Section 6
Watershed Plan Structural Actions

6.1 Introduction

The following sections present structural actions that meet the watershed plan goals, address watershed issues and prevent future degradation. Structural actions refer to watershed plan elements that require construction to implement. This section describes procedures used to identify the projects included in the actions, identifies each project's location and costs, and shows the locations of the actions.

The Fairfax County Stormwater Planning Division recognizes that appropriate public outreach and education is key to the successful implementation of these structural projects. The project costs include allowances for such programs.

Section 7 documents the ranking of these structural projects, the implementation program and the watershed plan's benefits.

Sections 6.2 through 6.9 summarize the following structural actions:

- Implement regional ponds or alternative stormwater controls (Section 6.2)
- Implement dry pond retrofit projects (Section 6.3)
- Implement Low Impact Development at public facilities (Section 6.4)
- Perform stream restoration (Section 6.5)
- Address stormwater runoff from neighborhoods without stormwater controls (Section 6.6)
- Perform stream buffer restoration (Section 6.7)
- Replace and upgrade road crossings (Section 6.8)
- Perform other structural actions (Section 6.9), including upgrading upland drainage systems and restoring riparian wetlands

Section 6.10 documents the status of the projects in the Storm Drainage and Flood Control Master Plan.

Section 6.11 summarizes the watershed plan structural projects by major subwatershed.

The watershed plan projects are numbered using the following convention:

- The first two characters identify the watershed with CU indicating projects in the Cub Run watershed and BR indicating projects in the Bull Run watershed.
- The third character is 9 for all projects.
- The fourth character indicates the project type:
  - 0 – Regional pond or alternative projects
  - 1 – Dry pond wetland retrofit (ponds 1 through 99)
  - 2 – Stream restoration
  - 3 – Buffer restoration
  - 6 – Road crossing improvement
  - 7 – Dry pond retrofit projects (ponds 100 on)
  - 8 – LID retrofit projects
  - 9 – Other projects, including dump site removal, neighborhoods without stormwater controls, upland drainage retrofit and riparian wetland studies
- The last two numbers indicate the project number. Projects are numbered sequentially starting at the lowest point in the watershed.

Appendix C includes fact sheets for each structural project including project descriptions, costs, and a map showing the project location.

6.2 Action - Reevaluate Status of Regional Ponds

6.2.1 Introduction

One action in the watershed plan is to evaluate the status of previously proposed but not constructed regional ponds within the Cub Run and Bull Run watersheds.

As discussed in Section 2.5.4, the county adopted a Regional Stormwater Management Plan in 1989, promoting regional ponds to service larger drainage areas (generally 100 to 300 acres) that encompass one or more site developments. These large ponds are designed to reduce the number of smaller onsite stormwater facilities.

Regional ponds reduce nutrients, sediment and other pollutants effectively and control peak flow discharges that can cause flooding and erosion. In addition, maintaining one large regional facility is generally less costly than maintaining numerous smaller facilities. However, construction of these large regional ponds within the stream valley can have negative effects aesthetically and ecologically.

The 1989 Regional Stormwater Management Plan identified 31 regional pond sites in the Cub Run watershed. Seventeen of these planned ponds were constructed. About 12 additional ponds exist that can be classified as "regional" due to their large drainage areas (e.g., larger than 100-acre watershed). These additional ponds either were in place at the time of the 1989 study or were constructed at locations not identified in that study. Also, four large regional ponds exist in the Loudoun county portion of the watershed. The existing 33 large ponds provide significant nutrient reduction and peak flow control benefits. These existing ponds are shown in Figure 6-1. Developers of land near the ponds constructed many of the regional ponds to meet county stormwater management requirements.

Regional ponds are an effective stormwater control method for both peak flow control and stormwater pollutant removal:

- Many of the ponds were proposed as "maximum efficiency" ponds that controlled the post-development peak flows from the two- and 10-year storms to a level that is as much as 33 percent of the predevelopment peak flows. This level of peak flow control is difficult to achieve with smaller, onsite ponds. Alternative stormwater controls such as bioretention, upstream culvert retrofit, buffer restoration and stream restoration have little or no effect on the two- and 10-year peak runoff rates.

- A regional pond typically controls a drainage area of 100 acres or more and therefore can receive and remove a significant annual mass of nutrients and other pollutants. As an example, proposed pond C18 will remove approximately 70 pounds of phosphorus annually from stormwater runoff. Approximately 1,040 medium-density residential bioretention rain garden facilities would be required to achieve this level of nutrient removal. Alternatively, about 43 dry pond wetland retrofit projects would be required to supplant the phosphorus removed by a single regional pond.

Regional ponds, however, negatively impact the streams, environment and community:

- Wet ponds present a potential safety hazard for children.

- Regional ponds do not protect the streams upstream, leaving a portion of the streams unprotected by stormwater controls.

- Regional ponds are typically within the stream valleys and therefore affect the health of the streams, wetlands and forested stream buffer.

- In most cases, the regional pond construction affects the Chesapeake Bay Preservation Ordinance Resource Protection Areas.

- Trees must be removed for dam construction and within areas frequently flooded by the dam.

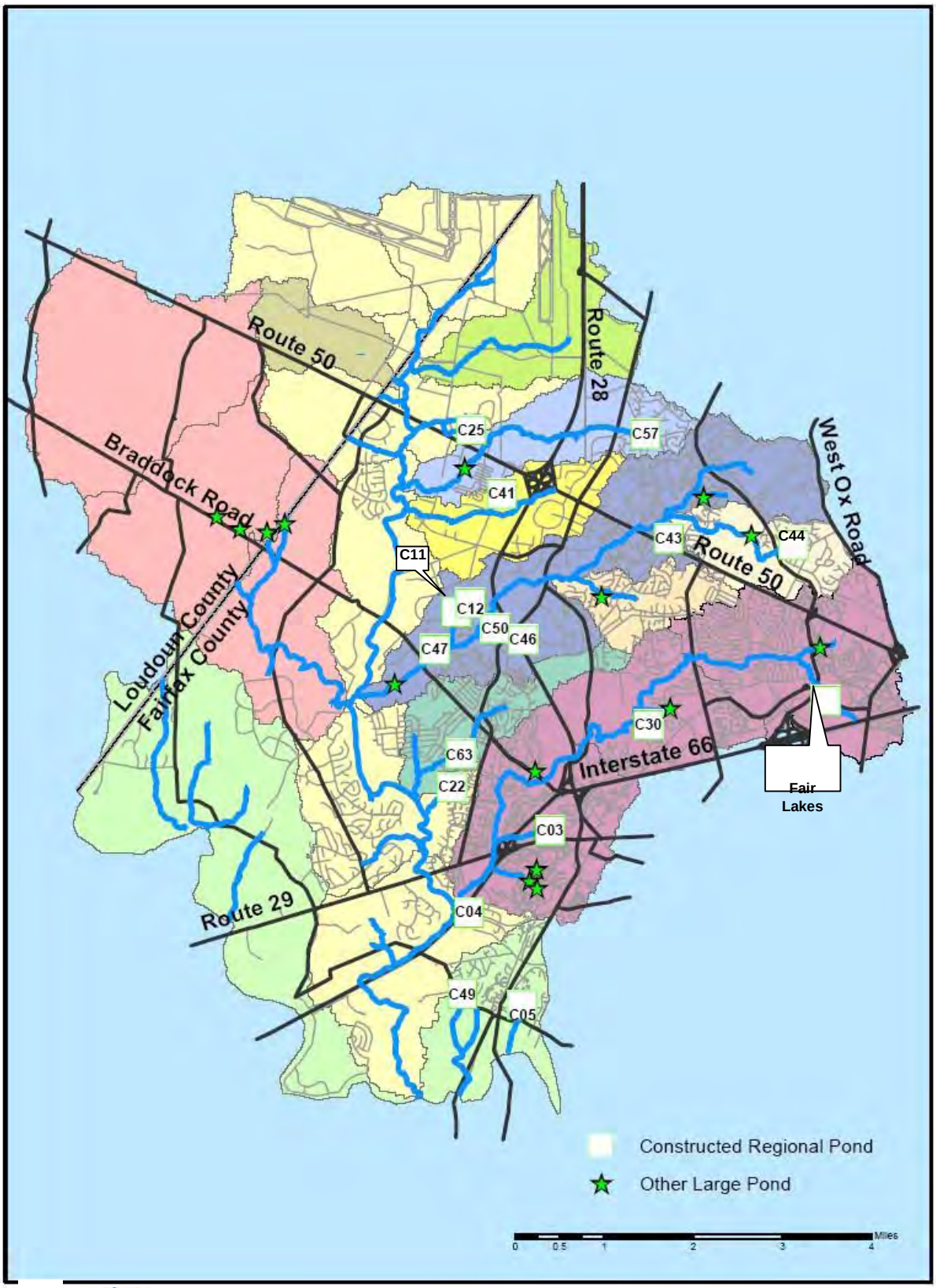


Figure 6-1
Constructed Regional Ponds and Other Large Ponds

The Fairfax County Stormwater Planning Division and citizen committees have reviewed the status of regional ponds in the county stormwater management program. Several of these studies are described in Section 2.5.4. The report "The Role of Regional Ponds in Fairfax County's Watershed Management" (March 2003) presents findings from the Regional Pond Subcommittee's review of the county's regional ponds. The subcommittee's unified position is that regional ponds should not be considered the preferred stormwater management alternative. Rather, regional ponds should be considered one of many tools available for stormwater planning.

This section reviews the status of the 14 planned regional ponds that have not been constructed: C18, C19, C20, C21, C23, C24, C28, C35, C37, C39, C40, C53, C54 and C62. These proposed ponds, shown in Figure 6-2, generally fall into two categories:

- Proposed regional ponds within the Residential-Conservation (R-C) District. Seven of the 14 ponds fall into this category (C21, C23, C24, C28, C35, C37 and C62).

- Proposed regional ponds outside the Residential-Conservation District. Seven of the 14 ponds fall into this category (C18, C19, C20, C39, C40, C53 and C54).

Sections 6.2.2 and 6.2.3 discuss general conditions and overall assumptions for the regional ponds in these two categories. Section 6.2.4 reviews each of the 14 unconstructed regional ponds.

6.2.2 Proposed Regional Ponds Located Within the R-C District

A portion of the county was rezoned in 1982 to protect the water quality in the Occoquan Reservoir. Section 2.6.1 provided additional information on the Occoquan Reservoir water quality protection measures. This rezoning resulted in major areas of the Cub Run and Bull Run watersheds being placed in the R-C District with maximum densities of one house per five acres. This density is referred to as Estate Residential in the generalized land use descriptions in the Fairfax County watershed plans. The rezoning was planned to achieve annual total phosphorus loadings equivalent to or lower than the planned land use prior to the rezoning, assuming treatment by dry ponds or wet ponds within the Fairfax County portions of the Occoquan Reservoir watershed.

The R-C District is a very effective implementation of low-impact development in which the maximum allowable development density is sufficiently low to minimize impacts on the water quality and peak flows. Also, 5,174 of the 11,716 acres (44 percent) of the land within the R-C District in Cub and Bull Run are preserved as parkland and golf courses. As a result, no additional water quality BMPs or detention ponds are required. Impervious areas are typically 5 to 10 percent for this land use. Studies correlating stream condition to impervious area typically find that impervious areas in this range have small impacts on streams (Schueler, T.R. and Holland H.K., "The Practice of Watershed Protection," Ellicott City, MD, 2000).

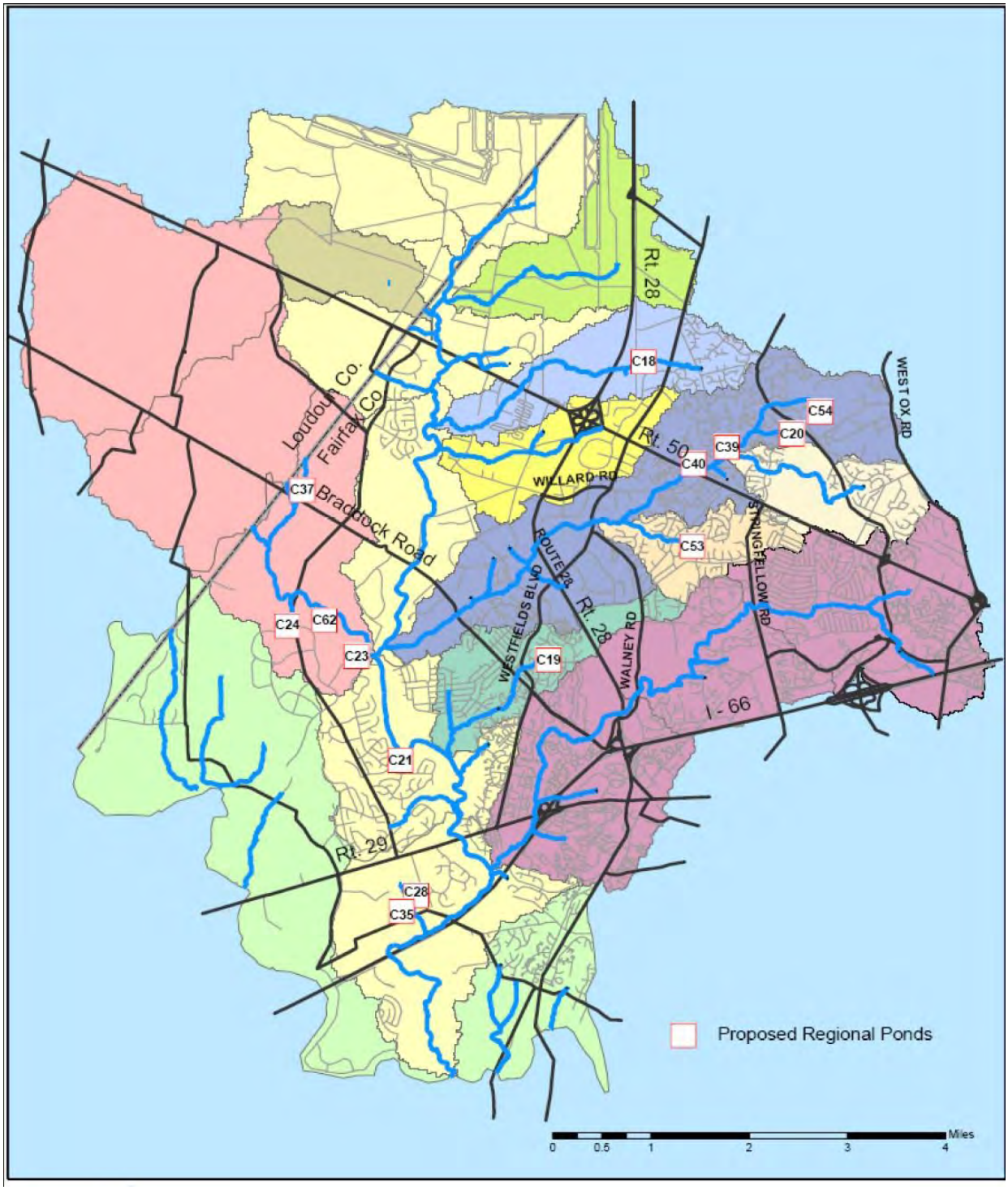


Figure 6-2
Unconstructed Proposed Regional Ponds

Seven of the 14 proposed regional ponds (C21, C23, C24, C28, C35, C37 and C62) are within the R-C District. These regional ponds were included in the 1989 Regional Stormwater Management Plan to control runoff from potential future development in case the rezoning was legally overturned. The rezoning has withstood several legal challenges over the years. A key factor in this defense was that the Estate Residential density of one house per 5 acres did not require structural water quality BMPs to provide the required water quality protection for the Occoquan Reservoir.

Several proposed regional ponds (C21 and C23) are in neighborhoods near Pleasant Valley Road (Virginia Run, Gate Post Estates, Pleasant Hills, etc.) that were developed at the planned medium- and low-density residential densities that existed at the time of the rezoning. These higher-density areas within the R-C District include extended detention dry pond water quality BMPs and peak flow controls.

The 5-acre Estate Residential land use protects the streams sufficiently such that:

1. The proposed regional ponds provide small watershed benefit relative to their cost and impact. As described in Section 6.2.4, ponds in the R-C District were eliminated from the watershed plan primarily for this reason.

2. Since the proposed ponds in the R-C District would provide very little to no stormwater management benefit, alternative stormwater control projects are generally not required due to the low impervious cover. As noted below, the area upstream from the regional pond includes dry pond wetland retrofit, stream restoration and other stormwater management actions to address stormwater issues such as stream bank erosion and deficient stream buffers near the regional ponds.

6.2.3 Proposed Regional Ponds Located Outside the R-C District

Seven of the proposed but unbuilt ponds (C18, C19, C20, C39, C40, C53 and C54) are outside the R-C District. As described below, the land area upstream from these remaining ponds is largely developed. The development upstream from the proposed unbuilt ponds is mostly medium- and low-density residential. As described in the following sections, in nearly all cases the upstream development includes onsite dry ponds or wet ponds that manage the stormwater runoff from these areas. As such, conditions have changed significantly from the time that the regional ponds were proposed in 1989.

Because of its location within the Occoquan Reservoir watershed, the county has issued very few, if any, water quality BMP waivers for the development upstream from the proposed regional ponds in the Cub Run and Bull Run watersheds. As a result, dry or wet ponds serve the development in nearly all cases. In some cases, houses near the stream valley or otherwise located such that the drainage could not be directed to an onsite pond may not have stormwater controls. Even in these cases, the onsite ponds that serve the remaining portions of the development likely provide additional stormwater control protection that compensates for the areas that are not

controlled. In isolated cases, the few houses directly adjacent to the proposed regional pond may have been granted water quality waivers.

Some upstream dry ponds may be "temporary" facilities constructed so the onsite pond could be developed once the proposed downstream regional pond is constructed. If the proposed regional pond is not constructed, these temporary facilities can remain as permanent facilities.

In some instances, the detention requirement to control the 2- and 10-year peak flow may have been waived in areas upstream from the pond. Therefore, some dry ponds upstream from the proposed ponds may include only extended dry detention volume to provide water quality control but not peak flow control detention volume. In other words, some areas upstream from the proposed regional ponds may not have the full stormwater peak flow controls required for other areas of the county.

The proposed but not constructed regional ponds outside the R-C District were reviewed to determine if the regional pond can still be constructed or is needed. In addition, the proposed pond watersheds were evaluated to identify alternatives to be implemented in place of the regional ponds.

These evaluations recognize that placing a new stormwater quality control practice upstream or downstream from an existing facility greatly reduces the water quality benefits provided by the new facility. The reason is that much of the pollutant removal occurs through settling in the existing facility. Solids that settle or are otherwise removed in the upstream pond reduce the removal efficiency of the downstream facility, thereby reducing the net water quality benefit from the new stormwater controls. Watershed plan actions to construct or promote LID practices such as bioretention, new dry ponds or wet ponds, and dry-pond wetland bottom retrofits focus on areas not upstream from existing wet ponds and extended detention dry ponds to provide the greatest pollution removal and stream protection benefits.

The following section provides an overview of the status of the proposed regional ponds based on the detailed evaluations performed in this watershed plan.

