-121 shopping center parking lot). This appears to be an ideal location for a dry swale or other linear BMP. However, there appears to be an existing underground structure. The outlet pipe from an existing curb inlet appears to go directly into the grass island, and there is no visible outlet pipe; also, the grass island has two PVC vent pipes protruding from the ground (Figures 3 and 4).

Figure 3: Curb inlet draining 0.8 ac gas station

Figure 4: Grass island with vent pipes (there is no record of a BMP being located there).

R-110 Technology Park Drive

Figure 1: Infiltration trench w/ low earthen berm

Figure 2: Erosion of outlet

Description: The Technology Park located off of Harris Road in the Dymer Creek watershed consists of multiple businesses located on individual parcels. Several of the parcels include relatively new water quality BMPs that are functioning well. However, the last business located at the end of Technology Park Drive has an infiltration trench with low earthen berms to convey runoff from the turf and impervious areas of the site to the trench. The turf areas are cut extremely short (it could be described as too short as there is very little "stem density" to the vegetation and evidence of erosion and sediment transport within the turf areas). The trench has a diversion structure that appears to be designed to bypass larger storm flows. However, the accumulation of sediment appears to divert more flow than designed, and the outlet channel is experiencing erosion (Figure 2).

Proposed Retrofit: The inlet and outlet channel areas of this BMP should be re-shaped and stabilized. The inlet should be retrofitted with a forebay or other pre-treatment to keep the sediment from blocking the flow area. The outlet should be fitted with a level spreader to ensure that the concentrated flow does not continue to erode a channel. (The parcel is relatively flat with most, if not all, of the impervious cover is effectively disconnected. However, the effect of implementing a BMP and conveying runoff to the BMP has created concentrated flows that are causing erosion).

Additionally, and equally important, basic turf grass maintenance should be implemented to establish a better stand of grass on the parcel.

R-113: Tartan Village – elderly independent living neighborhood

Figure 1. Bare soil in communal area

Figure 2. Bare, sandy soil on slopes

Figure 3. Detention basin in communal area

Figure 4. Basin outlet, with erosion at base

Figure 5. Steep basin inlet, eroding

Description: Tartan Village is an independent living complex for elderly residents, managed by Bay Aging. The property consists of multiple one-story apartment buildings and a central communal area for residents. The communal area has a gazebo, benches, two stormwater management basins, and a lot of open grass area. A third small detention basin is located in a corner of the complex. The property is surrounded by woods and the landscaping consists primarily of turf grass.

Soil at this site is very sandy and is not doing a good job of supporting turf grass growth. There are bare patches of soil in the communal area (Figure 1) and some slumping and erosion beginning to occur on slopes (Figure 2). Lawn mower marks are visible in the soil due to compaction by the tires. Compaction from frequent mowing may be one reason the grass is not growing well.

The large detention basin in the central communal area (Figure 3) has some erosion problems, due in part to the its steep side slopes, lack of vegetation, and sandy soils. A hole is starting to develop in the ground surrounding the concrete riser structure (Figure 4) and is certain to get worse. And the soil in at least one of the steep rip-rap inlet channels is eroding beneath the stone (Figure 5).

Proposed Retrofits: The stormwater basin shown in Figures 3 – 5 was built with inlets and side slopes that are simply too steep. This is in part to blame for the inlet erosion. If the inlet erosion becomes severe, the property owners may need to re-construct the inlets to reduce their steepness – perhaps by creating more gradually sloped inlets with terraced step-pools. In the meantime, reduce mowing in the basin to allow roots to grow and hold the soil.

The erosion around the concrete riser may be a sign that the joints in the concrete (that are underground) were not adequately sealed, so water is getting sucked in that way. The best solution would be to dig down to the bottom of riser and properly seal the joint.

Other Solutions: Several landscaping changes could help reduce the amount bare soil and erosion in this neighborhood. To increase the organic matter content of the soil, consider tilling in compost amendments in the fall. Where turf area is still needed, re-seed and straw following the addition of compost. Otherwise, replace turf grass with other perennial ground cover that is better suited to sandy soils and does not need to be mowed as frequently.

When mowing, set mower deck to high setting to avoid cutting grass too short. Taller grass produces stronger roots, will reduce stormwater runoff from the site, and will expose less soil to erosion. If possible, also try to reduce frequency of mowing to lessen soil compaction over time.

R-300: WalMart Parking Lot

Figure 1: Proposed bioretention location in green

Figure 2: Drainage area leading to potential retrofit

Description: Most or all of the runoff from the large parking lot and roof at WalMart drains to a wet pond behind the building. There is certainly some water quality treatment benefit to this stormwater management practice, but very little infiltration and groundwater recharge usually occurs in a wet pond. The retrofit proposed here would not only allow better groundwater recharge on the site, but also serve as a highly visible stormwater management and landscaping feature at the entrance of the parking lot.

Proposed Retrofit:

Construct bioretention structure in the relatively un-used section of the front parking lot furthest away from the WalMart store, near corner of Old Fairgrounds Way and Chesapeake Way. Up to 240 feet of parking area along the curb line is present in the vicinity of the existing storm drain inlet (shown just to right of red star in Figure 1).

Asphalt and soil could be removed and replaced with bioretention structure to capture and infiltrate stormwater runoff that would otherwise enter this storm drain inlet and flow to the wet pond. Overflow from the bioretention during heavy rains can go into this existing storm drain. An underdrain pipe would likely not be needed given the sandy nature of soils in Kilmarnock, but an infiltration test of the underlying soils should be conducted in order to verify that the infiltration rate is sufficient (minimum infiltration rate is > 1 inch/hour in order to omit the underdrain).

***Surface Area Available** ≈ 4,320 square feet*

***Drainage Area** ≈ 2.78 acres*

R-301A: Holiday Inn Express - front

Figure 1: Northern end of detention basin

Figure 2: Southern end of detention basin

Figure 3: Partially clogged inlet to basin

Description: The *detention basin shown in the photos above is located at the edge of the parking lot in front of the Holiday Inn Express. The surface dimensions of the basin are 26' x 153' and runoff from the parking lot enters the basin via several curb inlets, which are partially blocked by grass (Figure 3). There is a concrete riser-type structure at the southern end of the basin, but it is unclear if and how this structure functions as an overflow outlet. The entire basin is currently managed as grass turf and the soil is very sandy.