6.2.4 Reevaluation of Unconstructed Regional Ponds

6.2.4.1 Introduction

Each of the fourteen proposed but not constructed ponds were reviewed in detail, and alternatives consistent with the watershed plan goals and objectives were evaluated. Conditions have changed considerably from when the ponds were proposed in 1989. As described in Section 6.2.2, the R-C District has been upheld in court and is fully supported by the Fairfax County Board of Supervisors. Therefore, the necessity of regional ponds within this watershed area is greatly reduced. Also, smaller onsite ponds have been constructed within the drainage areas upstream from the proposed regional ponds. These new upstream ponds provide water quality protection for much of the upstream areas and reduce the need for the regional ponds.

The watershed plan presents alternatives to the proposed regional ponds that have not been constructed and accounts for the recommendations developed by the Regional Pond Subcommittee. The overall goal is to provide stormwater controls that provide the same approximate level of protection as would have been provided had the originally proposed regional pond been constructed. The goal of regional ponds and their proposed alternatives is the same - meet the goals and objectives of the watershed plan to protect and restore local streams, and downstream receiving waters.

These evaluations target providing phosphorus reductions similar to that of the original proposed regional pond. Phosphorus is used in these analyses as a surrogate for other nutrients, sediment, metals, etc., removed by the stormwater controls.

Tables are presented for each regional pond, documenting the phosphorus removal provided by the originally proposed regional pond without upstream stormwater controls. This provides a baseline for evaluating stormwater control alternatives.

Stormwater control options are identified next. The phosphorus removal provided both by the existing stormwater controls and by the proposed pond, accounting for the removal provided by existing upstream controls, are documented. Other stormwater control options are evaluated, including retrofit of upstream stormwater management facilities, new stormwater management controls, LID retrofit projects, stream restoration projects and a reduced size and type of regional pond. Regional ponds proposed as wet ponds near residential development were converted to dry ponds in these analyses. Upstream culvert retrofit projects were also evaluated.

Stormwater control alternatives were evaluated next. These alternatives consist of combinations of stormwater control options and are listed in declining order of efficiency.

Criteria to evaluate the proposed regional ponds and their stormwater control alternatives include:

- Existing stormwater management facilities within the pond drainage area and nearby subwatershed, and their benefits towards meeting the watershed controls
- Existing and future land use upstream from the pond
- Stream conditions upstream and downstream of the proposed pond, and the need for peak flow control at the proposed regional pond location
- Feasibility of constructing the pond at the planned location
- Nutrient load reduction provided by the pond in combination with existing stormwater controls compared with the removal provided by the originally proposed pond
- Amount of nutrient removal provided relative to other structural projects

- Impact of pond on parkland, streams, stream buffers, Chesapeake Bay Protection Ordinance Resource Protection areas and other critical resource areas

- Cost of constructing the pond and or alternative projects relative to the improvements provided

- Adjacent land use and land cover

As noted in the following sections, several previously proposed regional ponds are on Fairfax County Park Authority (FCPA) parkland. While this does not preclude regional pond construction, impact on this valuable community resource will be weighed against the pond's benefits. FCPA approval would be required and the pond would have to be constructed such that it minimizes parkland impacts.

Summary of Status of Previously Proposed Regional Ponds

Table 6-1 summarizes the status of the 14 previously proposed regional ponds based on the detailed evaluations performed for the watershed planning study. Please see detailed discussions of individual ponds for the rationale that supports their status in the Cub Run and Bull Run watershed plan.

Table 6-1
Status of Regional Ponds in the Cub Run and Bull Run Watershed Plan

Regional Pond	Regional Pond Status
C19, C21, C23, C24, C28, C40, C53 and C54	Delete the proposed regional pond and implement alternative projects
C37, C35, and C62	Delete the proposed regional pond and no alternative projects are necessary
C20	Defer the proposed regional pond and implement alternative projects. If the alternative projects cannot be implemented, then a modified regional pond may be considered at a future date
C18 and C39	Implement a reduced-size or modified regional pond. If the pond still cannot be implemented, then implement alternative projects (projects CU9002 and CU9001)

The following sections provided a detailed review of each proposed regional pond, presented in numerical order.

6.2.4.2 Proposed Regional Pond C18

Proposed Pond Description

The previously proposed regional pond C18 is on Cain Branch between Route 28 and Centreville Road. The planned pond is a maximum efficiency wet pond that shaves the peak two-year flow to 33 percent of the predevelopment flow. The drainage area is 416 acres.

The map on Figure 6-3 and data in Table 6-2 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The proposed pond and adjoining areas were undeveloped in 2002. The southern half of the pond has a planned land use of industrial. Portions of this area are being developed as this study was being prepared. The northern half of the planned pond is in undeveloped portions of the Fairfax County Park Authority's Sully Plantation Park.

The upstream watershed is split equally between medium- and low-density residential land use with little potential for additional development. The upstream drainage area already has four dry ponds, one wet pond and one regional dry pond (C57). Part (40 acres) of this uncontrolled area is undevelopable stream valley parkland. Together, these existing ponds and undevelopable parkland cover 73 percent of the proposed regional pond C18 watershed. Only 27 percent of the developed land is not served by a stormwater pond.

This proposed regional pond could have significant impacts on Sully Historic Site within the historic overlay district. Park Authority supports a reduced size or modified regional pond C18 and/or alternative projects upstream of the proposed pond location. The Park Authority does not support the proposed regional pond C-18 in its current location and size due to conflicts with the Sully Historic Overlay District, the approved alignment of the Metropolitan Washington Airports Authority access road through Sully Historic Site and the location of the Dominion high-voltage transmission lines.

The proposed pond is partially within a developing industrial area. Land acquisition costs may make this pond cost prohibitive and unbuildable.

Proposed Pond Evaluation

This pond was proposed as a maximum efficiency wet pond to provide a high level of water quality and peak flow control. The first line in Table 6-3 shows that the originally proposed wet pond reduces phosphorus by 50 percent without existing upstream stormwater controls.

Table 6-2
Watershed Overview for Unconstructed Regional Pond C18

Drainage Area: 416 Acres

Location: Cain Branch between Route 28 and Centreville Road

Type of Pond: Maximum efficiency wet pond that controls the peak two-year flow to 33 percent of the predevelopment flow.

Status of Pond Site: Split between commercial and an undeveloped portion of Sully Plantation Park.

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	4	172	41%
Dry ponds (no retrofit) – Includes Regional Pond C57	1	83	20%
Wet Ponds	1	9	2%
Undevelopable parkland downstream from stormwater controls		40	10%
Total	6	304	73%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
Commercial Area	62	15%
Single family residential	50	12%
Total	112	27%
Some potential for additional commercial development in the watershed. No downstream ponds.		

Summary of Stream Conditions Near Proposed Pond:	Erosion inventory lines with impact score of four approximately 1,000 feet downstream of proposed regional pond. This erosion indicates that peak flow control is required to prevent further erosion. Stream habitat is classified as good at the proposed pond.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofit projects	4	CU9711 – Franklin Middle School (54 acres) CU9713 – Lees Corner Road & Old Diary Road (81 acres) CU9712 – Centreville Road & Armfield Farm Road (30 acres) CU9714 – Franklin Farm Village Center (7 acres)
LID retrofit at public facilities	1	CU9825 - Franklin Middle School (0.6 acres)
Stream restoration projects	1	CU9220 - Restoration Project 4 located approximately 500 feet downstream from proposed regional pond.
Buffer restoration projects	3	Projects CU9335, CU9336 and CU9334
Upstream culvert retrofit projects	-	Closed pipe systems preclude this alternative.
Other Projects	1	Construct smaller dry pond at the existing site or immediately upstream.

Watershed Management Plan Recommendations	Construct regional pond C18 as a 1-year, 24-hour extended detention dry pond with a smaller pond area than proposed to reduce impacts on parkland and commercial area (project CU9002). The pond would provide enhanced stormwater control benefits at a critical headwater location. If the proposed pond is not constructed, then implement alternative stormwater controls including a smaller dry pond at an upstream location.

Table 6-3
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C18

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Originally Proposed Regional Pond C18 as a Wet Pond without Upstream Controls	190	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	87	23%
2 - Dry Pond Retrofit Projects (4 projects)	13	3%
3 - LID Retrofit Project	0.4	0.1%
4 – Stream Restoration Project	4.6	1.2%
5 - Modified Regional Pond C18 as a Dry Pond Combined with Existing Stormwater Controls	69	18%
6 - Regional Dry Pond Upstream from the Proposed Regional Pond Combined with Existing Stormwater Controls	50	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 - Modified Regional Pond C18 and Alternative Projects (Options 1, 2, 3, 4 and 5)	174	46%
Alternative 2 * – Modified Regional Pond C18 with No Alternative Projects (Options 1 and 5)	156	41%
Alternative 3 - Dry Pond Upstream from Proposed Pond and Alternative Projects (Options 1, 2, 3, 4 and 6)	155	41%
Alternative 4 –Dry Pond Upstream from Proposed Pond with No Alternative Projects (Options 1 and 6)	137	36%
Alternative 5–Alternative Projects with No Regional Pond (Options 1, 2, 3 and 4)	105	28%

* *Selected Alternative*

Stormwater Control Options

The following structural stormwater control options were evaluated:

1. Implement four dry pond wetland retrofit projects

2. Implement LID bioretention retrofit project for the Franklin Middle School

3. Perform stream restoration project for downstream portion of Cain Branch (CU9220) that includes 1,320 feet of stream restoration within Sully Park

4. Implement buffer restoration projects

5. Construct a smaller dry pond on the Cain Branch main stem at the proposed pond site. Because of the limited available storage volume, the pond may need to be constructed to provide only water quality and limited peak flow reduction benefits (e.g., one-year extended detention). The dry pond should include a wetland or vegetated bottom and maintain existing vegetation where possible.

6. Construct a smaller dry pond on the Cain Branch main stem upstream from the proposed regional pond, immediately upstream from Centreville Road. The dry pond should include a wetland or vegetated bottom and maintain existing vegetation where possible.

In addition to these structural options, additional stormwater controls can be implemented to improve watershed conditions:

1. Promote LID in the upstream watershed, focusing on development not upstream from existing ponds

2. Evaluate and retrofit headwater drainage systems

3. Promote buffer restoration in the upstream watershed

Table 6-3 summarizes the phosphorus reduction provided by structural stormwater control options:

- Option 1 provides the phosphorus reduction from the existing dry and wet ponds.

- Option 2 provides the incremental additional phosphorus reduction from the four proposed dry pond retrofit projects.

- Option 3 provides the additional phosphorus reduction from the LID retrofit projects at public facilities.

- Option 4 documents the phosphorus reduction from the downstream stream restoration project.

- Option 5 provides the additional phosphorus reduction from an extended detention dry pond (one-year, 24-hour stormwater runoff volume) at the site of the proposed regional pond combined with the existing dry and wet ponds. This pond has a smaller surface area compared to the proposed wet pond and is more compatible with the adjacent parkland. This alternative regional pond provides peak flow and water quality stormwater control benefits at a critical headwater location within the watershed that would reduce erosive velocities in downstream segments. The phosphorus reduction provided by this option is less than that provided by the originally proposed wet pond. The reason is that it is a dry pond rather than a wet pond, and the computations account for the phosphorus removed by the existing stormwater controls.

- Option 6 provides the phosphorus reduction from an extended detention dry pond constructed upstream from the proposed regional pond, as shown in Figure 6-3. This pond has a reduced surface area and avoids locating a pond closely adjacent to Sully Park. The nutrient reduction is smaller since this option controls a smaller drainage area. This pond would be constructed as an extended detention dry pond (one-year, 24-hour stormwater runoff volume).

Table 6-3 summarizes the nutrient reduction provided by five stormwater control alternatives that combine stormwater control options. These are in order of decreasing stormwater control effectiveness.

Updated Regional Pond Status
Regional pond C18 will be constructed at the proposed pond location as an extended detention dry pond that stores the runoff from the one-year, 24-hour storm event with reduced storage volume and footprint (Stormwater Control Alternative 2). The pond will be constructed with a wetland bottom to enhance nutrient removal efficiencies.

This pond enhances nutrient reduction in a critical headland portion of the watershed, further protecting the Cub Run streams and approaching the level of control provided by the originally recommended wet pond. The proposed pond has a smaller footprint compared to the proposed wet pond and is more compatible with the surrounding land uses and land cover. Construction of this facility would require approval from the Fairfax County Park Authority. This regional pond C18 is watershed plan project CU9002.

If construction of a dry pond at the proposed regional pond location is not possible, the next preferred alternative is to build a dry pond at an upstream location without the alternative stormwater controls (Stormwater Control Alternatives 4).

Finally, if a regional dry pond is not constructed, all identified alternative stormwater controls will be implemented to enhance nutrient and flow control in the upstream watershed (Stormwater Control Alternative 5).

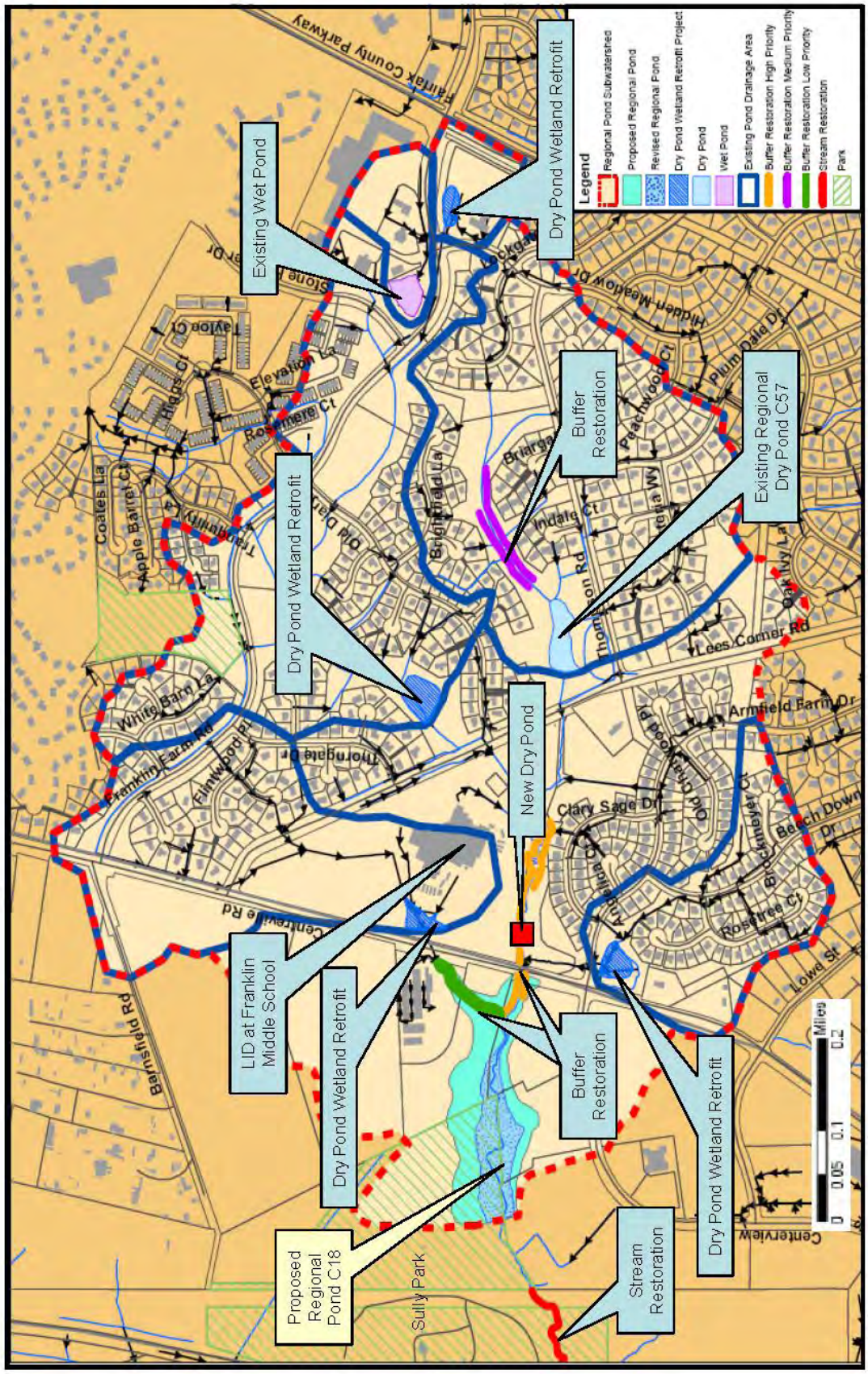


Figure 6-3
Proposed Regional Pond C18

6.2.4.3 Proposed Regional Pond C19

Proposed Pond Description

Regional pond C19 has a drainage area of 310 acres and was planned as a wet pond, which controls the 2- and 10-year peak flow to predevelopment conditions. The pond is on the upper reaches of the Round Lick Branch main stem upstream from Braddock Ridge Road. C19 was formally removed from the regional pond plan in 1998; however, it is included in this study for the development and evaluation of alternative projects.

The map in Figure 6-4 and data in Table 6-4 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

The first line in Table 6-5 documents the 50 percent phosphorus reduction provided by the originally proposed wet pond.

Residential development has occurred around the regional pond that precludes construction of a wet pond at the planned location and size or at a sufficient volume to provide adequate stormwater control. Construction of a pond of any size would have major impacts on several single-family homes adjacent to the site.

Three dry ponds serve 34 percent of the developed area upstream from the proposed pond. Furthermore, 152 acres or 49 percent of the drainage area to the proposed regional pond is in Ellanor C. Lawrence Park or other stream valley parks. As a result, 84 percent of the upstream area is controlled by existing ponds or protected as undeveloped parkland.

The streams above and for 2,500 feet below the proposed site do not exhibit stream bank erosion.

Several wet ponds constructed as Fairfax County regional wet pond C63 are downstream from the proposed pond. These ponds provide much of the water quality control that the proposed pond would provide.

Stormwater Control Options

Sixteen percent of the drainage area is single-family homes without stormwater controls. The closed pipe systems lack of open space leaves no potential sites for new ponds or upstream culvert retrofit projects.