*Check with Lancaster County staff to ensure that this was not intended as an infiltration basin. The practice should be observed during rain events to see how quickly stormwater currently infiltrates.

Proposed Retrofit: To improve pollutant reduction capabilities of this stormwater basin, two options are suggested:

1. Replace the turf with bioretention-friendly plants that can survive in both wet and dry conditions; or
2. Do a complete retrofit of the basin to convert it into a bioretention facility with layers of gravel, bioretention soil mix, mulch, and plants.

Since the basin currently has very sandy soil, if Option 1 is chosen, organic matter (e.g., compost) may need to be incorporated into the top 3 – 6 inches of soil to improve conditions for new plants.

Surface Area Available *≈ 3978 square feet*

Drainage Area *≈ 1.47 acres*

R-301B: Holiday Inn Express - back

Figure 1: Basin behind Holiday Inn

Figure 2: Riser structure at northern end of basin

Description: The *detention basin shown in the photos above is located at the back of the parking lot behind the Holiday Inn Express. The surface dimensions of the basin are 29' x 180' and runoff from half of the hotel roof and parking lot enters the basin via several curb inlets. There is a concrete riser-type structure at the northern end of the basin (Figure 2), but it is unclear if and how this structure functions as an overflow outlet. The entire basin is currently managed as grass turf and the soil is very sandy.

*Check with Lancaster County staff to ensure that this was not intended as an infiltration basin. The practice should be observed during rain events to see how quickly stormwater currently infiltrates.

Proposed Retrofit: To improve pollutant reduction capabilities of this stormwater basin, two options are suggested:

1. Replace the turf with bioretention-friendly plants that can survive in both wet and dry conditions; or
2. Do a complete retrofit of the basin to convert it into a bioretention facility with layers of gravel, bioretention soil mix, mulch, and plants.

Since the basin currently has very sandy soil, if Option 1 is chosen, organic matter (e.g., compost) may need to be incorporated into the top 3 – 6 inches of soil to improve conditions for new plants.

Surface Area Available *≈ 3420 square feet*

Drainage Area *≈ 1.41 acres*

R-302: Walgreens Detention Pond

Figure 1: Shrub clippings in detention pond

Figure 2: Trash around outlet structure

Description: Dry detention pond behind Walgreens store. Vegetation is currently managed as grass turf and basin has several minor maintenance needs, as described below.

Proposed Maintenance: Shrub and tree clipping waste was recently deposited in the pond, which is not a good use of the structure (Figure 1). This loose debris could float and clog up the trash rack on the concrete outlet structure. This debris as well as trash accumulated around the inlets and outlet (Figure 2) should be removed.

Proposed Retrofit: To improve the pollutant removal capacity of this stormwater management practice, those who maintain the pond could reduce mowing to only 1 - 2 times a year to allow vegetation to grow taller. Greater plant mass will increase pollutant and nutrient uptake, and water uptake.

More sophisticated retrofit options also exist, including installing pre-treatment forebay cells at the two inlets and retrofitting the bottom of the pond to include multiple ponding areas of different depths. This would increase the flow path between the inlets and the outlet structure and allow for more sediment to drop out of the stormwater before leaving the pond. Figure 3 below shows an example of this type of retrofit design for existing detention ponds.

***Surface Area Available** ≈ 4,320 square feet*

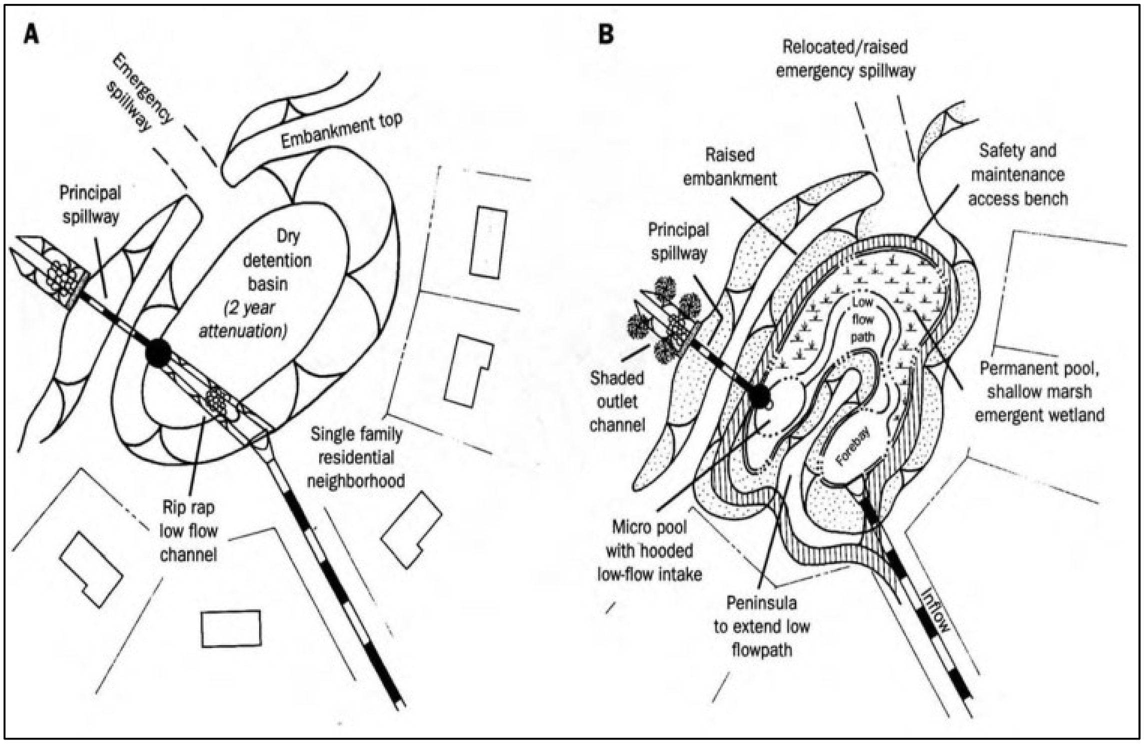


Figure 3: Example of retrofit design to extend flow path in detention ponds.