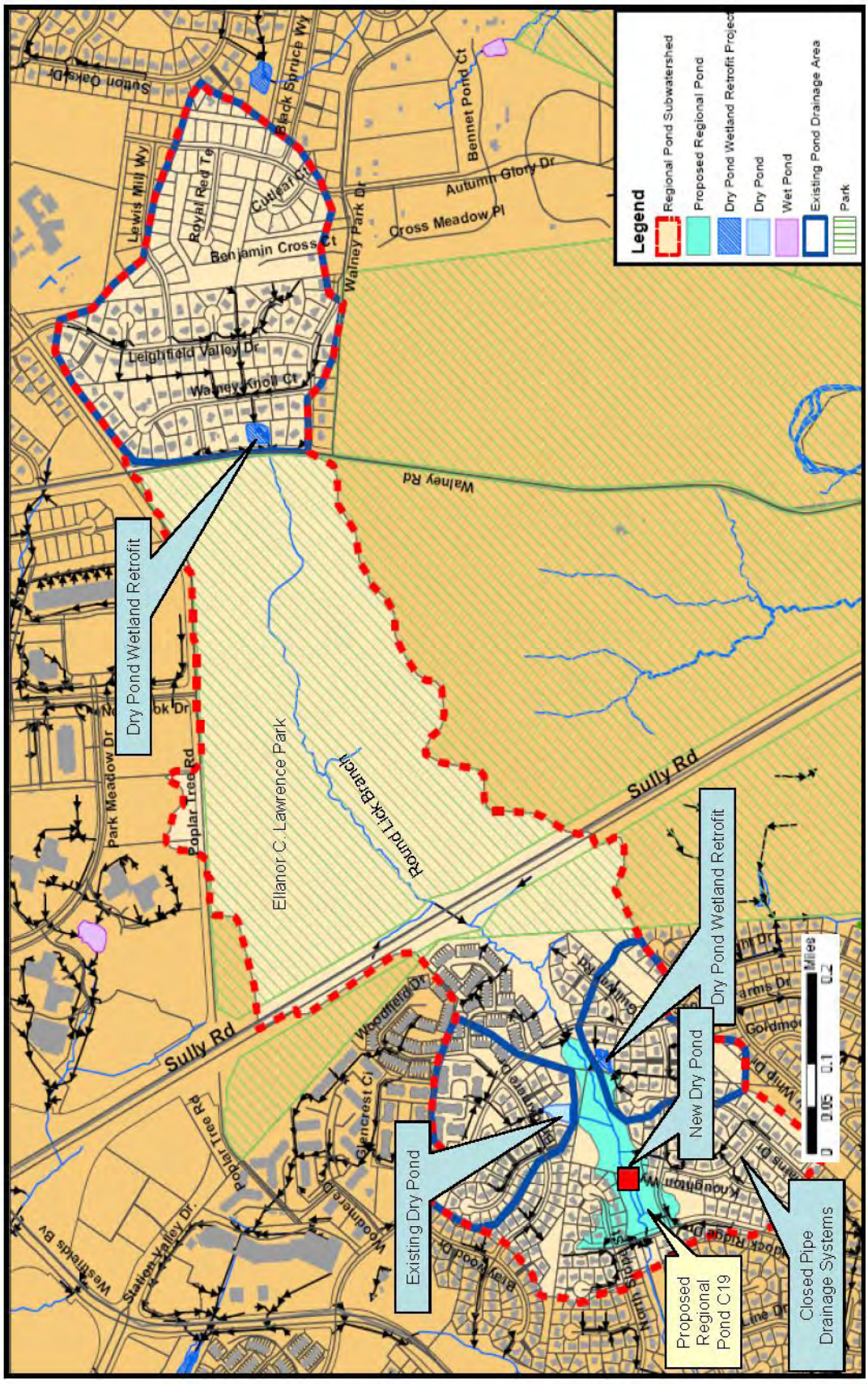


Figure 6-4
Proposed Regional Pond C19

Table 6-4
Watershed Overview for Unconstructed Regional Pond C19

Drainage Area: 310 Acres

Location: Round Lick Branch main stem upstream from Braddock Ridge Road

Type of Pond: Wet pond which controls the two-year and 10-year peak flow to predevelopment conditions

Status of Pond Site: Pond can no longer be constructed due to nearby single-family homes.

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	2	88	28%
Dry Ponds (no retrofit)	1	20	6%
Wet Ponds	0	-	-
Ellanor C. Lawrence Park	-	152	49%
Total	3	260	84%

Regional wet pond (C63) is downstream from the proposed pond (was constructed as two ponds).

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
Single-family residential with piped drainage system	50	16%

No potential for future development within watershed.

Summary of Stream Conditions Near Proposed Pond Site	No erosion inventory points within 2,500 feet. A stream restoration project is located about 2,900 feet downstream from the proposed pond. Stream habitat is classified as fair and poor at the proposed pond.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	2	Project CU9159 – Walney Road & Walney Park Drive (70 acres) Project CU9158 – Belle Plains Drive & Sequoia Farms Drive (17 acres)
LID retrofit at public facilities	-	
Stream restoration projects	1	Project CU9212 is 2,900 feet downstream
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	Closed pipe systems preclude this alternative.
Other Projects	1	Construct smaller dry pond upstream from proposed regional pond location.

Watershed Management Plan Recommendations	Delete regional pond C19 and implement the identified alternative stormwater control options. Do not construct smaller dry pond. Eighty-three percent of the upstream area is controlled by existing ponds or is in parkland. Also, a major regional wet pond (C63) is located downstream. The alternative stormwater projects (excluding the new smaller dry pond) compensate for a portion of the water quality improvements produced by the regional ponds and the stream restoration project addresses stream erosion in Round Lick Branch. Downstream regional ponds reduce the water quality benefits of the proposed regional pond and alternative dry pond.

Table 6-5
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C19

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Original Proposed Regional Wet Pond C19 without Upstream Controls	79	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	37	23%
2 - Dry Pond Retrofit Projects (2 projects)	8	5%
3 – Stream Restoration Project	5	3%
4 - Regional Dry Pond Upstream from Proposed Pond Combined with Existing Stormwater Controls	33	21%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 - Regional Dry Pond and Alternative Projects (Options 1, 2, 3 and 4)	83	52%
Alternative 2 – Regional Dry Pond without Alternative Projects (Options 1 and 4)	70	44%
Alternative 3 * – Delete Regional Pond C19 and Implement Alternative Projects (Options 1, 2 and 3)	50	32%

** Selected Alternative*

The following structural stormwater control options were evaluated:

1. Implement two dry pond wetland retrofit projects

2. Perform stream restoration project CU9212 located 2,900 feet downstream from the proposed pond location

3. Construct a smaller pond on the Round Lick Branch upstream from the proposed regional pond. A dry pond that does not provide peak flow controls, for example a one-year extended detention pond, may be considered.

Additional, nonstructural options can be considered to further enhance conditions in the watershed:

1. Promote LID in the upstream watershed, focusing on areas not upstream from existing stormwater ponds

2. Evaluate and rehabilitate stormwater outfalls to reduce stream erosion and improve stream habitat

Line numbers 1 through 4 in Table 6-5 show the incremental nutrient reduction provided by structural stormwater control options:

- Option 1 presents the phosphorus reduction provided by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction provided by the two proposed dry pond retrofit projects.

- Option 3 presents the additional phosphorus reduction provided by the downstream stream restoration project CU9212.

- Option 4 presents the additional phosphorus reduction provided by an extended detention dry pond close to the proposed regional pond.

Stormwater control alternatives were evaluated that combine the above stormwater control options. These appear in Table 6-5 in order of decreasing nutrient reduction benefit.

Alternatives 1 and 2 include an alternative regional dry pond upstream from the proposed pond combined with existing upstream stormwater controls. These alternatives provide water quality benefits roughly equal to the proposed regional pond. Alternative 3 excludes the regional pond but includes alternative stormwater controls that supplant some of the water quality improvements from the proposed pond and address erosion conditions in the local streams.

Updated Regional Pond Status

Regional pond C19 is deleted from the Cub Run and Bull Run watershed plan, and the following alternative projects will be implemented:

- Dry pond retrofit projects CU9158 and CU9159
- Stream restoration project CU9212
- Nonstructural projects, including promoting LID in the upstream watershed, and evaluating and rehabilitating stormwater outfalls to reduce stream erosion and improve stream habitat

The proposed regional pond, or alternative pond, has major impacts on surrounding residential properties and the stream valley. Two regional wet ponds downstream of proposed pond C19 (regional pond C63) remove many of the nutrients not captured by the alternative regional pond projects. In other words, these downstream ponds effectively negate the net phosphorus reduction provided by the proposed or alternative regional pond. The alternative stormwater control projects enhance stream and habitat conditions in the watershed upstream from regional pond C63.

6.2.4.4 Proposed Regional Pond C20

Proposed Pond Description

Regional pond C20 is on an unnamed tributary of Flatlick Branch. The drainage area to the original proposed pond is 124 acres. The pond was proposed as a maximum efficiency wet pond to reduce the two-year peak flow to 33 percent of the predevelopment peak flow.

The map in Figure 6-5 and data in Table 6-6 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

A large dry pond has been constructed downstream from the proposed pond. This pond can be considered "regional" due to its large drainage area but was not constructed as part of the county regional pond program. This downstream pond greatly reduces the water quality benefits that regional pond C20 would provide. The pollutant removal presented in Table 6-7 is based on the total area upstream from this existing downstream dry pond shown on Figure 6-5.

As shown in Table 6-7, proposed pond C20 would remove 29 pounds of phosphorus per year as originally planned. This is 27 percent of the total loads at the existing dry pond.

Nearby residential development requires that the C20 dam be moved 110 feet upstream to avoid existing structures. This new upstream location has insufficient storage for a one-year, 24-hour extended detention dry pond. An extended detention dry pond with a smaller extended detention volume (e.g., standard 0.86 inches of runoff from the impervious area) could be created at this site.

Section 6
Watershed Plan Structural Actions

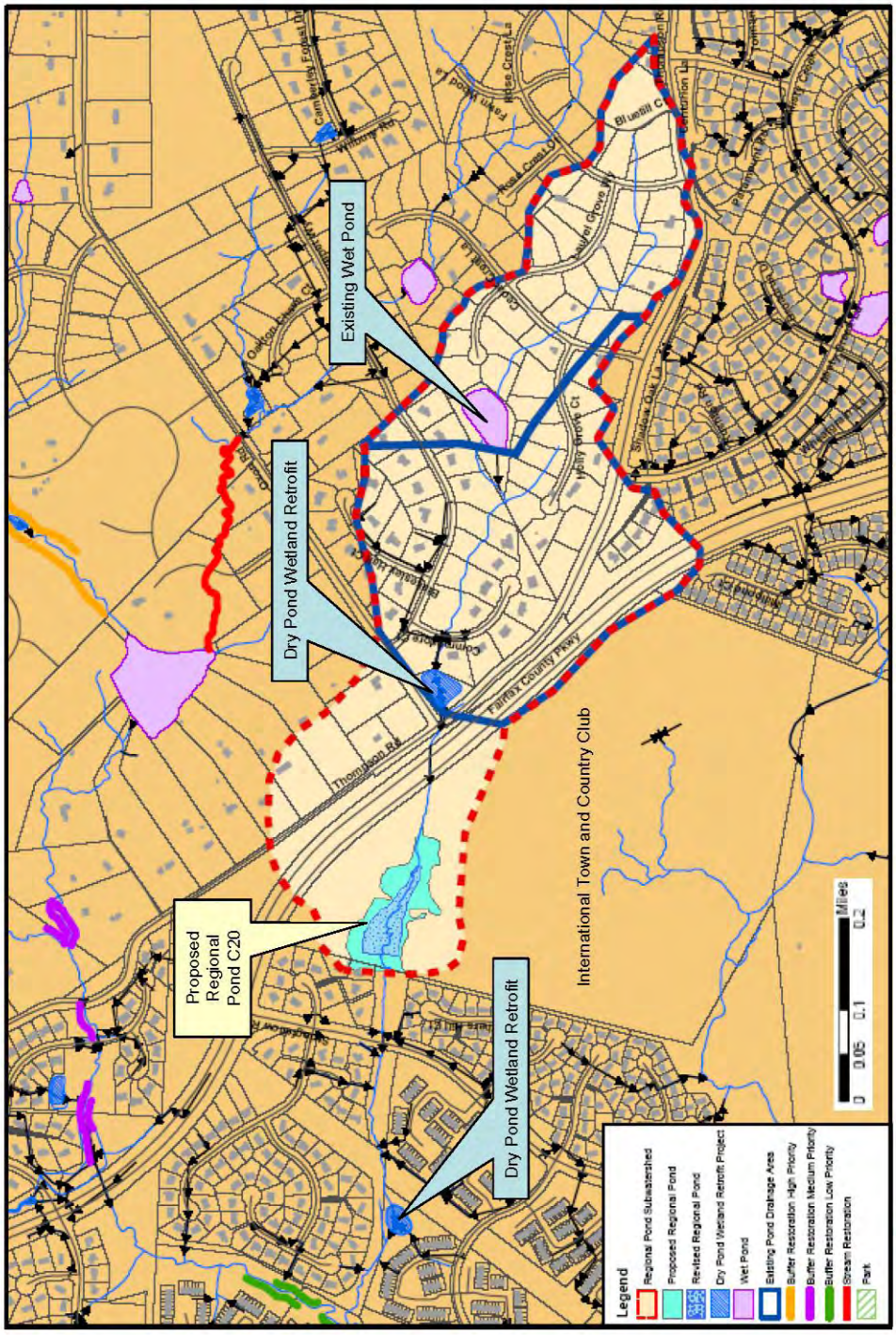


Figure 6-5
Proposed Regional Pond C20

Table 6-6
Watershed Overview for Unconstructed Regional Pond C20

Drainage Area: 124 Acres

Location: Unnamed tributary of Flatlick Branch

Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 33 percent of the predevelopment peak flow.

Status of Pond Site: Pond cannot be constructed at the location and size planned due to residential development. Pond could be constructed upstream as an extended detention dry pond with a dam located several hundred feet upstream from the proposed location. The proposed ponds would be located on the International Town and Country Club and would temporarily flood golf course fairways during storm events.

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	1	52	42%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	36	29%
Total	2	88	71%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
Golf Course fairways and forested land	36	29%

No potential for future development. There is a constructed dry pond 1,400 feet downstream from proposed pond. This pond was not constructed as part of the County regional pond program but can be considered regional in nature due to its large drainage areas. This pond is a proposed wetland bottom retrofit project.

Summary of Stream Conditions Near Proposed Pond Site :	Single erosion inventory point 2,100 feet downstream from pond indicates that streams are not severely eroded. The physical habitat within the pond area is classified as fair.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	2	Project CU9194 – Fairfax County Parkway & Oxon Road (52 acres) Project CU9193 – Mazewood Lane (Downstream of proposed pond) (89 acres)
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Defer proposed regional pond and construct alternative projects. The upstream and downstream ponds effectively control the runoff from the developed areas in the watershed. Implement the regional pond if the dry pond retrofit projects are not implemented.

Table 6-7
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C20

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C20 without Upstream or Downstream Controls	29	27%
Stormwater Control Options		
1 - Existing Stormwater Controls Including Downstream Dry Pond	42	39%
2 - Dry Pond Retrofit Projects (2 projects including downstream dry pond)	3	3%
3 - Proposed Regional Pond C20 Constructed as a Dry Pond Combined with Existing Stormwater Controls Including Downstream Dry Pond	6	6%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Regional Dry Pond with Alternative Projects (Options 1, 2and 3)	51	48%
Alternative 2 –Regional Dry Pond without Alternative Projects (Options 1 and 3)	48	45%
Alternative 3 * –Alternative Projects (Options 1 and 2) and Defer Construction of Regional Pond C20	45	42%

* - *Selected Alternative*

The pond would be entirely within the International Town and County Club golf course and adjacent woodlands. Pond construction would require clearing of wooded areas on the golf course. The extended detention volume would temporarily flood fairways during a rainfall event.

The upstream watershed includes one wet and one dry pond that serve all of the low-density residential development in the watershed. There is little opportunity for additional development in the remaining undeveloped area within the International Town and Country Club. The golf course will likely not be redeveloped.

Stormwater Control Options
Since the upstream residential area is entirely served by existing dry and wet ponds, and a dry pond exists downstream, little benefit would come from installing alternative stormwater controls upstream from the proposed regional pond.

The following structural stormwater control option was evaluated for regional pond C20:

1. Implement two dry pond retrofit projects

In addition, nonstructural stormwater control options would enhance conditions in this watershed:

2. Promote LID within the upstream watershed

3. Work with International Town and Country Club golf course to reduce stream buffer impacts and ensure that operations minimize fertilizer and pesticide impacts on the streams

Table 6-7 summarizes the incremental annual phosphorus removed by the structural stormwater control options. The percent reductions are for the total watershed area upstream from the existing dry pond.

- Option 1 provides the phosphorus reduction from the three existing ponds.

- Option 2 provides the additional phosphorus reduction from two dry pond retrofit projects.

- Option 3 provides the additional phosphorus reduction from a dry pond constructed near the proposed pond location.

Table 6-7 summarizes three stormwater control alternatives that combine the identified stormwater control options, in order of decreasing effectiveness.

Alternative 1 represents the new dry pond combined with existing stormwater controls and two dry pond retrofit projects. The proposed regional pond C20 provides small water quality benefit (removing only 6 pounds of phosphorus per year) since the areas between it and upstream ponds is undeveloped.

Alternative 2 represents the new dry pond without the two dry pond retrofit projects.

Alternative 3 represents the existing stormwater controls with the two dry pond retrofit projects. The existing stormwater controls, combined with the proposed dry pond retrofit projects, remove nutrients more effectively than would the proposed regional pond. This is the selected watershed plan alternative.

Alternatives 1, 2 and 3 provide similar phosphorus reduction that all are greater than that of the original proposed pond. The downstream dry pond causes the proposed regional pond to have little nutrient reduction benefit.

Updated Regional Pond Status
Defer the construction of regional Pond C20 and implement two dry pond wetland retrofit projects (CU9193 and CU9194). If the alternative projects cannot be implemented, a modified regional pond may be considered. Implement nonstructural controls, including promoting LID in the watershed and working with the International Town and Country Club to reduce buffer impacts, and nutrient and pesticide runoff.

The proposed regional pond's benefits are small relative to the cost and impact while the alternative projects provide greater protection.

6.2.4.5 Proposed Regional Pond C21

Proposed Pond Description
Regional pond C21 is in the R-C District in the Virginia Run/Pleasant Hills community (downstream from Hidden Canyon Road adjacent to Knoll View Place). The pond is on an unnamed tributary to the Middle Cub Run main stem. The pond has a drainage area of 156 acres and was planned as a wet pond that reduces the peak two-year flow to pre-development conditions. The drainage area is largely developed as medium-density residential, which was planned before rezoning.

The map in Figure 6-6 and data in Table 6-8 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
Proposed regional pond C21 removes 41 pounds of phosphorus per year (Table 6-9). The following bullets discuss conditions at the proposed site:

- The dam is within FCPA parkland, which is a valuable watershed resource. The pond would need to demonstrate significant watershed improvements to be constructed at this location.

- Nearby residential development precludes construction of a wet pond with the originally proposed storage volume.

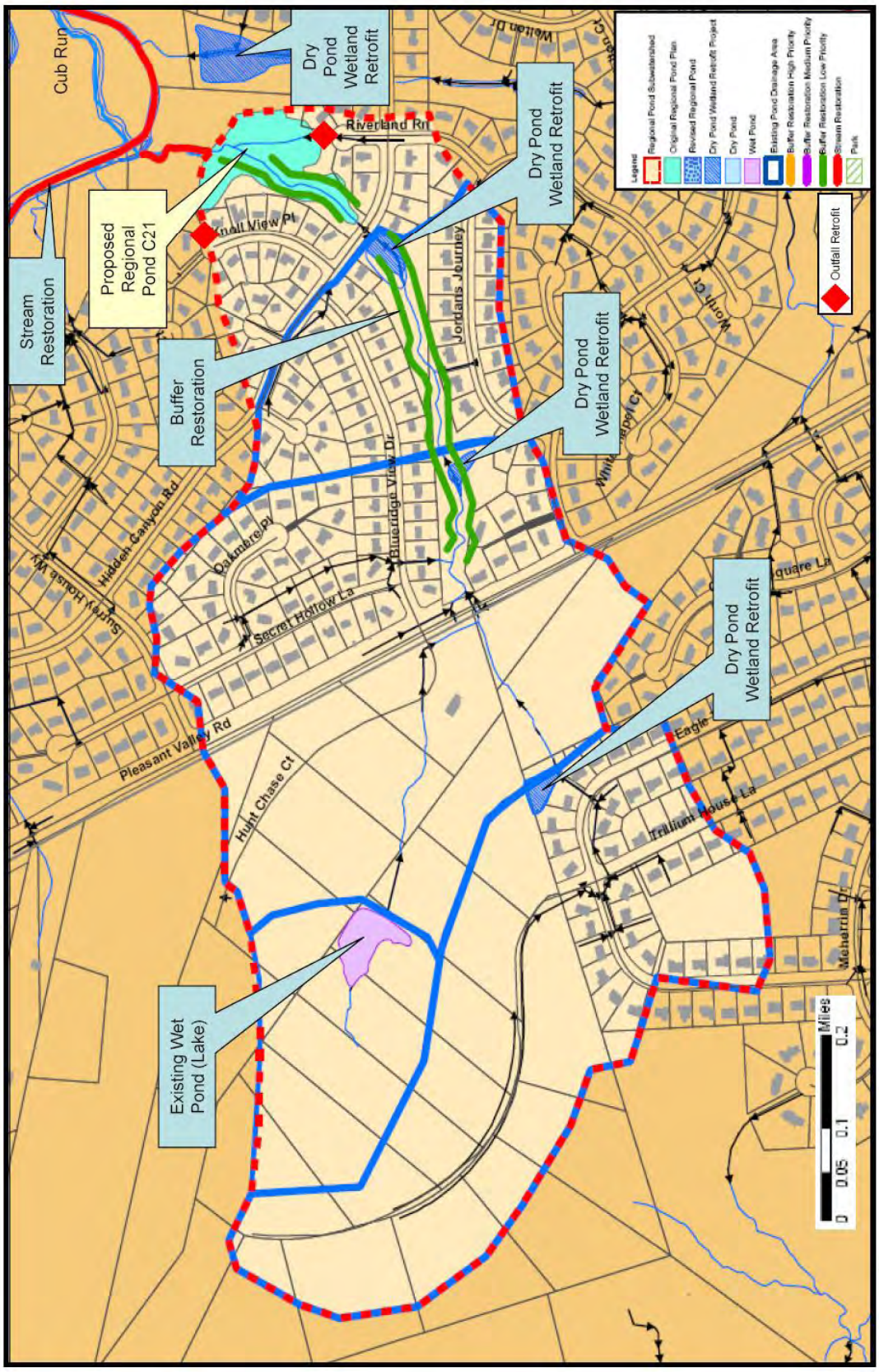


Figure 6-6
Proposed Regional Pond C21

Table 6-8
Watershed Overview for Unconstructed Regional Pond C21

Drainage Area: 156 Acres	
Location: R-C District in the Virginia Run/Pleasant Hills community (downstream from Hidden Canyon Road adjacent to Knoll View Place. Unnamed tributary to the Middle Cub Run main stem.	
Type of Pond: Wet pond that controls the peak two-year flow to predevelopment conditions.	
Status of Pond Site: The proposed regional pond is located within Fairfax County Park Authority Parkland. Nearby residences prevent construction of pond with the proposed storage volume.	

Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	3	130	83%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	16	10%
Total	4	146	93%

Summary of Uncontrolled Developed Area	**Area (Acres)**	**Percent of Total Area**
Stream Valley and about 15 single family homes	10	7%
No potential for future development.		

Summary of Stream Conditions Near Proposed Pond Site:	Erosion inventory line (approximately 320 feet) with impact score of seven on tributary stream where it joins Cub Run. This erosion results from down cutting of Cub Run. The physical habitat is classified as fair near this pond site.

Alternative Stormwater Control Options	**Number of Projects**	**Description**
Dry pond wetland retrofits	4	CU9160 – Oakengate Way (Outside Watershed) (10 acres) CU9162 – Blueridge View Drive (59 acres) CU9161 – Hidden Canyon Road (12 acres) CU9163 – Eagle Tavern Place (47 acres)
LID retrofit at public facilities	-	
Stream restoration projects	1	Restoration included in Middle Cub Run Stream Restoration Project CU9211 which includes restoration in this tributary where it joins Cub Run
Buffer restoration projects	1	Restore buffer throughout much of stream upstream from the proposed pond – Project CU9316
Upstream culvert retrofit projects	-	
Other Projects	2	Stormwater outfall retrofit projects for Riverland Run and Knoll View Place cul-de-sacs.

Watershed Management Plan Recommendations	Delete regional pond C21 and construct all identified alternative stormwater control options. Upstream ponds effectively control runoff from 93 percent of the developed areas in the watershed including Estate Residential Development. Alternative stormwater control options enhance pollution reduction provided by the existing stormwater control faculties, mitigate runoff from uncontrolled areas, improve health of stream by addressing buffer impact and address stream erosion downstream from the proposed pond.

Table 6-9
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C21

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C21 without Existing Controls	41	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	28	34%
2 - Dry Pond Retrofit Projects (4 projects)	7	9%
3 – Stream Restoration Project	1	1%
4 – Proposed Regional Pond C21 Combined with Existing Stormwater Controls	9	11%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond with Alternative Projects (Options 1, 2, 3 and 4	45	55%
Alternative 2 – Proposed Regional Pond without Alternative Projects (Options 1 and 4	37	45%
Alternative 3 * - Deleted Regional Pond and Implement Alternative Projects (Options 1, 2 and 3)	36	44%

* - *Selected Alternative*

- The upstream drainage area includes three dry ponds and one wet pond/lake that provide water quality and peak flow benefits for 93 percent of the development upstream of the pond.

- The pond is near the middle Cub Run main stem. A stormwater pond at this location could potentially increase flows in Cub Run by delaying and extending the peak flows from the local small watershed.

- The stream has erosion where it joins Cub Run, possibly because of down-cutting in the Cub Run main stem. Stream restoration in this reach is proposed as part of the restoration project that includes Cub Run.

The stream buffers upstream from the regional pond have been affected by mowing and nearby lawns. These areas are included in a stream restoration project.

Stormwater Control Options
The following alternative structural stormwater control options were evaluated for regional pond C21:

1. Four dry pond retrofit projects

2. Stream restoration project for downstream segment upstream of Cub Run (CU9211)

3. Buffer restoration project for stream segments upstream of the proposed regional pond (CU9316)

4. Two stormwater outfall retrofit projects for the stormwater culvert outlets that drain the cul-de-sacs on 1) Riverland Run and 2) Knoll View Place. These projects are recommended to enhance the stormwater controls for this area. The projects include energy dissipaters, flow spreading devices and stream restoration to mitigate impact of flows from these culverts on the small streams or ditches that receive the flows.

In addition, the following nonstructural project can be implemented to further enhance conditions near the proposed regional pond:

1. Promote LID within the upstream subwatershed

Table 6-9 summarizes the phosphorus removal provided by structural stormwater control options:

- Option 1 presents the phosphorus reduction provided by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the four dry pond retrofit projects.

- Option 3 presents the additional phosphorus reduction produced by the stream restoration project downstream from the regional pond.

- Option 4 presents the additional phosphorus reduction produced by the proposed regional pond in combination with the existing stormwater controls.

Table 6-9 also summarizes three stormwater control alternatives for Regional Pond C21. These alternatives combine stormwater control options and appear in order of decreasing effectiveness.

Alternative 1 is the regional stormwater pond with alternative projects.

Alternative 2 is the regional stormwater pond without the alternative projects.

Alternative 3 excludes the regional pond but includes the upstream alternative projects. This is the selected alternative.

Updated Regional Pond Status
Regional pond C21 is deleted from the watershed plan, and the alternative stormwater projects will be implemented to enhance the watershed's stream conditions and meet the watershed plan's goals and vision. The following alternative projects will be implemented:

- Dry pond retrofit projects CU9160, CU9161, CU9162 and CU913

- Part of stream restoration project CU9211

- Buffer restoration project CU9316

- Stormwater outfall retrofit projects for Riverland Run and Knoll View Place cul-de-sacs

The proposed regional pond provides little water quality benefit (removes 9 pounds of total phosphorus) compared with other regional ponds outside the R-C District, particularly relative to its cost and impact.

The dry pond retrofit projects nearly offset the phosphorus reductions provided by the regional pond. The alternative stormwater controls enhance the pollution removal efficiency of the existing facilities, enhance the health of the streams by addressing buffer impacts and address stream erosion issues downstream of the proposed regional pond location.

6.2.4.6 Proposed Regional Pond C23

Proposed Pond Description
Regional pond C23 is in the R-C District in the Virginia Run and the Estates neighborhood, north of Kentwell Circle. The pond is on an unnamed tributary to Elklick Run near its confluence with Cub Run. The identified pond location has a drainage area of 102 acres, and the pond was proposed as a maximum efficiency wet

pond that controls the peak runoff for both the 2- and 10-year storm to 33 percent of the predevelopment peak flow rate.

The map in Figure 6-7 and data in Table 6-10 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
The proposed pond would have removed 7.5 pounds of phosphorus per year as summarized in Table 6-11.

Approximately 50 percent of the watershed is within FCPA parkland. Of the remaining area, 30 percent is large five-acre lot estate residential development. The remainder is developed at a low residential land use density (0.7-acre lot size). This land use is an effective low-impact development BMP that does not require additional structural stormwater controls to address stormwater flows or water quality. This development was either planned during the rezoning of this area or built at a higher development by way of clustering. No opportunity for additional development in the drainage area exists. This higher-density development has a dry pond recommended for a wetland bottom retrofit.

The dam site and area to be included in the pond are in FCPA parkland and private property. The dam site is near the Cub Run main stem. A pond at this location would delay and extend the peak flows from this area, potentially increasing peak flows in Cub Run.

Stormwater Control Options
The following structural stormwater control options were evaluated as replacement projects for proposed regional pond C23:

1. Construct dry pond wetland retrofit project CU9705 to enhance nutrient removal from this existing facility

The following nonstructural project could be implemented to further enhance conditions in this local stream:

1. Promote LID in the upstream subwatershed

Table 6-11 provides the phosphorus reduction from stormwater control options:

- Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the dry pond retrofit project.

- Option 3 presents the additional phosphorus reduction produced by the proposed regional pond C23 together with the existing stormwater controls.

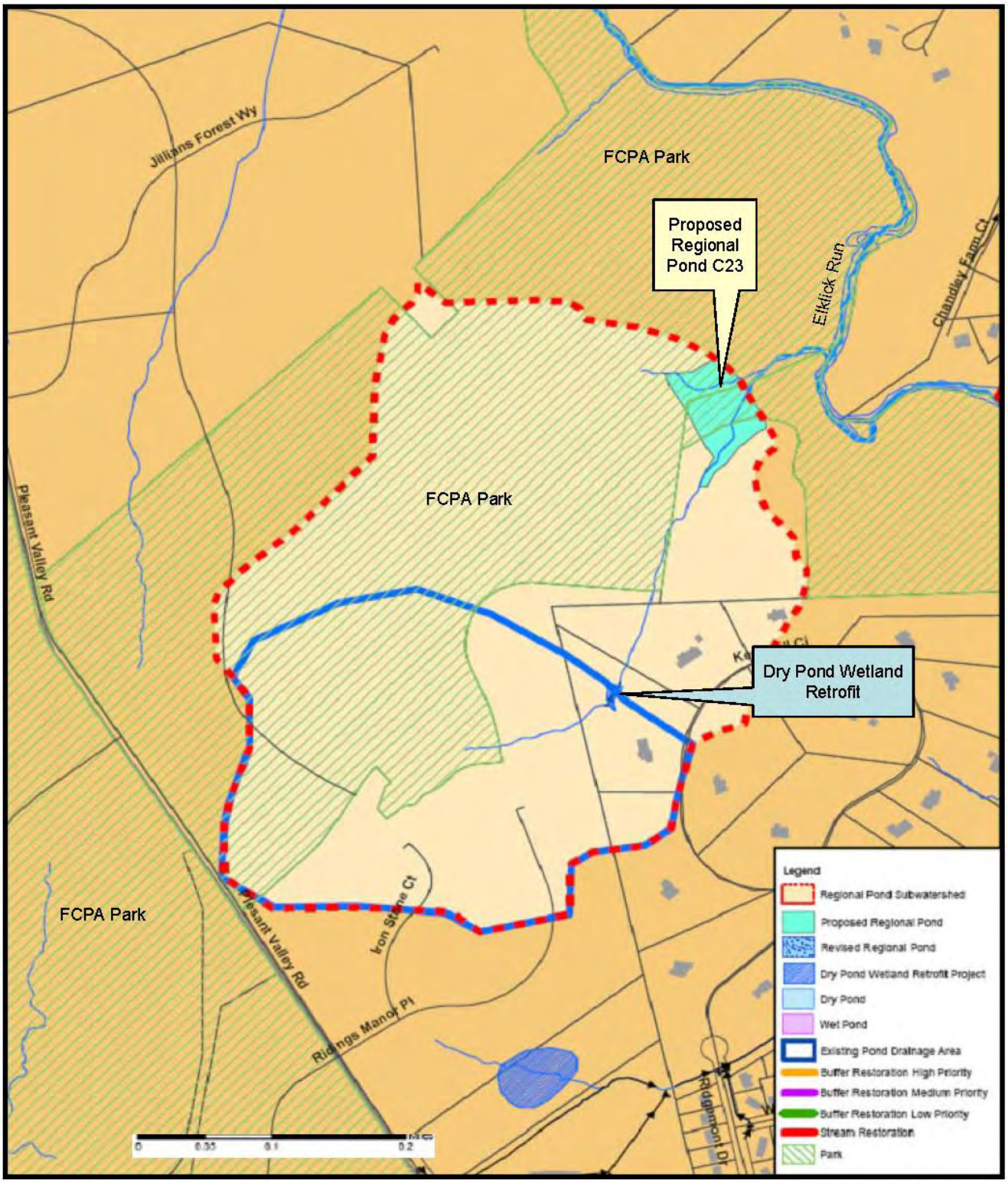


Figure 6-7
Proposed Regional Pond C23

Table 6-10
Watershed Overview for Unconstructed Regional Pond C23

Drainage Area: 102 Acres			
Location: R-C District in the Virginia Run - The Estates neighborhood, north of Kentwell Circle. Unnamed tributary to Lower Elklick Run.			
Type of Pond: Maximum efficiency wet pond that controls the peak runoff for both the two-year and 10-year storm to 33 percent of the predevelopment runoff.			
Status of Pond Site: Within Fairfax County Park Authority Parkland and residential lot.			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	1	44	43%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
FCPA Parkland		40	39%
Three estate-residential lots	-	18	18%
Total	1	102	100%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
		0	0%
No potential for future development.			
Summary of Stream Conditions Near Proposed Pond Site:	Stream not inventoried.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	1	Project CU9705 – Ridings Manor Place (44 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete proposed regional pond C23 and implement dry pond retrofit project.		

Table 6-11
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C23

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C23 without Existing Controls	7.5	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	1.3	8%
2 - Dry Pond Retrofit Project	0.3	2%
3 - Proposed Regional Pond C23 Combined with Existing Stormwater Controls	6.1	40%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Regional Pond With Alternative Projects (Options 1, 2 and 3)	7.7	51%
Alternative 2 – Regional Pond without Alternative Projects (Options 1 and 3)	7.4	49%
Alternative 3 * - Delete Regional Pond C23 and Implement Alternative Projects (Options 1 and 2)	1.6	11%

* - *Selected Alternative*

Table 6-11 also summarizes the phosphorus reduction for three stormwater control alternatives that combine stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status
Proposed regional pond C23 is deleted from the Cub Run and Bull Run watershed plan, and the alternative stormwater control project will be implemented to enhance stormwater protection and meet watershed goals and vision:

- Dry pond retrofit project CU9705

Because of the low development densities, the proposed regional pond provides small reductions in annual total phosphorus loadings (removing 6.1 pounds per year) compared to other regional ponds outside the R-C district that remove 36 to 69 pounds per year. As such, the pond provides low nutrient reductions and stormwater improvements relative to the costs and impacts of construction. Alternative projects enhance nutrient reduction provided by the existing stormwater facility and improve the stream's health.

6.2.4.7 Proposed Regional Pond C24

Proposed Pond Description
Regional pond C24 is on a small, unnamed tributary to Elklick Run within the R-C District just west of Pleasant Valley Road. The drainage area to the proposed regional pond is 81 acres. The pond is proposed to be a maximum efficiency wet pond that reduces the two-year peak flow to 33 percent of the existing predevelopment flow.

The map in Figure 6-8 and data in Table 6-12 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
As presented in Table 6-13, proposed regional wet pond C24 would remove 1.8 pounds of phosphorus per year.

The pond and watershed drainage area is entirely within the FCPA parkland. The watershed is undeveloped and, being parkland, will not be developed. No existing stormwater controls are within this undeveloped watershed.

Pleasant Valley Road affects the stream and stream buffer downstream from the proposed pond. These impacts will increase if Pleasant Valley Road increases to four lanes as planned.

Stormwater Control Options
The following structural projects were evaluated as alternative stormwater control projects for regional pond C24:

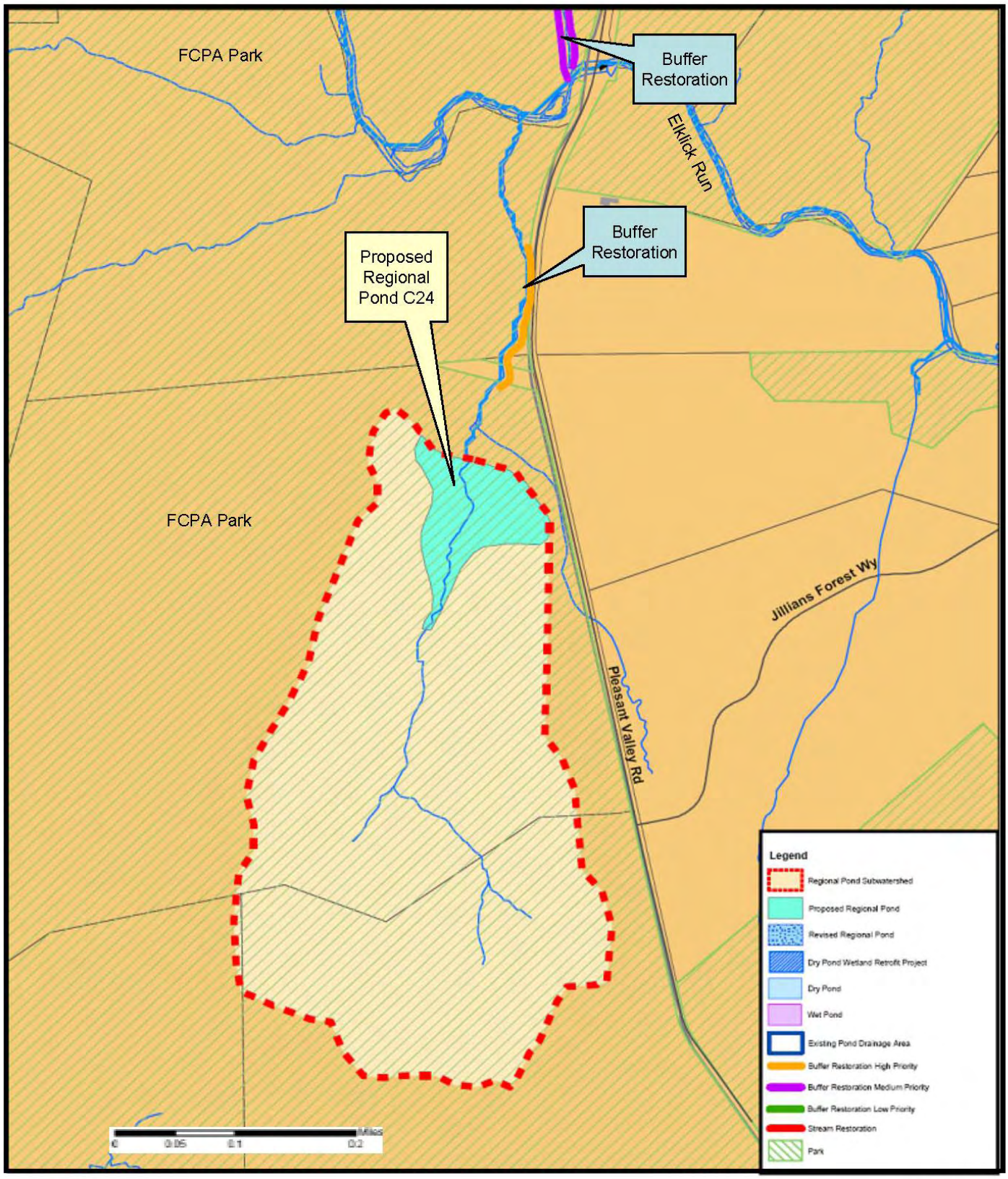


Figure 6-8
Proposed Regional Pond C24

Table 6-12
Watershed Overview for Unconstructed Regional Pond C24

Drainage Area: 81 Acres

Location: R-C District on a small, unnamed tributary to Elklick Run west of Pleasant Valley Road.

Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 33 percent of the existing predevelopment flow

Status of Pond Site: Pond site and watershed are entirely within Fairfax County Park Authority parkland

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
FCPA Parkland	-	81	100%
Total	0	81	100%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
	0	0%

No potential for future development.

Summary of Stream Conditions Near Proposed Pond Site :	Erosion inventory line (300 feet) with impact score of five at the pond. This appears to be naturally occurring erosion or have resulted from past land uses since the watershed is totally undeveloped. Buffer downstream from the pond is affected by Pleasant Valley Road. The physical habitat is classified as fair.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	-	
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	2	Restore buffer at Pleasant Valley Road south and north of Elklick Run, Projects CU9330 and CU9331
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Delete Regional pond C24 from the watershed plan and restore buffer at Pleasant Valley Road at two locations to improve the health of the streams.

Table 6-13
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C24

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C24 without Existing Controls	1.8	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0.0	0%
2 - Buffer Restoration Projects	0.0	0%
3 - Proposed Regional Pond C24 with Existing Stormwater Controls	1.8	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Proposed Wet Pond with Alternative Projects (Options 1, 2 and 3)	1.8	50%
Alternative 2 * – Deleted Regional Pond C24 and Implement Alternative Buffer Restoration Projects (Options 1 and 2)	0.0	0%

* - *Selected Alternative*

1. Buffer restoration project along Pleasant Valley Road south of Elklick Run

2. Buffer restoration project along Pleasant Valley Road north of Elklick Run These

buffer restoration projects will improve the health of the local streams in and near this subwatershed. No additional opportunities for alternative stormwater controls exist within the watershed upstream of the proposed pond. Furthermore, none are required since the watershed is undeveloped.

Table 6-13 summarizes the phosphorus removal provided by the stormwater control options:

- Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction produced by the buffer restoration projects.

- Option 3 presents the additional phosphorus reduction produced by the proposed regional pond in combination with the existing upstream stormwater controls.

Table 6-13 also presents the total phosphorus removed by stormwater control alternatives that combine the stormwater control options. These appear in decreasing order of effectiveness.

Updated Regional Pond Status
Delete regional pond C24 and construct two buffer restoration projects CU9330 and CU9331. The open space in the subwatershed results in low levels of phosphorus in the runoff and demonstrates that the proposed pond provides minimal watershed benefits. The proposed ponds only remove about 2 pounds of phosphorus per year whereas ponds outside the R-C District remove more than 36 pounds per year.

6.2.4.8 Proposed Regional Pond C28

Proposed Pond Description
Regional pond C28 lies within R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem. Proposed regional Pond C35 is on an adjacent subwatershed. The proposed pond has a drainage area of 104 acres and was proposed as a maximum efficiency wet pond that controls the two-year peak flow to 50 percent of the predevelopment peak flow rate.

The map in Figure 6-9 and data in Table 6-14 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Although the watershed is entirely within the R-C district, it includes 30 acres with 0.7- to 1.2-acre lots that existed at the time of the rezoning. The remaining area can be developed at the five-acre Estate Residential density.

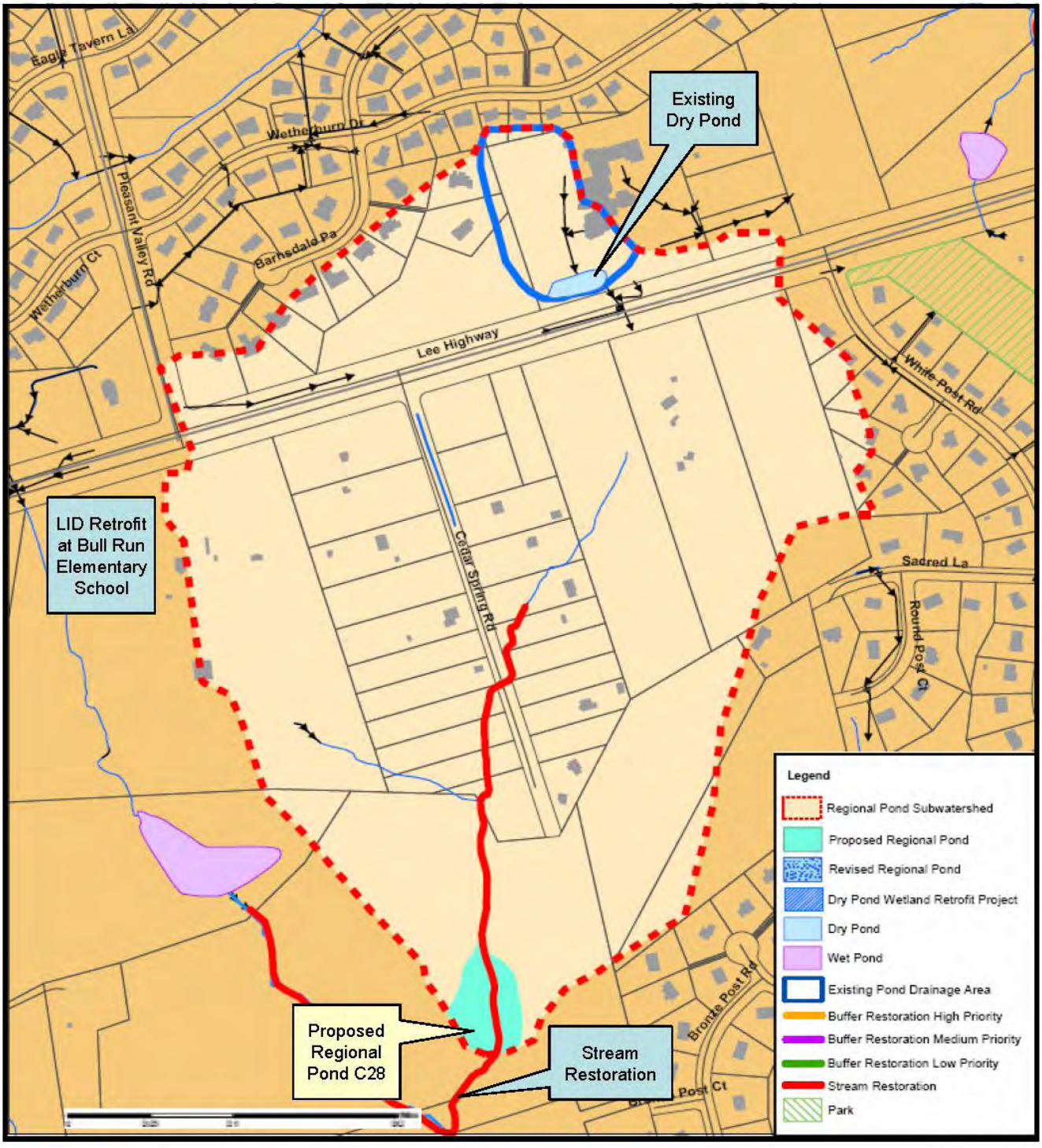


Figure 6-9
Proposed Regional Pond C28

Table 6-14
Watershed Overview for Unconstructed Regional Pond C28

Drainage Area: 104 Acres

Location: R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem.

Type of Pond: Maximum efficiency wet pond that controls the two-year peak flow to 50 percent of the predevelopment peak flow

Status of Pond Site: Undeveloped privately owned wooded area

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit) Centerville Baptist Church	1	4	4%
Wet Ponds	0	0	0%
R-C District Estate-Residential Land Use		100	96%
Total	1	104	100%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
	0	0%

Summary of Stream Conditions Near Proposed Pond Site:	Erosion inventory line (1,000 feet) with impact score of 7 within tributary downstream from proposed pond. The cause of this stream erosion is uncertain. The development density is very low in the watershed and should not be contributing to the erosion. The erosion may be naturally occurring, result from past land uses (e.g. farming), or result from down cutting of Cub Run. The physical habitat is classified as good.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	-	
LID retrofit at public facilities	1	Bull Run Elementary School (2 acres) (CU9801)
Stream restoration projects	1	CU9202
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Delete regional pond C28 and implement two identified alternative structural projects. The watershed is entirely R-C District Estate-Residential land use, which is an effective low-impact development BMP where additional stormwater controls are not required.

Proposed Pond Evaluation
The proposed pond removes 18 pounds of phosphorus per year (Table 6-15).

Review of the Stream Physical Assessment data indicates the streams upstream and downstream of the proposed regional pond show significant erosion, the cause of which is uncertain. These stream reaches are included in a stream restoration project. The density of development in the watershed is not sufficient to produce the erosion found in this reach. The stream erosion may result from natural stream erosion, past land uses (e.g., farming), or down-cutting of Cub Run.

The physical habitat is classified as good near the proposed pond.

Stormwater Control Options
The following stormwater control options were evaluated for regional pond C28:

1. LID retrofit at Bull Run Elementary School (CU9801). The Bull Run Elementary school is a new facility that includes a wet pond that drains to an adjacent watershed.

2. Stream restoration project CU9202

These improvements enhance the water quality removal of the existing facilities and address the stream erosion in the local streams.

Table 6-15 summarizes the incremental annual phosphorus removed by the stormwater controls options:

- Option 1 presents the phosphorus reduction from the existing stormwater controls.

- Option 2 presents the additional phosphorus reduction from the LID retrofit project.

- Option 3 presents the additional phosphorus reduction from the stream restoration project.

- Option 4 presents the additional phosphorus reduction from the proposed wet pond C28 in combination with the existing upstream stormwater controls

Table 6-15 presents the phosphorus reduction produced by three stormwater control alternatives that combine the stormwater control options. These appear in order of decreasing effectiveness.

Table 6-15
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C28

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C28 without Existing Controls	18	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	2.5	7%
2 - LID Retrofit Project	1.3	4%
3 – Stream Restoration Project	8	22%
4 - Proposed Regional Pond C28 Combined with Existing Stormwater Controls	15	42%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond with Alternative Projects (Options 1, 2, 3 and 4)	26.8	74%
Alternative 2 – Proposed Regional Pond without Alternative Projects (Options 1 and 4)	17.5	49%
Alternative 3 * - Delete Proposed Regional Pond C28 and Implement Alternative Stormwater Controls (Options 1, 2and 3)	11.8	33%

* - *Selected Alternative*

Updated Regional Pond Status
Delete proposed regional pond C28 and implement the following two alternative stormwater control alternatives:

- LID Retrofit project CU9801

- Stream restoration project CU9202

Proposed regional pond C28 removes about 15 pounds of phosphorus per year, whereas ponds outside the R-C District remove more the 36 pounds per year. Alternative stormwater control projects will be implemented to enhance stormwater controls, and meet watershed goals and vision.

6.2.4.9 Proposed Regional Pond C35

Proposed Pond Description

Regional pond C35 lies within the R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem. Proposed regional Pond C28 is in an adjacent subwatershed and has a drainage area of 117 acres. It was planned as a maximum efficiency wet pond that reduces the peak flow for the 2- and 10-year storms, respectively, to 33 and 80 percent of the predevelopment flow.

The map in Figure 6-10 and data in Table 6-16 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation

The proposed regional wet pond would have removed 17 pounds of phosphorus as presented in Table 7-17.

The upstream watershed includes five-acre or larger lots with little or no development. No existing stormwater controls are within this undeveloped watershed. These lots will likely be redeveloped to include modern homes on five-acre lots. Stormwater controls are not required for this development density because it is an effective low-impact development BMP.

Erosion does not affect the stream on which the proposed pond is located. It does, however, affect stream segments downstream after this stream joins other small streams. This stream erosion was described in the discussion on pond C28.

Stormwater Control Options

Downstream stream restoration project CU9202 was evaluated as a potential replacement for regional pond C35. This project was shared with regional pond C28.

No opportunities exist for alternative stormwater controls in the upstream watershed since the subwatershed is undeveloped.

Table 6-17 summarizes the total annual phosphorus removed by the stormwater control options for the area upstream from the proposed regional pond.

As shown under Option 1, the undeveloped watershed does not have stormwater controls that reduce the phosphorus loads. Option 2 documents the nutrient reduction produced by the stream restoration project downstream of the proposed pond. Option 3 presents the phosphorus reduction produced by the proposed pond.

Table 6-17 presents the total phosphorus reduction produced from three alternative combinations of the stormwater control options, listed in order of decreasing effectiveness.

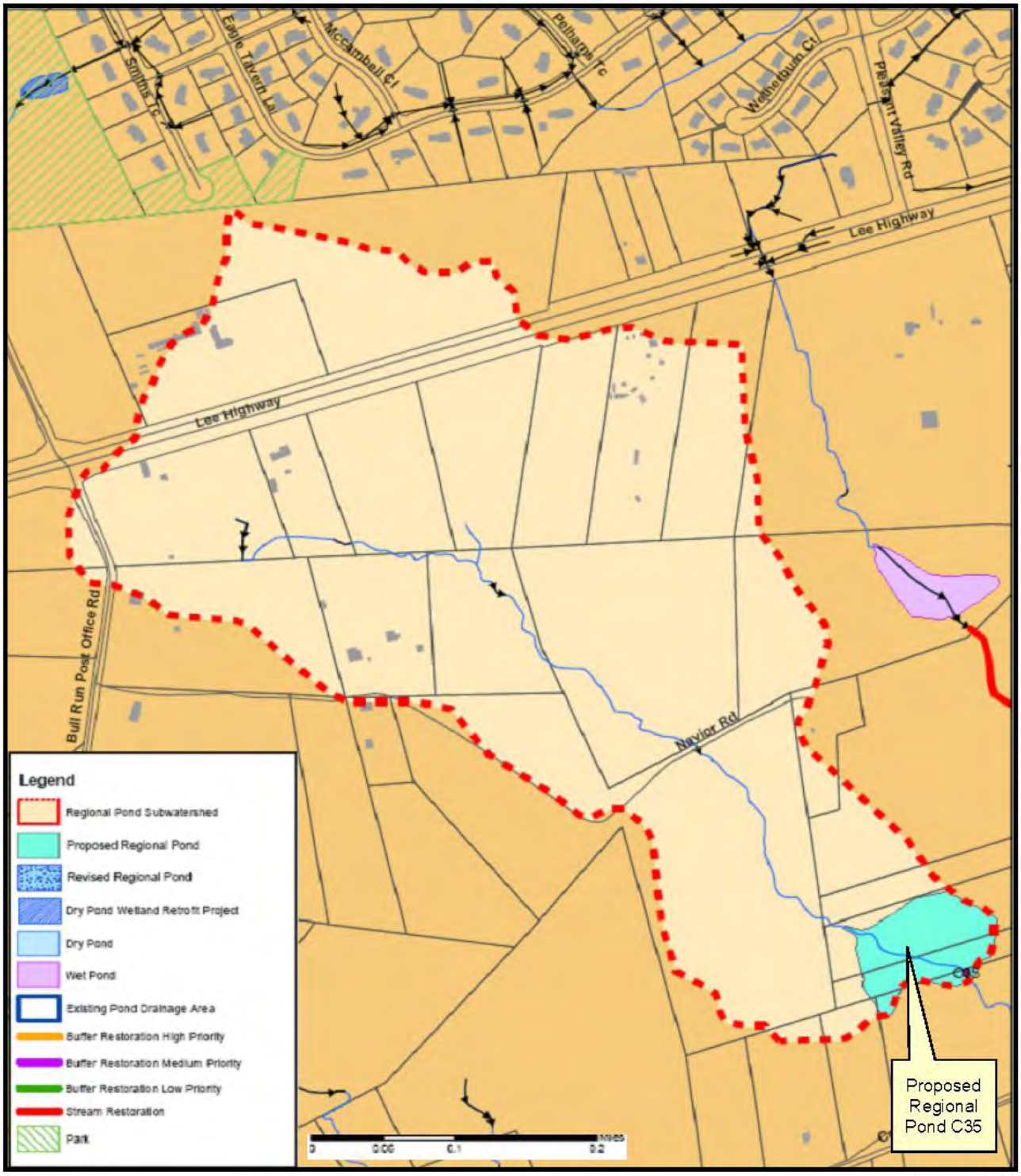


Figure 6-10
Proposed Regional Pond C35

Table 6-16
Watershed Overview for Unconstructed Regional Pond C35

Drainage Area: 117 Acres			
Location: R-C District south of Route 29. The pond is on an unnamed tributary to the Lower Cub Run main stem			
Type of Pond: Maximum efficiency wet pond that reduces the peak flow for the two-year storm down to 33 percent of the predevelopment flow and the 10-year storm down to 80 percent of the predevelopment peak flow			
Status of Pond Site: Undeveloped privately owned wooded area			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
R-C District Estate-Residential	-	87	74%
Total	0	87	74%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Medium Density Residential with 0.6 – 2 acre lots (average 1.1 acres)		30	26%
Summary of Stream Conditions Near Proposed Pond Site :	The stream immediately downstream from the proposed pond is not affected by erosion. There are erosion inventory lines (700 feet total length) with impact score of 7 on a stream segment downstream from the confluence of several tributaries. See discussion for regional pond C28. The physical habitat is classified as good.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	-		
LID retrofit at public facilities	-		
Stream restoration projects	1	Project CU9202	
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete regional pond C35 and no alternative projects are necessary. The watershed is entirely R-C District Estate-Residential land use, which is an effective low impact development BMP that does not require additional structural stormwater controls.		