R-303: CVS Wet Pond

Figure 1: Wet pond with metal overflow structure

Figure 2: Metal outlet pipe partially clogged

Description: Wet retention pond behind CVS. Vegetation around pond is lush, which provides good erosion control and habitat. Although the pond appears to be currently functioning properly, several aspects of its design and/or construction may cause problems in the future: (1) The overflow structure (Figure 1) and the outlet pipe (Figure 2) are made of metal and are beginning to rust. These will eventually need to be replaced with concrete structures to avoid structural problems in the dam. (2) The emergency spillway was placed over top of the dam instead of to the side of the dam. (3) The bottom of the outlet pipe is partially submerged by water and sediment, which could eventually cause the outlet to be clogged. (4) The channel at the outfall is beginning to erode slightly and some trash has accumulated in the vicinity.

Proposed Maintenance: Some of these problems can be dealt with in the near term by the property managers: Remove sediment from the outlet pipe and remove trash from the site; apply better erosion control at the outfall, such as a small plunge pool and/or rip-rap stone apron (see Virginia Erosion and Sediment Control manual for ideas).

Proposed Retrofit: The other problems will have to be addressed with structural retrofits. The corrugated metal pipes will undoubtedly need to be replaced in the future with rust-proof structures such as concrete. The time during which these changes are being made would be a good opportunity to move the emergency spillway to the side of the dam instead of in the center of it.

This pond should be checked annually for any signs of structural failure.

R-304: Bowling Alley Retention Pond

Figure 1: Wet pond behind new bowling alley

Figure 2: Dam section eroded out at spillway

Figure 3: Stream filled in by sand from blown out dam

Description: An existing stormwater detention or retention pond is located behind the new bowling alley on Main Street (Figure 1). A section of the earthen dam has blown out near the rip-rap spillway (Figure 2), depositing sand in the stream. With the dam un-secure, more erosion could occur and the pond will not retain as much stormwater as needed.

Proposed Repair: The cause of the dam failure is unknown, but it appears that the soil used for constructing the dam was too erodible or was not properly compacted. In order to repair the dam, soil with higher clay content may need to be brought in to replace the dam.

The pond is located very close to the stream. Caution must be used to not impact the waterway during repairs.

R-400: Municipal Parking Lot

Figure 1: Existing drainage from parking lot

Figure 1: Downstream of existing BMP

Description: This site was initially looked at as a channel head cut. The two primary drainages contributing to the head cut are the municipal parking lot (Figure 1-east side of North Main Street directly across from Cralle Street), the rear of properties on Church Street, and the Main Street drainage. The drainage all comes together in the woods at the lower end of the parking lot where the municipal parking lot BMP discharges into the channel. Immediately beyond this point is an exposed sanitary sewer connection (Figure 2), and beyond that the channel gradually drops through steps of debris and sediment that appear to be moving downstream with each heavy storm. The channel eventually crosses 1st Street and appears to have reached a lower gradient at that crossing that is accumulating the sediment from the upstream erosion.

The BMP serving the parking lot is completely overgrown with woody scrub vegetation. Deep networks of roots are exposed and provide ample pathways to either infiltrate or simply drain through the BMP without any retention. There is a riser pipe that does not appear to back up any water. The outfall has been undermined by the flow in the adjacent channel, not the discharge of water from the outlet pipe.

Proposed Retrofit: This location can benefit from combined BMP maintenance and channel stabilization effort. The BMP ponding area and embankment should be cleared of woody vegetation. Selectively clearing the vegetation between the BMP and the parking lot will help in keeping the BMP clean and functional since it will be visible. (Figure 3)

The riser and outlet pipe appear in good condition, although the outlet protection should be restored in conjunction with channel stabilization. (Figure 4)

The Channel downstream of the BMP does not appear to have the significant head cut drops of some of the other channels investigated. However, it could benefit from spot clearing of debris and shaping the channel banks. Also, the sewer connection bracing across the channel should be evaluated for stability and durability since it is very exposed.

Figure 3: Inflow to BMP from parking lot

Figure 4: BMP ponding area and riser (blue pipe in background)

R-401: Lancaster Middle School

Figure 1: Parking lot and bus loop

Figure 1: Outfall (end section, upper left)

Description: The Lancaster Middle School property includes a typical amount of impervious cover: a bus loop (Figure 1), teacher and visitor parking, and rooftop, all directly connected to a drainage system. The system outfall is hidden in the dense vegetation adjacent to the property and is undergoing significant erosion (Figure 2).

Proposed Retrofits: There are several opportunities to implement stormwater retrofits on the property. The site investigation identified four potential bioretention areas, and one dry swale (or retention trench).

Each location can be evaluated and implemented individually over time, or all at once. These retrofit opportunities should be considered as 1) an educational tool given that they will be on school grounds and there is science curriculum available that incorporates stormwater treatment, and 2) beneficial to the stormwater infrastructure. Even full implementation of the retrofits will not be able to reverse the damage at the system outfall. However, the retrofits may help reduce the cost of the outfall repair and help to sustain the newly repaired outfall by reducing the stormwater discharges.

Figure 3 provides a photo and retrofit location map: seven photographs and bioretention basins A through D, and a dry swale retention trench.

The Retrofit Reconnaissance Investigation (RRI) Worksheet provides the preliminary design information for evaluating the relative benefits and configuration of the retrofits.

Photo 1: Front driveway – proposed Biofilter A

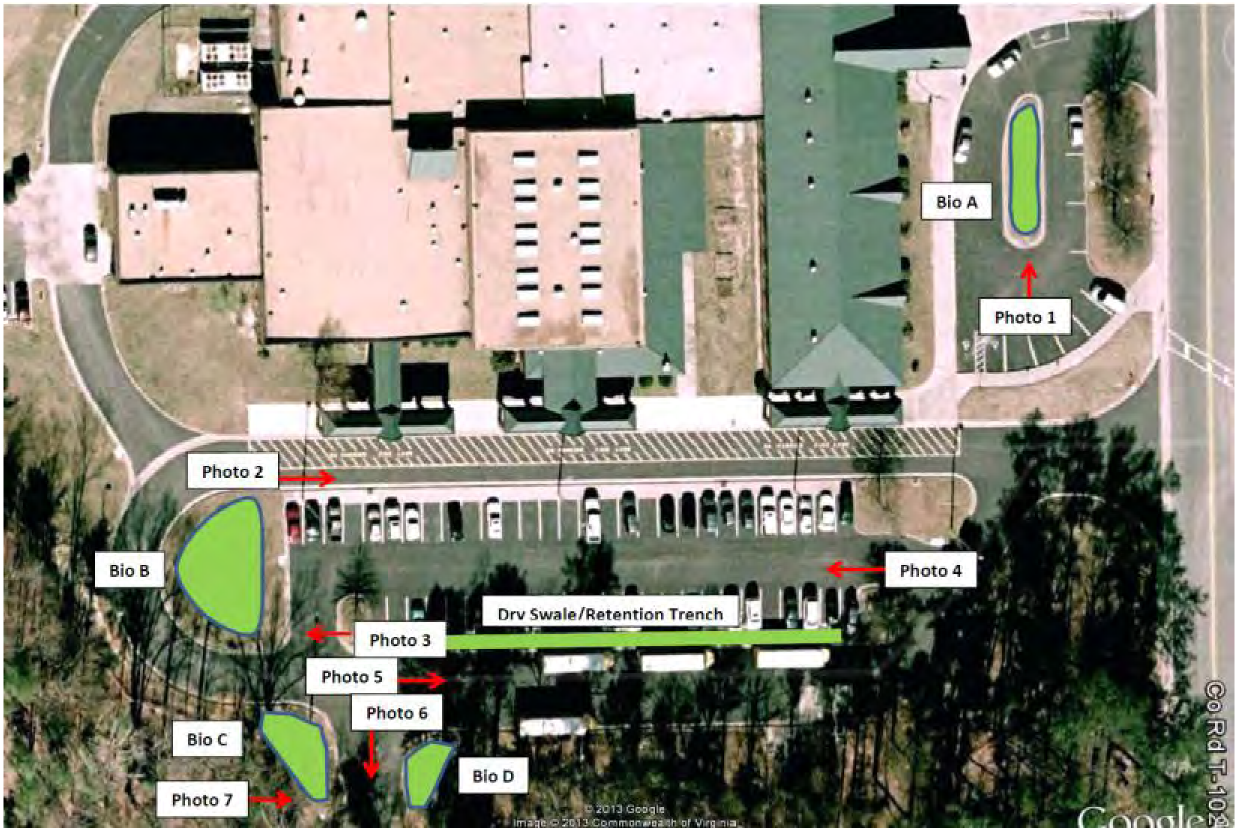
Photo 2: Driveway drainage to Biofilter B

Photo 3: Proposed Biofilter B (grassy knoll to right)

Photo 4: Drainage to Dry Swale/Retention Trench

Photo 5: Location of Dry Swale (left) & drainage to Biofilter D.

Photo 6: Location of Biofilter D (right) and looking towards outfall


Bio A
Photo 1
Photo 2
Bio B
Photo 4
Dry Swale/Retention Trench
Photo 3
Photo 5
Photo 6
Bio C
Bio D
Photo 7
Co Rd T-102
© 2013 Google
Image © 2013 Commonwealth of Virginia
Google

WATERSHED: CORROTOMAN		**SUBWATERSHED:**	**UNIQUE SITE ID:** R401
DATE:	**ASSESSED BY:**	**CAMERA ID:**	**PICTURES:**
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: LANCASTER MIDDLE SCHOOL
Address: ______

Ownership: ☒ Public ☐ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other: ______

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID: ______

Proposed Retrofit Location:

Storage
☐ Existing Pond ☐ Above Roadway Culvert
☐ Below Outfall ☐ In Conveyance System
☐ In Road ROW ☐ Near Large Parking Lot
☐ Other: PUBLIC MIDDLE SCHOOL

On-Site
☐ Hotspot Operation ☐ Individual Rooftop
☐ Small Parking Lot ☐ Small Impervious Area
☐ Individual Street ☐ Landscape / Hardscape
☐ Underground ☐ Other: ______

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ SEE BELOW
Imperviousness ≈ 100 %
Impervious Area ≈ ______

Notes: DA's : BIO A = 0.16 Ac
BIO B = 0.28 Ac
BIO C = 0.14 Ac
BIO D = 0.22 Ac
RETENTION TRENCH = 0.29 Ac

Drainage Area Land Use:
☐ Residential
☐ SFH (< 1 ac lots)
☐ SFH (> 1 ac lots)
☐ Townhouses
☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☒ Other: SCHOOL

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width: ______

EXISTING DRAINAGE SYSTEM, DROP INLETS & PIPE

Existing Head Available:

SEE NOTES.

Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)

MEASURED FROM RIM OF MANHOLE

PROPOSED RETROFIT

Purpose of Retrofit:
[X] Water Quality [ ] Recharge [ ] Channel Protection [ ] Flood Control
[ ] Demonstration / Education [ ] Repair [X] Other: VOLUME REDUCTION

Retrofit Volume Computations - Target Storage:	Retrofit Volume Computations - Available Storage:
BIO A = 552 ft^3	BIO A = 552 ft^3
BIO B = 966 ft^3	BIO B = 966 ft^3
BIO C = 483 ft^3	BIO C = 483 ft^3
BIO D = 759 ft^3	BIO D = 759 ft^3
DRY SWALE = 1,000 ft^3	DRY SWALE = 1000 ft^3

Proposed Treatment Option:
[ ] Extended Detention [ ] Wet Pond [ ] Created Wetland [X] Bioretention
[ ] Filtering Practice [ ] Infiltration [ ] Swale [ ] Other: ______

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:
EACH RETROFIT CROSS SECTION ON SHEET 4 FIGURES

Available Width:	
Available Length:	
Available Area:	
Ponding Depth:	
Soil Depth:	

SITE CONSTRAINTS

Adjacent Land Use:
[ ] Residential [ ] Commercial [ ] Institutional
[ ] Industrial [ ] Transport-Related [ ] Park
[ ] Undeveloped [X] Other: SCHOOL