Table 6-17
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C35

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C35 without Existing Controls	17	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0.0	0%
2 - Stream Restoration Project CU9202	8	24%
3 – Proposed Regional Pond C35 with Existing Stormwater Controls	17	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Propose Regional Wet Pond with Alternative Projects (Options 1, 2and 3)	25	74%
Alternative 2 – Proposed Regional Wet Pond without Alternative Projects (Options 1 and 3)	17	50%
Alternative 3 - Alternative Projects Excluding Proposed Regional Pond C35 (Options 1 and 2)	8	24%
Alternative 4 * – Delete Regional Pond C35 with No Alternative Projects	0	0%

* - Selected Alternative

Updated Regional Pond Status
Delete regional pond C35, and no alternative projects are required. Based on these detailed evaluations, the proposed pond provides little benefit relative to its cost and impact. Its drainage area is entirely within the R-C district where existing and future development densities will be low. The proposed regional pond C35 removes an estimated 17 pounds of phosphorus per year, whereas ponds outside the R-C District remove more the 36 pounds per year. Stream restoration project CU9202 will be an alternative for proposed regional pond C28.

6.2.4.10 Proposed Regional Pond C37

Proposed Pond Description
Regional pond C37 is in the R-C District on a tributary to Elklick Run near the Fairfax County/Loudoun County border. The pond has a drainage area of 433 acres and is planned to be a wet pond that reduces the 2- and 10-year peak flow to the predevelopment conditions.

The map in Figure 6-11 and data in Table 6-18 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Proposed Pond Evaluation
The proposed regional pond would have removed approximately 80 pounds of phosphorus per year as summarized in Table 6-19.

The following bullets evaluate the conditions at proposed regional pond C37:

- The lower portion of the watershed (approximately 30 percent of the total area) is Fairfax County Park Authority parkland that requires no stormwater controls.

- Other areas in the Fairfax County portion of the watershed (approximately 35 percent of the total area) will be developed as five-acre Estate Residential land use where no stormwater controls area required.

- Much of the Loudoun County portion of the watershed (approximately 35 percent of the watershed) is developed as medium- and high-density residential within South Riding. This area is served by a large wet pond on the Loudoun County side of the border. This pond adequately controls peak flows and pollutant runoff from this developed land.

- The pond is entirely within FCPA parkland. Construction of a large wet pond at this location would affect more than 30 acres of parkland. If such a pond fits into the Sully Woodlands development plan, it would benefit the Elklick stream by removing 20 pounds of nutrients per year and controlling peak flow.

- The streams upstream and downstream of the proposed regional pond do not exhibit erosion. This area consists of natural wetlands with numerous beaver dams.

Stormwater Control Options
No opportunities exist for additional alternative stormwater controls in the watershed upstream of the proposed pond. Additional stormwater controls are not required within the Fairfax County portions of the watershed since the land use is parkland and Estate Residential, which are effective low-impact development BMPs that do not require additional structural stormwater controls. Furthermore, the streams in the watershed do not display erosion impacts.

Table 6-19 summarizes the incremental annual phosphorus removed by the stormwater control options and alternatives.

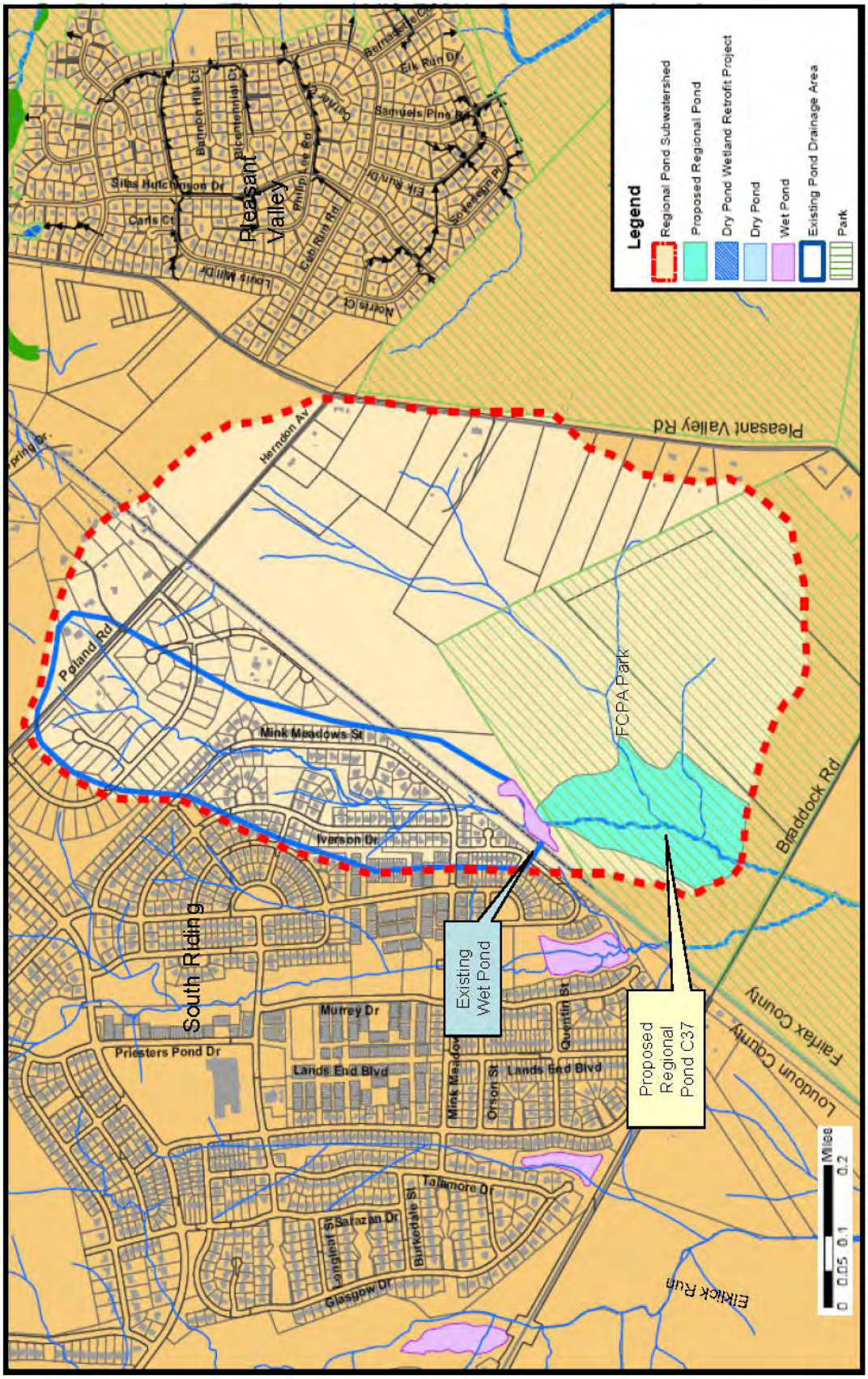


Figure 6-11
Proposed Regional Pond C37

Table 6-18
Watershed Overview for Unconstructed Regional Pond C37

Drainage Area: 433 Acres			
Location: R-C District on a tributary to Elklick Run near the Fairfax County /Loudoun County border			
Type of Pond: Wet pond that reduces the two-year and 10-year peak flow to the predevelopment conditions			
Status of Pond Site: Fairfax County Park Authority Parkland			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	1	94	22%
R-C District Estate Residential Land Use	-	204	47%
Parkland	-	135	31%
Total	1	433	100%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
		0	0%
Summary of Stream Conditions Near Proposed Pond Site :	No erosion inventory lines. Numerous beaver dams. No evidence of stream erosion. The physical habitat is classified as fair.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	-		
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	-		
Upstream culvert retrofit projects	-		
Other Projects	-		
Watershed Management Plan Recommendations	Delete proposed regional Pond C37 and no alternative stormwater controls are necessary. The watershed is entire parkland or R-C District Estate Residential density, which are effective low-density development BMPs where additional structural stormwater controls are not required. An upstream wet pond controls runoff from the South Riding development in the Loudoun County portion of the subwatershed.		

Table 6-19
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C37

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C37 without Existing Controls	80	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	59	37%
2 - Proposed Regional Pond C37 with Existing Controls	20	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Wet Pond C37 (Options 1 and 2)	79	50%
Alternative 2 - Delete Regional Pond C37 with No Alternative Projects (Option 1)	59	37%

* - *Selected Alternative*

Option 1 presents the phosphorus reduction produced by the existing large wet pond that controls development within Loudoun County. Option 2 presents the additional phosphorus reduction produced by the proposed regional pond C27 in combination with the upstream wet pond.

No other stormwater control options were identified within this area. As described later in Section 6, this area of Fairfax County provides an opportunity as a wetland restoration project. Such a project would reduce pollutant loads and peak flows.

Table 6-19 presents the phosphorus reduction produced by two alternatives that combine the stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status
Delete proposed regional pond C37, and no alternative stormwater controls are necessary. The proposed pond would remove 20 pounds of phosphorus per year when combined with the existing upstream wet pond. Construction of the pond would affect 30 acres of parkland. The benefits provided by this pond are small relative to the cost and parkland impacts. The regional wet pond could be considered if appropriate for this parkland's development plans.

This area contains natural wetlands with existing beaver ponds, and it may be appropriate for a wetland restoration project that would retain the tree cover and benefit wildlife significantly. This alternative is discussed further in Section 6.9.

6.2.4.11 Proposed Regional Pond C39

Proposed Pond Description

Regional pond C39 is on an unnamed tributary to Flatlick Branch. The pond is in the Foxfield community, and the pond watershed includes areas in Franklin Glen Governance. The proposed pond has a drainage area of 127 acres and is proposed as a maximum efficiency extended dry pond that reduces the peak two-year flow to 83 percent of predevelopment conditions.

The map in Figure 6-12 and data in Table 6-20 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The pond's watershed is primarily medium- and low-density residential with some high-density residential development. The upstream area includes two existing dry ponds that serve 44 percent of the developed area.

Field reconnaissance suggests that regional pond construction started at the proposed pond's site. An existing facility consists of a low berm or dam with a large-diameter pipe and an emergency overflow on one bank. The facility does not have a flow control structure, and the pipe is sufficiently large that flows are not detained. It also has a small storage volume compared to the upstream drainage area, providing little stormwater control benefit. The stormwater control benefits could be improved by installing an appropriate flow control structure.

Proposed Pond Evaluation

The proposed dry pond provides 46 pounds of phosphorus reduction as shown in Table 6-21. This is one of the largest nutrient reductions provided by any of the proposed regional ponds.

Review of this pond indicates that the one-year, 24-hour extended detention storage volume cannot be provided at the proposed pond location due to nearby residences. The pond can be constructed as a dry pond with a smaller extended detention volume by eliminating the two-year peak flow shaving storage volume.

The stream on which this pond is located is included in a stream restoration project due to the low stream-bank stability scores. Field reconnaissance indicates no active stream erosion.

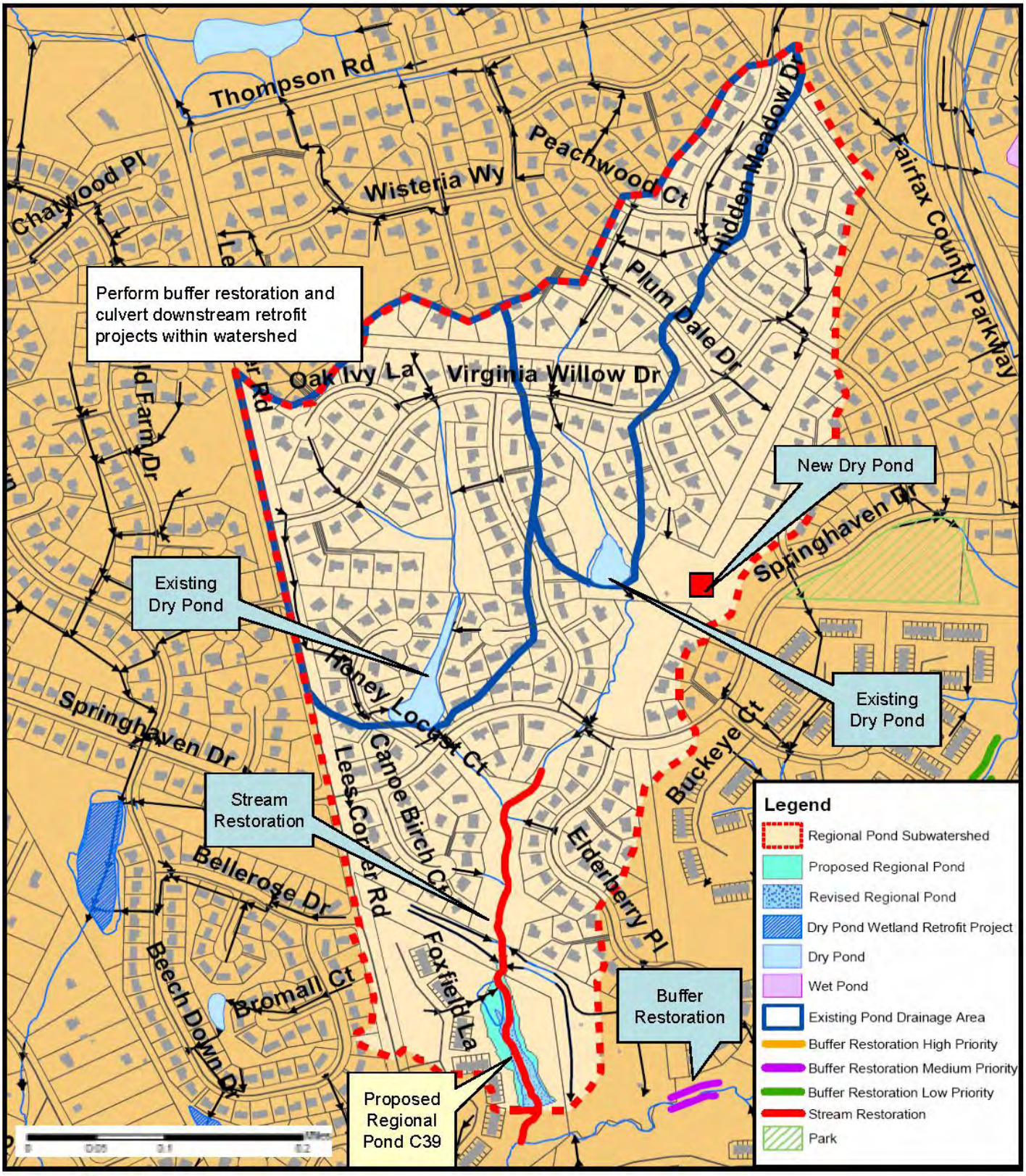


Figure 6-12
Proposed Regional Pond C39

Table 6-20
Watershed Overview for Unconstructed Regional Pond C39

Drainage Area: 127Acres

Location: Unnamed tributary to Flatlick Branch. The pond is located in the Foxfield community and the pond watershed includes areas in Franklin Glen Governance

Type of Pond: Maximum efficiency extended dry pond that reduces the peak two-year flow to 83 percent of predevelopment conditions

Status of Pond Site: Privately owned open space

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	2	56	44%
Wet Ponds	0	0	0%
Total	2	56	44%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area
Medium Density Residential	71	56%
Little potential for additional development		

Summary of Stream Conditions Near Proposed Pond Site :	One erosion inventory line with impact score of 5 (78 feet) upstream from the pond. The stream segments near the pond are included in a restoration project due to low bank stability scores. The stream habitat is classified as very poor.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	-	Existing dry ponds are not considered candidates for wetland bottoms due to nearness to residences.
LID retrofit at public facilities	-	
Stream restoration projects	1	Restore stream reach upstream and downstream from pond, Project CU9216.
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	3	(1) Perform buffer restoration in small stream segments within the watershed upstream from reaches included in the Physical Assessment Study. (2) Review small drainage systems and mitigate erosion and impact of storm drain outfalls within the watershed upstream from reaches included in the Physical Assessment Study. (3) Construct smaller onsite dry pond.

Watershed Management Plan Recommendations	Construct regional pond C39 at the proposed location as a dry pond with an extended detention storage volume equivalent to approximately one-inch of runoff from the impervious area. Implement identified alternative stormwater projects to address stream erosion within and downstream from the dry pond and to improve health of the streams upstream from the regional pond. If regional pond is not constructed, then construct smaller onsite dry pond.

Table 6-21
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C39

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C39 without Existing Controls	46	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	26	23%
2 - Stream Restoration Projects	6	5%
3 – Proposed Regional Pond C39 Constructed as a Dry Pond Combined with Existing Stormwater Controls	21	18%
4 - New Dry Pond at Upstream Location	15	13%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 * - Proposed Regional Pond C39 as a Smaller Dry Pond with Alternative Projects. (Options 1, 2 and 3)	53	46%
Alternative 2 - New Dry Pond at Upstream Location with Alternative Projects (Options 1, 2 and 4)	47	41%
Alternative 3 – Proposed Regional Pond C39 without Alternative Projects (Options 1 and 3)	47	41%
Alternative 4 – New Dry Pond at Upstream Location without Alternative Projects (Options 1 and 4)	41	36%
Alternative 5 – Alternative Projects with No New Pond (Options 1 and 2)	32	28%

* - *Selected Alternative*

Stormwater Control Options

The following stormwater control options were evaluated as replacement projects for proposed regional pond C39:

1. Construct new dry pond with wetland bottom at the site of the proposed regional pond. Based on preliminary evaluations, we estimate that a volume equivalent to at least one inch of runoff from the impervious surface can be provided at this location. The pond should be constructed with a wetland bottom to enhance nutrient removal efficiencies. The proposed dry pond has a smaller surface area compared to the pond proposed in the 1989 plan.

2. Construct a smaller dry pond within the watershed upstream from the proposed pond

3. Implement stream restoration project CU9216

4. Perform stream buffer restoration projects within the watershed in areas not covered in the Stream Physical Assessment Study

5. Evaluate small drainage system, and mitigate impact of small storm drainage outfalls in the watershed and perform mitigation where required

6. Promote LID within the upstream subwatershed

The upstream dry ponds have small drainage areas or are too close to existing houses to be considered feasible wetland bottom retrofit projects. This could change as part of the public information program.

Table 6-21 summarizes the annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the stream restoration project. Option 3 presents the additional phosphorus reduction produced by the proposed regional dry pond C39 constructed as a smaller dry pond together with alternative stormwater controls. Option 4 presents the additional phosphorus reduction produced by an upstream dry pond.

Table 6-21 provides the total annual phosphorus removed by five stormwater control alternatives that combine the stormwater control options, listed in order of decreasing effectiveness.

Updated Regional Pond Status

Construct regional pond C39 as a reduced size dry pond and implement alternative projects. The regional dry pond constructed at the proposed regional pond will maximize the extended detention volume possible within the site constraints. CDM analyses suggest the pond cannot store the runoff from the one-year, 24-hour storm but would store greater than 0.9 inches of runoff from the impervious area. The pond should be constructed with a wetland bottom to enhance nutrient removal efficiencies. It would provide additional stormwater protection to Flatlick Branch,

which exhibits high stream erosion. Regional pond C39 is included in watershed plan project CU9001. The following projects will also be implemented to enhance conditions in the watershed upstream from the regional pond and address existing stream erosion:

- Stream restoration project CU9216
- Perform and promote buffer restoration within the watershed
- Review small drainage systems and mitigate erosion and impact of storm drain outfalls.

If the regional pond is not constructed, alternative stormwater controls should be, including an onsite dry pond within the upstream watershed and the other identified alternative projects.

6.2.4.12 Proposed Regional Pond C40

Proposed Pond Description

Regional pond C40 is on an unnamed tributary to Flatlick Branch. The pond's drainage area is 133 acres, and the pond was originally proposed as a maximum efficiency extended dry pond that reduces the peak two-year flow to 60 percent of the predevelopment peak flow.

The map in Figure 6-13 and data in Table 6-22 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Pond C40 is the only proposed regional pond in the Cub Run watershed that has significant area of development not controlled by a dry or wet pond. The pond drainage area is fully developed. The upper portion of the watershed is medium-density residential in the Armfield Farms community. The lower portion of the watershed (approximately 40 percent of the drainage area) is low-density residential (Chantilly Estates) with lot sizes ranging from 0.6 to 1 acre. The watershed includes four existing dry ponds that serve 76 percent of the watershed area. The lower area with no stormwater facilities is predominately low-density residential. The existing ponds provide small detention volumes and possibly provide only water quality control.

Proposed Pond Evaluation

The proposed pond removes 43 pounds of phosphorus per year as shown in Table 6-23. Construction of a regional pond with sufficient storage to provide stormwater benefits is not feasible commensurate with both the cost of constructing this facility and the impacts on nearby residences and private property.

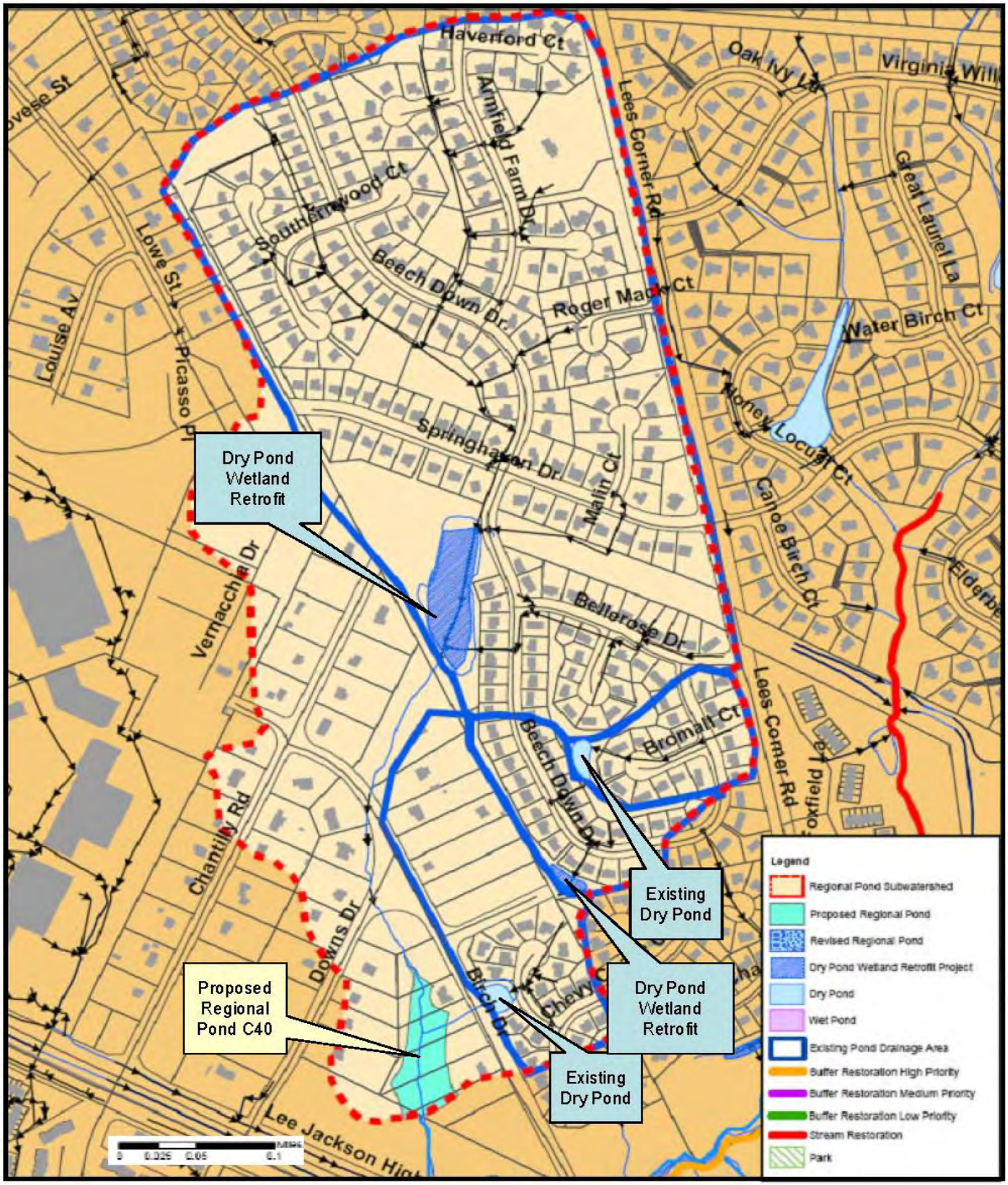


Figure 6-13
Proposed Regional Pond C40

Table 6-22
Watershed Overview for Unconstructed Regional Pond C40

Drainage Area: 133 Acres			
Location: Unnamed tributary to Flatlick Branch. Chantilly Estates			
Type of Pond: Maximum efficiency extended dry pond that reduces the peak two-year flow to 60 percent of the predevelopment peak flow			
Status of Pond Site: Privately owned open space. Because of residential development, the proposed regional pond cannot be constructed as proposed with sufficient volume to control peak flows.			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	2	84	63%
Dry Ponds (no retrofit)	2	18	13%
Wet Ponds	0	0	0%
Total	4	101	76%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Low Density Residential (0.7 – 1 acre lots)		32	24%
Little potential for additional development			
Summary of Stream Conditions Near Proposed Pond Site :	Two erosion inventory lines (175 feet) with impact score of 6. Other than this localized area, the streams do not have excessive stream erosion. The stream physical habitat is classified as fair.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofit projects	2	Project CU9186– Beech Down Drive & Bellerose Drive (77 acres) Project CU9185 – King Charles Drive (6 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	-		
Upstream culvert retrofit projects	-	Closed pipe conduit systems preclude implementation of this alternative.	
Other Projects	3	(1) Perform buffer restoration in small stream segments on privately owned common areas. (2) Promote buffer restoration and preservation by property owners in the lower reaches of the stream near the proposed regional pond. (3) Review small drainage systems and mitigate erosion and other impacts of storm drain outfalls.	
Watershed Management Plan Recommendations	Delete regional pond C40 and implement alternative projects to reduce nutrient runoff from this watershed and improve the health of the local streams.		

Table 6-23
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C40

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C40 without Existing Controls	43	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	33	31%
2 - Dry Pond Retrofit Projects	7	7%
3 - Regional Dry Pond C40 Combined with Existing Stormwater Controls	11	11%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 –Regional Dry Pond with Alternative Projects (Options 1, 2 and 3)	51	47%
Alternative 2 – Regional Dry Pond without Alternative Projects (Options 1 and 3)	44	41%
Alternative * 3 – Delete Regional Pond C40 and Implement Alternative Projects (Options 1 and 2)	40	38%

* - *Selected Alternative*

Stormwater Control Options
The following stormwater control options were evaluated as replacement projects for proposed regional pond C40:

1. Implement two dry pond retrofit projects

2. Perform buffer restoration in small stream segments on privately owned common areas upstream from stream reaches in the Physical Assessment Study

3. Promote buffer restoration and preservation by property owners in the lower reaches of the stream near the proposed regional pond

4. Review small drainage systems, and mitigate erosion and other impacts of storm drain outfalls

5. Promote LID on private property within the upstream subwatershed

Upstream portions of the watershed have closed pipe drainage systems with few opportunities to provide alternative stormwater controls. Because of the limited

topographic relief, stormwater controls such as upstream culvert retrofits are not recommended.

Table 6-23 summarizes the total annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus removal provided by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the two dry pond retrofit projects. Option 3 presents the additional phosphorus reduction produced by the proposed regional pond when combined with the existing upstream stormwater controls.

Table 6-23 also presents the total phosphorus reduction produced by three alternative combinations of the stormwater control options, in order of decreasing effectiveness.

Updated Regional Pond Status
Delete regional pond C40 and implement the following alternative projects:

- Two dry pond wetland retrofit projects CU9185 and CU9186
- Perform buffer restoration on small stream segments
- Promote buffer restoration and preservation by property owners near the lower reaches of the stream near the proposed pond
- Review small drainage systems and mitigate erosion and other impacts of storm drain outfalls

The alternative projects provide nutrient removal approximately equal to the proposed regional dry pond and improve the health of the streams within the watershed. Further, the proposed pond cannot be constructed without affecting nearby residences and residential property.

6.2.4.13 Proposed Regional Pond C53

Proposed Pond Description
Regional pond C53 is on a tributary to Frog Branch downstream from Smallwood Court. The upstream watershed is mostly medium-density residential with some low-density residential. The proposed regional pond has a drainage area of 88 acres and was originally proposed to be a maximum efficiency extended detention dry pond to reduce the peak flow from the two-year storm to 33 percent of the predevelopment peak flow.

The map in Figure 6-14 and data in Table 6-24 provides an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

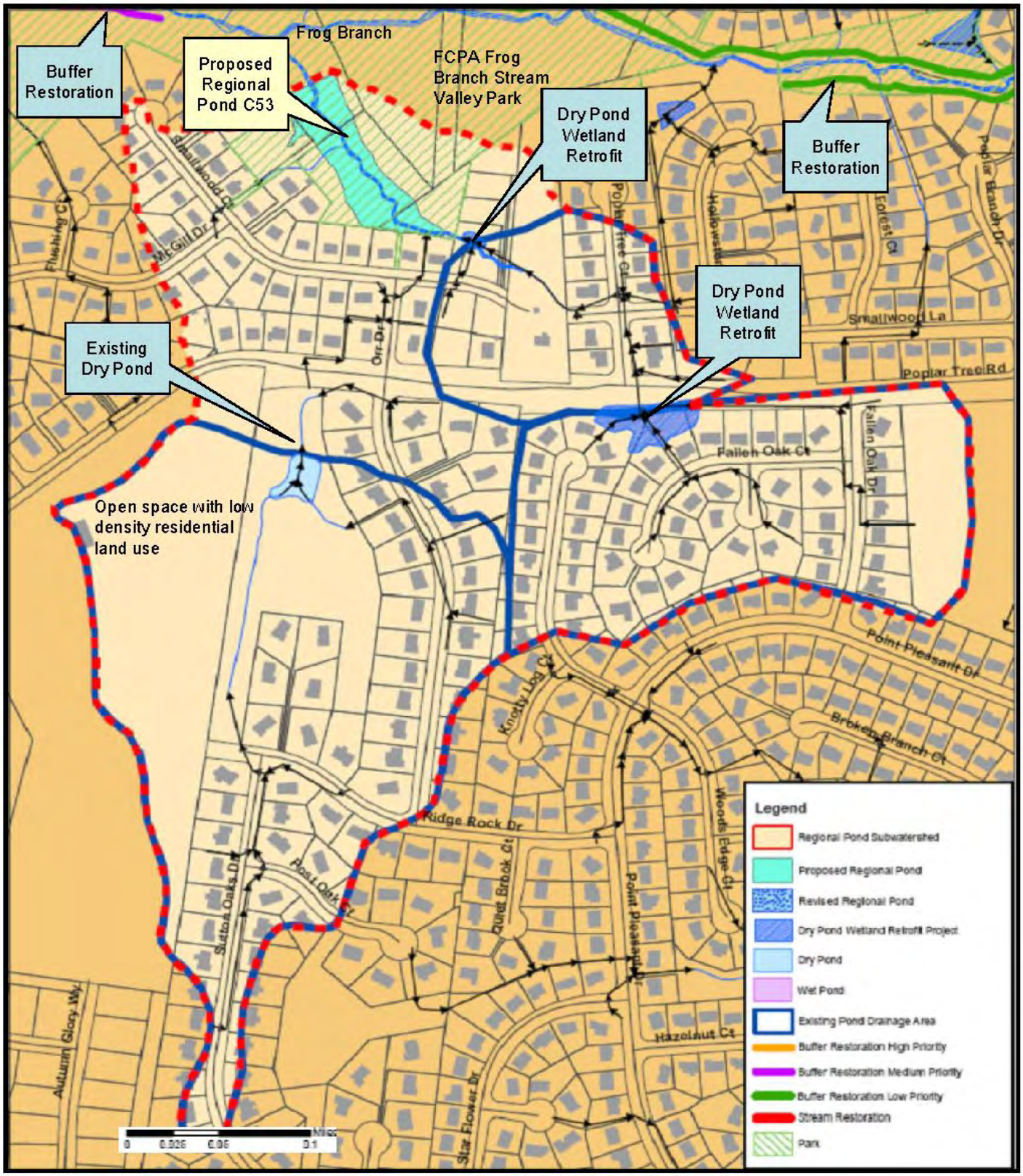


Figure 6-14
Proposed Regional Pond C53

Table 6-24
Watershed Overview for Unconstructed Regional Pond C53

Drainage Area: 88 Acres			
Location: Tributary to Frog Branch downstream from Smallwood Court			
Type of Pond: Maximum efficiency extended detention dry pond that reduces the peak flow from the two-year storm to 33 percent of the predevelopment peak flow			
Status of Pond Site: Fairfax County Park Authority. Wooded			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	2	29	33%
Dry Ponds (no retrofit)	1	35	39%
Wet Ponds	0	0	0%
Total	3	64	72%
Future development - twelve acres of low density residential			
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Medium Density Residential		24	28%
Summary of Stream Conditions Near Proposed Pond Site :	No erosion identified in local streams. Stream buffers are affected in downstream reaches. The physical habitat within the pond is classified as excellent.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	2	Project CU9178 – Fallen Oak Court (20 acres) Project CU9177 – Smallwood Court (9 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	-		
Buffer restoration projects	2	Restore buffer in Frog Branch at two locations. Projects CU9318 and CU9319	
Upstream culvert retrofit projects	-		
Other Projects			
Watershed Management Plan Recommendations	Deleted regional pond C53 and implement alternative projects to enhance nutrient removal efficiencies and improve the health of the local streams.		

Table 6-25
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C53

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C53 without Existing Controls	27	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	22	32%
2 - Dry Pond Retrofit Projects	2.2	3%
3 - Proposed Regional Pond C53 Combined with Existing Stormwater Controls	7	10%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Proposed Regional Pond C53 with Alternative Projects (Options 1, 2 and 3)	31.2	46%
Alternative 2 – Proposed Pond C53 without Alterative Projects (Options 1 and 3)	29	43%
Alternative 3 * – Delete Regional Pond C53 and Implement Alternative Projects (Options 1 and 2)	24.2	35%

* - *Selected Alternative*

Three onsite dry ponds control 72 percent of the watershed. Two of these ponds are recommended wetland bottom retrofit projects. The watershed includes 12 acres of open land that has low-density residential planned land use and will likely be developed. This development will likely include stormwater controls.

Proposed Pond Evaluation
The proposed regional pond C53 removes 27 pounds of phosphorus per year as documented on Table 6-25.

The proposed dam site and pool are within the FCPA Frog Branch Stream Valley Park. Although a regional pond at the proposed location may be feasible, construction would remove significant tree buffer within the park and along the stream.

Stormwater Control Options
The following stormwater control options were evaluated as replacement projects for proposed regional pond C53:

1. Construct two dry pond retrofit projects

2. Implement two buffer restoration projects on nearby Frog Branch

3. Promote LID upstream from the proposed regional pond

The closed pipe systems in this area prevent the use of culvert upstream retrofit projects. No public facilities such as schools or libraries exist in the watershed for use as LID retrofit projects.

Table 6-25 summarizes the annual phosphorus removed by stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls. Option 2 presents the additional phosphorus reduction produced by the two dry pond retrofit projects. Option 3 presents the additional phosphorus removed by the proposed regional pond together with the existing stormwater controls.

Table 6-25 also presents the total phosphorus reduction produced by alternative combinations of the stormwater control options, in order of decreasing effectiveness.

Updated Regional Pond Status
Delete regional pond C53 and implement the following alternative projects:

- Implement dry pond wetland retrofit projects CU9177 and CU9178
- Perform buffer restoration projects CU9318 and CU9319
- Promote LID in the proposed pond watershed

These alternative projects enhance stormwater control within the watershed. The proposed pond removes only 7 pounds of phosphorus per year. The existing stormwater controls combined with alternative projects provide watershed protection similar to that provided by the proposed pond. Pond construction would have significant impacts on portions of the FCPA Frog Branch stream valley park and severely affect a stream in which the physical habitat is classified as excellent.

6.2.4.14 Propose Regional Pond C54

Proposed Pond Description
Regional pond C54 is at the site of an existing lake in the upper reaches of the Flatlick Branch watershed. The drainage area is 334 acres and the proposed regional pond was designed as a maximum efficiency extended dry pond to reduce the peak flow from the two-year storm to 33 percent of the predevelopment peak flow.

The map in Figure 6-15 and data on Table 6-26 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

The existing development near the pond is large-lot, single-family residential but has a planned land use of low-density residential. These sites will likely be developed at the higher planned density. In fact, many of these large lots have been developed as this study progressed.