Possible Conflicts Due to Adjacent Land Use? [ ] Yes [ ] No
If Yes, Describe:

Access:
[ ] No Constraints
Constrained due to
[ ] Slope [ ] Space
[X] Utilities [X] Tree Impacts
[ ] Structures [ ] Property
Ownership
[ ] Other: ______

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	[ ]	[ ]	[ ]	[X]
Water:	[ ]	[ ]	[ ]	[X]
Gas:	[ ]	[ ]	[ ]	[X]
Electric to Streetlights:	[ ]	[ ]	[ ]	[X]
Other:	[ ]	[ ]	[ ]	[X]

Potential Permitting Factors:

Dam Safety Permits Necessary	[ ] Probable	[X] Not Probable
Impacts to Wetlands	[ ] Probable	[X] Not Probable
Impacts to a Stream	[ ] Probable	[X] Not Probable
Floodplain Fill	[ ] Probable	[X] Not Probable
Impacts to Forests	[ ] Probable	[X] Not Probable
Impacts to Specimen Trees	[ ] Probable	[X] Not Probable

How many? ______
Approx. DBH ______

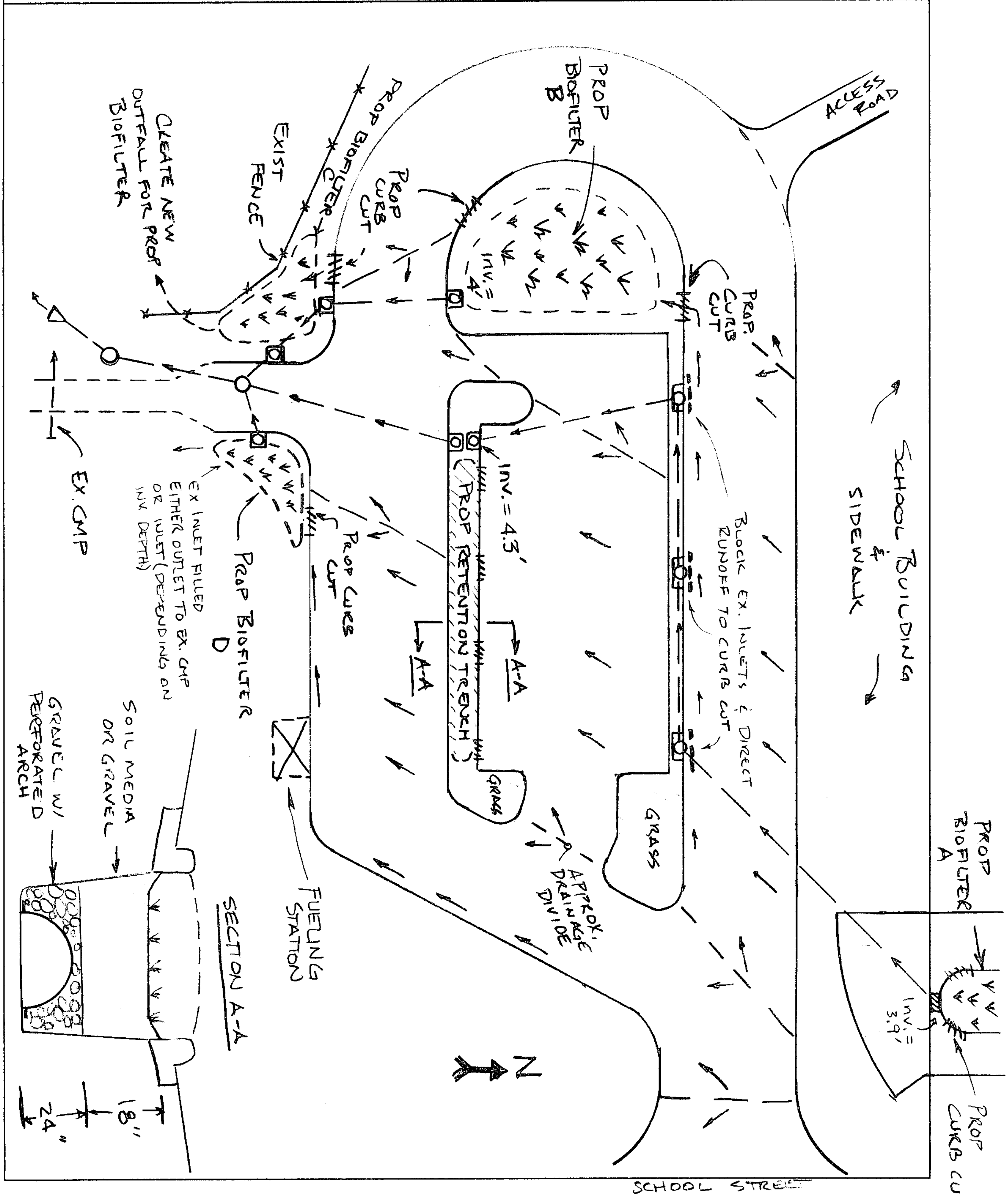
Other factors: ______

Soils:

Soil auger test holes:	[ ] Yes	[X] No
Evidence of poor infiltration (clays, fines):	[ ] Yes	[X] No
Evidence of shallow bedrock:	[ ] Yes	[X] No
Evidence of high water table (gleying, saturation):	[ ] Yes	[X] No

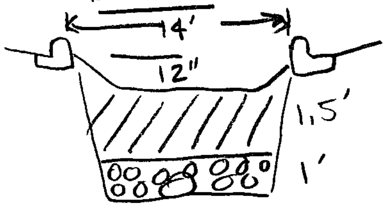
Possible good infiltration

SKETCH


ACCESS ROAD
PROP BIOFILTER B
PROP BIOFILTER C
EXIST FENCE
CREATE NEW OUTFALL FOR PROP BIOFILTER
PROP CURB CUT
INV. = 4'
PROP. CURB CUT
EX. CMP
EX INLET FILLED EITHER OUTLET TO EX. CMP OR INLET (DEPENDING ON INV. DEPTH)
PROP BIOFILTER D
PROP CURB CUT
INV. = 4.3'
PROP RETENTION TRENCH
A-A
A-A
SCHOOL BUILDING & SIDEWALK
BLOCK EX. INLETS & DIRECT RUNOFF TO CURB CUT
GRASS
GRASS
APPROX. DRAINAGE DIVIDE
FUELING STATION
SOIL MEDIA OR GRAVEL
GRAVEL W/ PERFORATED ARCH
SECTION A-A
18"
24"
N
PROP BIOFILTER A
INV. = 3.9'
PROP CURB CUTS
SCHOOL STREET

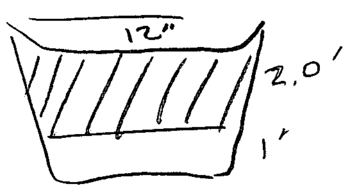
DESIGN OR DELIVERY NOTES

BIO A



VERY TIGHT LOCATION IN TERMS OF WIDTH
INV. = 3.9'

BIO B



PLENTY OF ROOM
INV. = 4.0'

BIO C – SURFACE AREA TO BE ALIGNED W/ EXISTING FENCE.
– UNDERDRAIN IS TO BE CONFIGURED TO DISCHARGE INTO ADJACENT WOODS
MAY NEED SLOPE DRAIN

BIO D

INVESTIGATE OUTFALL OPTIONS
EITHER DISCHARGE TO ADJACENT CATCH BASIN (FILLED WITH LEAF MULCH – INVERT UNKNOWN)
OR
DISCHARGE TO CMP PIPE FURTHER DOWN SCHOOL STREET

DRY SWALE/ RETENTION TRENCH

SEE CROSS SECTION ON SHEET 3.
ISLAND IS 6' WIDE. COVER CAN BE GRAVEL OR MULCH
INVERT = 4.3'

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- [ ] Confirm property ownership
- [ ] Confirm drainage area
- [ ] Confirm drainage area impervious cover
- [ ] Confirm volume computations
- [X] Complete concept sketch
- [ ] Other: ______
- [ ] Obtain existing stormwater practice as-builts
- [ ] Obtain site as-builts
- [ ] Obtain detailed topography
- [ ] Obtain utility mapping
- [ ] Confirm storm drain invert elevations
- [ ] Confirm soil types

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

EACH PRACTICE AREA SHOULD BE MAXIMIZED TO HELP REDUCE IMPACTS AT OUTFALL.

SITE CANDIDATE FOR FURTHER INVESTIGATION: [ ] YES [ ] NO [ ] MAYBE
IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S): [ ] YES [ ] NO [ ] MAYBE
IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S): [ ] YES [ ] NO [ ] MAYBE
IF YES, TYPE(S): ______

Unique Site ID: R401

R-402: Boys and Girls Club

Figure 1: Left side of building downspout

Figure 1: Right side downspout

Description: The Boys and Girls Club building on North Main Street is set in a large expanse of pavement that is shared with the adjacent property – more so than appears needed for parking demand (but it's unclear if the area is used temporarily for other purposes; Figure 3). There are two foundation planters in front of the building on either side of the front entrance: see Figure 1 and Figure 2 (planter in Figure 1 is partially hidden by the wooden ramp).

Proposed Retrofits: There are two potential retrofits for this site.

1) Redirect the downspouts located at each corner of the building into the foundation planters. The current downspout configuration includes piping to convey the roof water around, through, or under the planters (the downspout pipe is shown protruding from under the wooden ramp in Figure 1, and in Figure 2, it daylights where the two planter walls meet). This appears to be a very simple retrofit to redirect these downspouts into the existing planters. This type of practice is referred to as Urban Planters in the Virginia Stormwater BMP Design Specifications, primarily because they are suited for buildings in urban areas that may not have room for traditional bioretention.

2) Remove some pavement in the front parking lot (Figure 3) and either replace it with landscaping or bioretention to promote infiltration, or if the parking areas are needed for events, replace it with permeable pavers in select locations. The paved area in front of the building has only minimal markings for parking, so it is difficult to equate the parking demand with a specific number of spaces. However, utilizing input from the building occupants should allow for a quick assessment of the viability of the options – pavement removal and landscaping, or replacement with permeable pavers.

Figure 3: Paved area in front of building

R-403: Peebles Shopping Center

Figure 1: Typical parking lot inlet

Figure 1: Stormwater basin behind shopping center

Description: This shopping center has several tenants – Peebles appears to be the biggest. The entire front of the shopping center is a parking lot, approximately 3.6 acres, served by three drainage inlets. The shopping center rooftop is approximately 2 acres, and additional rooftop and parking for restaurants and a bank are located on the out parcels between the main parking lot and North Main Street (an additional 3 acres of impervious cover). There is also a large stormwater pond behind the shopping center. It is uncertain if this pond was designed to hold water (retention pond), or if it was intended to be a dry (extended detention) pond. In either case, there is evidence of erosion at one pipe outlet into the pond (the relatively small drainage from the rear loading dock) and sloughing on the side slopes in multiple locations. The combined effect of the internal erosion is the loss of storage volume (or pool volume if intended as a wet pond).

Proposed Retrofits: While the pond requires basic maintenance to fix the erosion, it appears to be functioning. A more rigorous analysis of the initial design and a survey of the current condition will verify if any dredging of the storage area is needed. Alternatively, installing bioretention retrofits in the front parking lot can possibly offset the loss in storage and provide an educational tool since it is a high traffic parking lot.

The parking lot is served by 3 inlets, each located in the center of a diagonal parking space row. Each row also incorporates a large landscape island closer to the store front. Installing the bioretention retrofits at the 3 inlet locations would eliminate a significant number of spaces if the retrofits are sized for the full contributing area (this is a big parking lot for only 3 inlets!) There is some flexibility in sizing, in terms of the design volume capture, i.e. capture only a portion of the contributing volume. Since there is plenty of depth, there are also options to add storage under the soil in retrofit A and B (refer to RRI form). If parking is a premium, some spaces can be recovered by converting the existing islands to parking (a swap for the retrofit landscaping – although this would require additional cost to construct). There is adequate drop in each inlet to accommodate a bioretention retrofit, which makes this an excellent demonstration site if even only one location is selected.

WATERSHED: CORROTOMAN	**SUBWATERSHED:**	**UNIQUE SITE ID:** R 403

DATE:	**ASSESSED BY:**	**CAMERA ID:**	**PICTURES:**
GPS ID:	**LMK ID:**	**LAT:**	**LONG:**

SITE DESCRIPTION

Name: PEEBLES SHOPPING CENTER
Address: N, MAIN STREET

Ownership: ☐ Public ☒ Private ☐ Unknown
If Public, Government Jurisdiction: ☐ Local ☐ State ☐ DOT ☐ Other:______

Corresponding USSR/USA Field Sheet? ☐ Yes ☐ No If yes, Unique Site ID:______

Proposed Retrofit Location:

Storage
☐ Existing Pond ☐ Above Roadway Culvert
☐ Below Outfall ☐ In Conveyance System
☐ In Road ROW ☐ Near Large Parking Lot
☒ Other: IN PARKING LOT

On-Site
☐ Hotspot Operation ☐ Individual Rooftop
☐ Small Parking Lot ☐ Small Impervious Area
☐ Individual Street ☐ Landscape / Hardscape
☐ Underground ☐ Other:______

DRAINAGE AREA TO PROPOSED RETROFIT

Drainage Area ≈ SEE BELOW
Imperviousness ≈ 100 % %
Impervious Area ≈ SEE BELOW

Notes: A = 1.2 Ac.
B = 0.9 Ac.
C = 1.5 Ac

Drainage Area Land Use:
☐ Residential
☐ SFH (< 1 ac lots)
☐ SFH (> 1 ac lots)
☐ Townhouses
☐ Multi-Family
☐ Commercial
☐ Institutional
☐ Industrial
☐ Transport-Related
☐ Park
☐ Undeveloped
☐ Other:______

EXISTING STORMWATER MANAGEMENT

Existing Stormwater Practice: ☐ Yes ☒ No ☐ Possible
If Yes, Describe:

Describe Existing Site Conditions, Including Existing Site Drainage and Conveyance:
Existing Street Width:______

LARGE PARKING LOT. EXISTING ISLANDS – NO IN LOW POINTS. 3 LARGE INLETS (DI-7) SPACED IN PARKING LOT.

Existing Head Available:
YES A = 7.0'
B = 5.0'
C = 3.9'

Note where points are measured from: (i.e. street elevation to catch basin invert, manhole rim to catch basin invert, other)
MEASURED FROM GRATE.

PROPOSED RETROFIT

Purpose of Retrofit:
☒ Water Quality ☐ Recharge ☐ Channel Protection ☐ Flood Control
☒ Demonstration / Education ☐ Repair ☐ Other:

Retrofit Volume Computations - Target Storage:	Retrofit Volume Computations - Available Storage:
A = 4,138 ft³ B = 3,104 ft³ C = 5,173 ft³	FULL STORAGE IS AVAILABLE BASED ON AVAILABLE SPACE. SEE PAGE 4.

Proposed Treatment Option:
☐ Extended Detention ☐ Wet Pond ☐ Created Wetland ☒ Bioretention
☐ Filtering Practice ☐ Infiltration ☐ Swale ☐ Other:

Describe Elements of Proposed Retrofit, Including Surface Area, Maximum Depth of Treatment, and Conveyance:

TYPICAL SECTION FOR A + B = 12" PONDING, 24" SOIL MEDIA, 12" STONE
" FOR C = 12" PONDING, 18" SOIL MEDIA, 12" STONE

Available Width:	
Available Length:	
Available Area:	
Ponding Depth:	
Soil Depth:	

SURFACE AREA FOR ALL THREE IS BASED ON 36' WIDTH OF DIAGONAL PARKING ROW. LENGTH OF EACH RETROFIT VARIES AND WILL BE BASED ON PARKING ALLOWANCE.

SITE CONSTRAINTS

Adjacent Land Use:
☐ Residential ☒ Commercial ☐ Institutional
☐ Industrial ☐ Transport-Related ☐ Park
☐ Undeveloped ☐ Other:

Possible Conflicts Due to Adjacent Land Use? ☒ Yes ☐ No

If Yes, Describe: PARKING – POSSIBLE SWAP OF EXISTING ISLANDS WITH NEW BIORETENTION ISLANDS – MAY BALANCE W/ PARKING

Access:
☒ No Constraints
Constrained due to
☐ Slope ☐ Space
☐ Utilities ☐ Tree Impacts
☐ Structures ☐ Property
Ownership
☐ Other:

Conflicts with Existing Utilities:

	Yes	Possible/ Modifiable	No	Unknown
Sewer:	☐	☐	☐	☒
Water:	☐	☐	☐	☒
Gas:	☐	☐	☐	☒
Electric to Streetlights:	☐	☐	☐	☐
Other:	☐	☐	☐	☐

Potential Permitting Factors:

Dam Safety Permits Necessary	☐ Probable	☒ Not Probable
Impacts to Wetlands	☐ Probable	☒ Not Probable
Impacts to a Stream	☐ Probable	☒ Not Probable
Floodplain Fill	☐ Probable	☒ Not Probable
Impacts to Forests	☐ Probable	☒ Not Probable
Impacts to Specimen Trees	☐ Probable	☒ Not Probable

How many?
Approx. DBH

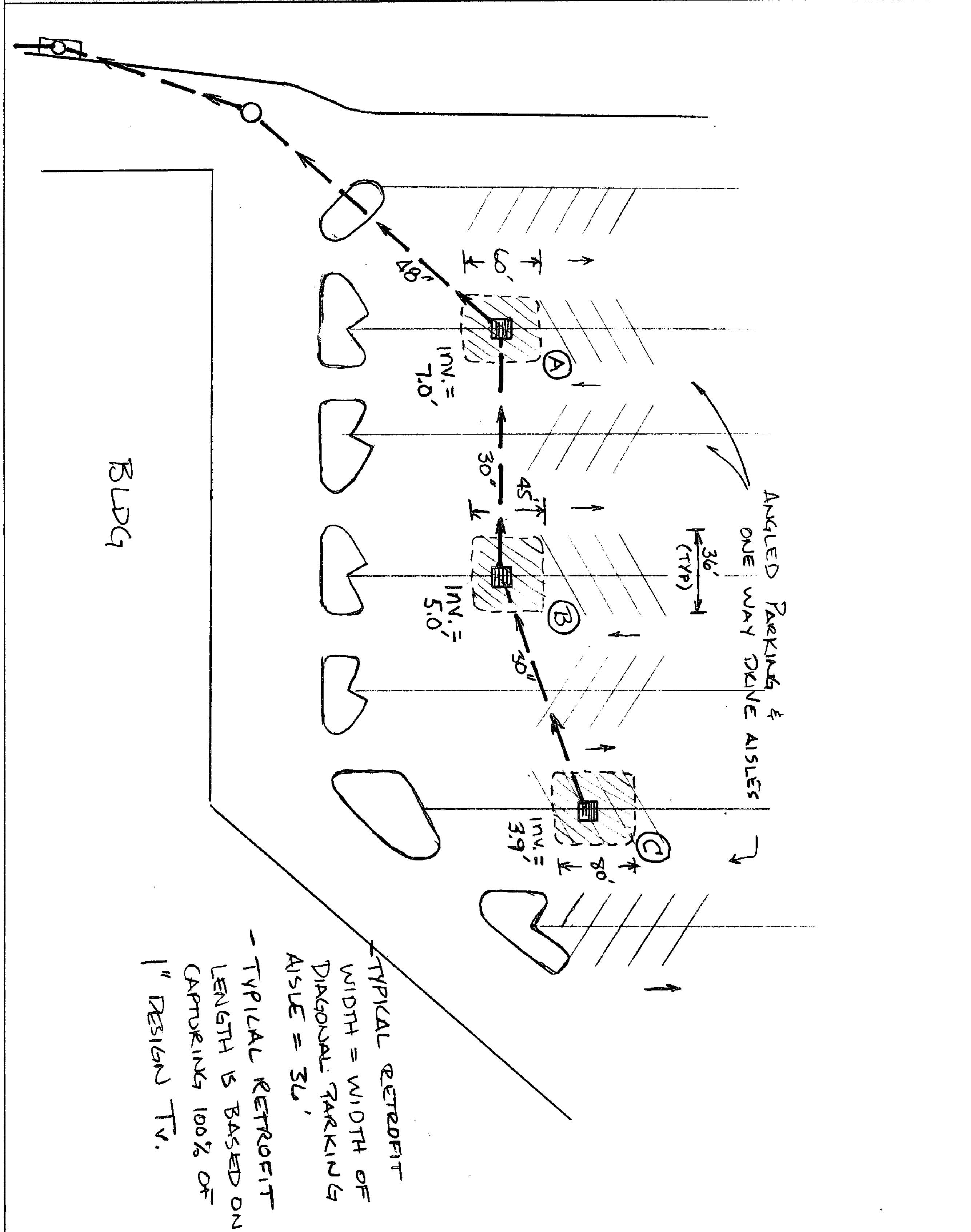
Other factors:

Soils:

Soil auger test holes:	☐ Yes	☒ No
Evidence of poor infiltration (clays, fines):	☐ Yes	☒ No
Evidence of shallow bedrock:	☐ Yes	☒ No
Evidence of high water table (gleying, saturation):	☐ Yes	☒ No

 Unique Site ID: R403

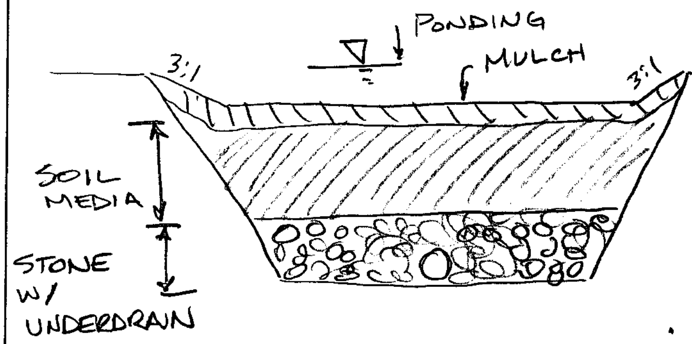
SKETCH



Unique Site ID: R403

DESIGN OR DELIVERY NOTES

TYPICAL SECTION FOR BIORETENTION



RETROFIT A

36' x 60' SURFACE AREA (INCL. SIDE SLOPES)

= 12" PONDING, 24" SOIL, 12" STONE

= 4,140 ft^3 STORAGE VOLUME

= 10 PARKING SPACES

RETROFIT B

36' x 45' SURFACE AREA (INCL. SIDE SLOPES)

= 12" PONDING, 24" SOIL, 12" STONE

= 3,110 ft^3 STORAGE VOLUME

= 8 PARKING SPACES

RETROFIT C

36' x 80' SURFACE AREA (INCL. SIDE SLOPES)

= 12" PONDING, 18" SOIL, 12" STONE

= 5,180 ft^3 STORAGE VOLUME

= 14 PARKING SPACES

FOLLOW-UP NEEDED TO COMPLETE FIELD CONCEPT

- ☐ Confirm property ownership
- ☐ Confirm drainage area
- ☐ Confirm drainage area impervious cover
- ☐ Confirm volume computations
- ☒ Complete concept sketch
- ☐ Obtain existing stormwater practice as-builts
- ☐ Obtain site as-builts
- ☐ Obtain detailed topography
- ☒ Obtain utility mapping
- ☐ Confirm storm drain invert elevations
- ☐ Confirm soil types
- ☒ Other: VERIFY WILLINGNESS ~~OF~~ OWNER

INITIAL FEASIBILITY AND CONSTRUCTION CONSIDERATIONS

ONLY ISSUES:

- PARKING
- PRIVATE PARKING LOT

SITE CANDIDATE FOR FURTHER INVESTIGATION: ☐ YES ☐ NO ☐ MAYBE

IS SITE CANDIDATE FOR EARLY ACTION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE

IF NO, SITE CANDIDATE FOR OTHER RESTORATION PROJECT(S): ☐ YES ☐ NO ☐ MAYBE

IF YES, TYPE(S): ______

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