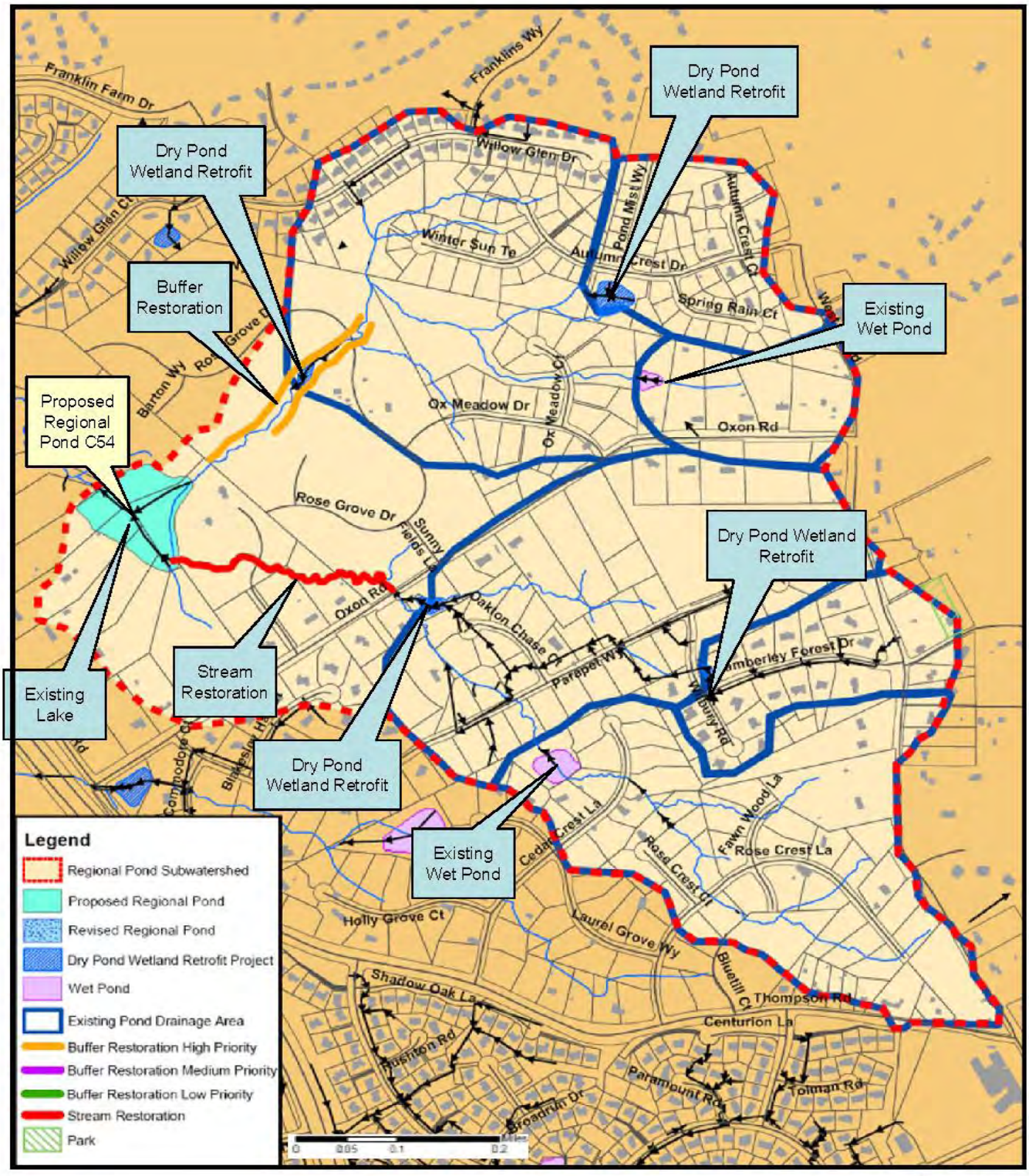


Figure 6-15
Proposed Regional Pond C54

Table 6-26
Watershed Overview for Unconstructed Regional Pond C54

Drainage Area: 334 Acres			
Location: Site of an existing private pond in the upper reaches of the Flatlick Branch watershed			
Type of Pond: Maximum efficiency extended detention dry pond that reduces the peak flow from the two-year storm to 33 percent of the predevelopment peak flow			
Status of Pond Site: Privately owned pond			
Existing Upstream Stormwater Controls	**Number of Facilities**	**Total Controlled Area (Acres)**	**Percent of Total Area**
Dry ponds with proposed wetland retrofit	4	180	54%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	2	79	24%
Total	6	259	78%
Summary of Uncontrolled Developed Area		**Area (Acres)**	**Percent of Total Area**
Low Density Residential Development		75	22%
Future development – development is ongoing, low-density residential development that should provide onsite dry and wet ponds.			
Summary of Stream Conditions Near Proposed Pond Site :	Stream buffers are affected by new development. Stream reach upstream from the proposed regional pond and downstream from Oxon Road has low bank stability scores but no erosion inventory points. The stream habitat is poor and very poor.		
Alternative Stormwater Control Options	**Number of Projects**	**Description**	
Dry pond wetland retrofits	4	Project CU9702 – Autumn Crest Dr. (22 acres) Project CU9701 – Rose Grove Dr. (72 acres) Project CU9703 – Oxon Road and Oakton Chase Ct. (65 acres) Project CU9704 – Camberley Forest Dr. and Wilbury Rd (21 acres)	
LID retrofit at public facilities	-		
Stream restoration projects	1	Project CU9217 upstream from pond identified based on poor bank stability scores.	
Buffer restoration projects	1	Project CU9329 upstream from pond	
Upstream culvert retrofit projects	-		
Other Projects			
Watershed Management Plan Recommendations	Delete regional pond C54 and implement identified alternative projects. Implement alternative stormwater controls to enhance nutrient removal provided by existing facilities, address stream erosion upstream from the proposed pond and improve and protect the health of the local streams.		

Upstream areas in the watershed are largely low-density residential. The low-density developed areas include four dry ponds.

Proposed Pond Evaluation
The proposed pond C54 removes 86 pounds of phosphorus per year as documented in Table 6-27.

The following summarizes existing conditions for regional pond C54:

- Constructing the proposed extended detention dry regional pond requires removing an existing lake.
- The upstream development includes existing dry ponds that control the stormwater flows from 78 percent of the watershed. New development will likely include dry and wet ponds.
- The lake, though not designed as a stormwater pond, provides supplemental nutrient removal for the upstream watershed. As a result, construction of the proposed dry pond will have little additional nutrient removal benefit. The new dry pond would provide greater peak flow control than the lake.

Stormwater Control Options
The following stormwater control options were evaluated as replacement projects for proposed regional pond C54:

1. Construct four dry pond retrofit projects
2. Implement one buffer restoration project
3. Perform stream restoration for upstream reach
4. Promote LID in the upstream watershed, focusing on areas not upstream of existing stormwater controls
5. Promote and perform buffer restoration, and small drainage system assessment and rehabilitation in the upstream watershed

No other alternative stormwater controls, such as upstream culvert retrofits, are practical because of the limited topographic relief and high development density. No public facilities such as schools or libraries for LID retrofit projects exist in the watershed.

Table 6-27 summarizes the total annual phosphorus removed by the stormwater control options. Option 1 presents the phosphorus reduction produced by the existing stormwater controls.

Table 6-27
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C54

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C54 without Existing Controls	86	40%
Stormwater Control Options		
1 - Existing Stormwater Controls	61	28%
2 - Existing Lake or Proposed Regional Dry Pond C54 Combined with Existing Stormwater Controls	33	15%
3 - Dry Pond Retrofit Projects	9	4%
4 – Stream Restoration Project		
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 * - Delete Proposed Regional Pond C54 and Implement Alternative Projects (Includes Existing Lake)	103	48%
Alternative 2 – Existing Lake or Regional Pond C54 without Alternative Projects	94	44%

* - *Selected Alternative*

Option 2 presents the phosphorus reduction produced by the lake. This option also represents the approximate phosphorus reduction provided by the proposed dry pond at this same location. The removal represents that provided by a dry pond with a wetland bottom. While the lake provides similar phosphorus reductions to the proposed dry pond, the latter would enhance peak flow control.

Option 3 presents the phosphorus reduction produced by the four dry pond retrofit projects. Option 4 presents the phosphorus reduction produced by the stream restoration project.

Updated Regional Pond Status
Delete regional dry pond C54 and implement the following alternative stormwater controls:

- Implement four dry pond retrofit projects CU9701, CU9702, CU9703 and CU9704
- Perform stream restoration project CU9217

- Perform buffer restoration project CU9329
- Promote LID in the upstream watershed
- Promote and perform buffer restoration, and small drainage system assessment and rehabilitation in the upstream watershed

The identified alternative stormwater controls will enhance phosphorus reduction and watershed health. Eliminating the lake and constructing a dry pond provides no net nutrient reduction benefit. The streams downstream of the lake do not exhibit significant stream erosion.

6.2.4.15 Proposed Regional Pond C62

Proposed Pond Description

Regional pond C62 is on an unnamed tributary to Elklick Run near the confluence with Cub Run within the rezoned R-C District. As of 2002, the watershed was undeveloped forest. Pond C62 has a drainage area of 80 acres and was planned to be a wet pond to reduce the peak two-year flow to predevelopment flow rates. The watershed is largely privately owned land within the R-C District. This area could be developed at a density of one house per five acres. The watershed also includes FCPA parkland.

The map in Figure 6-16 and data in Table 6-28 provide an overview of the conditions within the proposed regional pond watershed. These include the existing stormwater facilities and watershed plan structural projects.

Regional Pond Evaluation

The proposed pond would remove 8 pounds of phosphorus as documented in Table 6-29. The following bullets summarize the existing conditions at regional pond C62:

- The dam site is within FCPA parkland. Pond construction would affect several acres of forested land within the park.
- The upstream watershed contains about 30 percent FCPA parkland and 70 percent Estate Residential land use. The area in the Estate Residential land use may be developed as five-acre lots. Stormwater controls are not required for this low-density R-C District development.
- The pond is near the Cub Run main stem. A detention facility may delay peak flows such that they could coincide with higher flows and potentially produce higher peak flows in Cub Run.

Stormwater Control Options

No stormwater controls exist in the undeveloped watershed, and there is no opportunity or need for alternative ones.

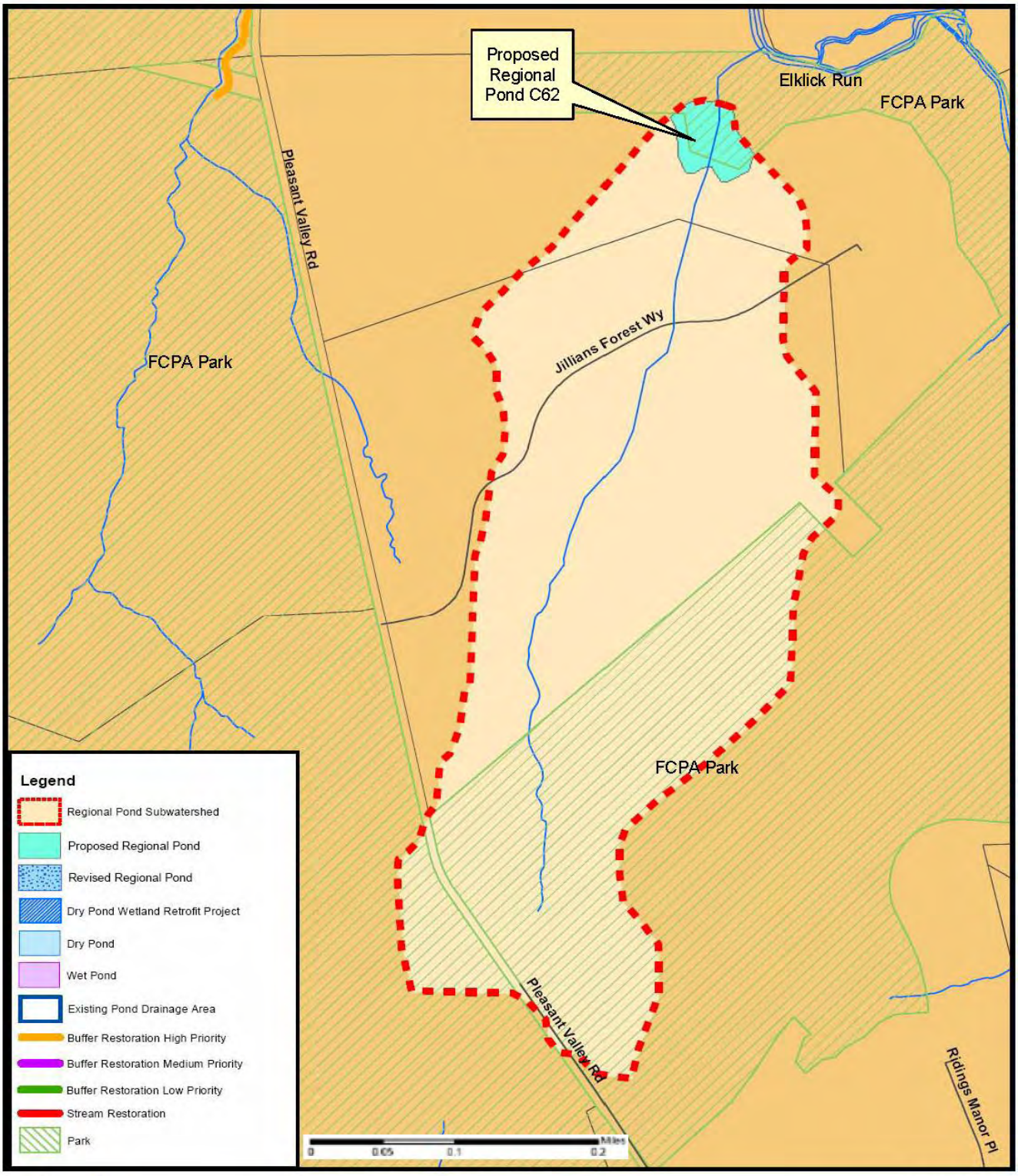


Figure 6-16
Proposed Regional Pond C62

Table 6-28
Watershed Overview for Unconstructed Regional Pond C62

Drainage Area: 80 Acres

Location: R-C District on unnamed tributary to Elklick Run

Type of Pond: wet pond that reduces the peak two-year flow to predevelopment flow rates

Status of Pond Site: Fairfax County Park Authority Parkland

Existing Upstream Stormwater Controls	Number of Facilities	Total Controlled Area (Acres)	Percent of Total Area
Dry ponds with proposed wetland retrofit	0	0	0%
Dry Ponds (no retrofit)	0	0	0%
Wet Ponds	0	0	0%
R-C District Estate Residential	-	33	41%
Parkland	-	47	59%
Total	0	80	100%

Summary of Uncontrolled Developed Area	Area (Acres)	Percent of Total Area

Summary of Stream Conditions Near Proposed Pond Site :	Stream was not inventoried. Watershed is totally undeveloped woodland that should not have any stream erosion. The physical habitat is classified as fair.

Alternative Stormwater Control Options	Number of Projects	Description
Dry pond wetland retrofits	-	
LID retrofit at public facilities	-	
Stream restoration projects	-	
Buffer restoration projects	-	
Upstream culvert retrofit projects	-	
Other Projects	-	

Watershed Management Plan Recommendations	Delete regional pond C62 and no alternative stormwater controls are required. The watershed is R-C District Estate Residential land use or preserved as open space parkland. These land uses are effective low impact development BMPs that effectively control the runoff from these lands and therefore do not require structural stormwater controls. Pond construction would affect forested FCPA parkland and provide little watershed improvements.

Table 6-29 summarizes the total annual phosphorus removed by the stormwater controls considered for regional pond C62 watershed. The proposed pond removes only 8 pounds of phosphorus due to the lack of development in the watershed.

Table 6-29
Summary of Phosphorus Reduction Provided by
Stormwater Improvement Options and Alternatives for Regional Pond C62

Scenario	Total Phosphorus Removed (Pounds per year)	Percent of Total Phosphorus
Proposed Regional Pond C62 without Existing Controls	8	50%
Stormwater Control Options		
1 - Existing Stormwater Controls	0	0%
2 - Proposed Regional Pond C62 Combined with Existing Controls	8	50%
Stormwater Control Alternatives (Combinations of Stormwater Control Options)		
Alternative 1 – Regional Pond C62	8	50%
Alternative 2 * – Deleted Regional Pond C62 and no Alternative Projects	0	0%

* - *Selected Alternative*

Updated Regional Pond Status
Delete regional pond C62 and no alternative projects are required. Because of the low density of development in the subwatershed, the proposed regional pond provides little reduction in nutrient loads (8 pounds per year). The watershed is undeveloped and will not have much future development. Constructing the pond will affect forested FCPA parkland and provide little watershed benefit.

6.3 Action - Dry Pond Wetland Retrofit Projects

6.3.1 Action

Most of the residential and commercial areas in the watershed include peak flow control and water quality BMPs. Wet ponds and extended-detention dry (EDD) ponds are the primary structural stormwater controls. Under this action, selected dry ponds will be modified to include wetland features thereby increasing phosphorus and nitrogen removal by 10 and 25 percent, respectively. Other improvements will be evaluated and implemented at the time that the facilities are retrofitted.

Several watershed plan goals and objectives will be met through the dry pond wetland bottom retrofit projects:

1. Maximize the benefits provided by existing dry ponds

2. Improve aesthetics of existing dry ponds by removing concrete trickle channels and mowed grassed area, providing plantings and other improvements

3. Reduce nutrient runoff

4. Provide habitat for native flora and fauna

5. Improve the health of the streams within and near the dry ponds

Figure 6-17 represents an existing dry pond and elements to consider in the dry pond wetland retrofit projects. The pond bottom will be excavated to create a functioning wetland, including (depending on space constraints) a micro-pool, sediment forebay and riparian buffer. If possible, a low berm or peninsula will be placed in the pond to increase the flow path though it. The goal is to eliminate the mowed pond bottom and concrete low flow channels, and create an aesthetically pleasing wetland feature that performs ecological functions. Native wetland plants will be placed within the wetland area. Additional plantings will provide habitat, shade and screening of the pond.

The pond site will be evaluated during the retrofit for additional opportunities to enhance the stormwater control:

- Manufactured BMPs (Stormceptor or Filterra), bioretention, drainage swales or other LID controls could be installed at parking lots or other areas with a large percentage of impervious area near the pond to remove sediments, nutrients, petroleum products and other pollutants before they enter the dry pond.

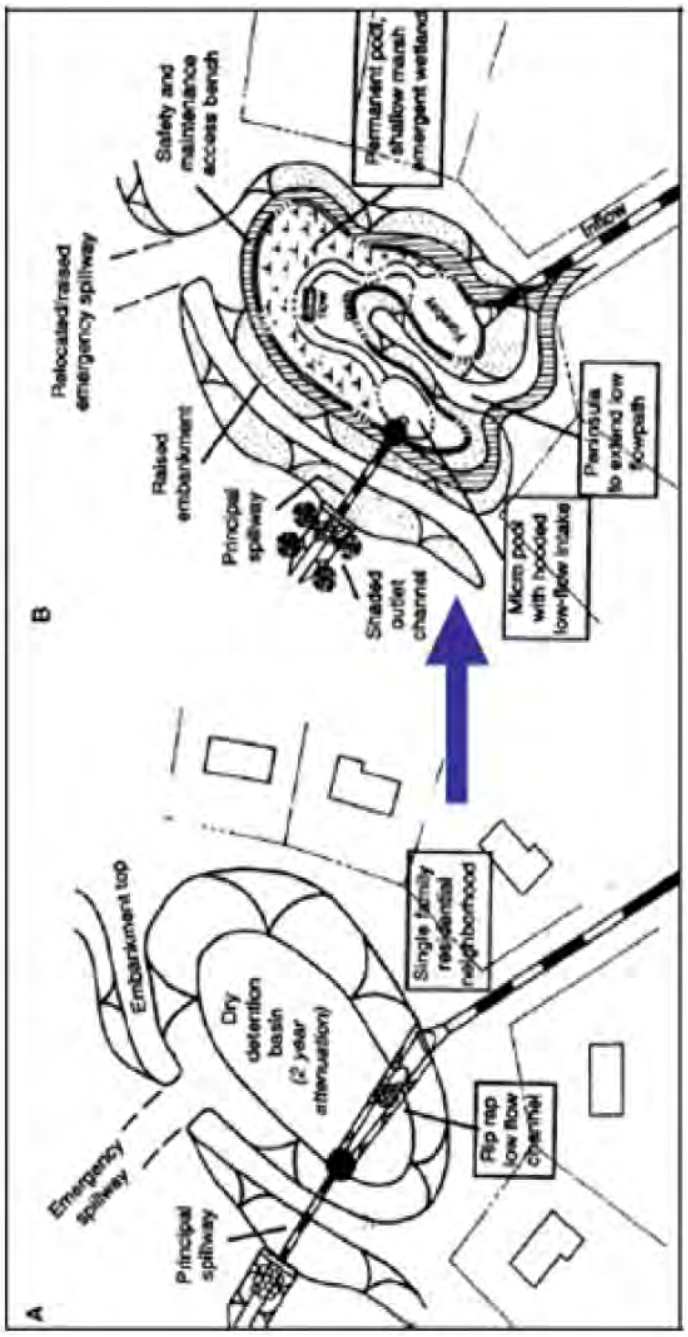
- Modify the outlet structure to increase the extended detention volume or otherwise improve the functioning of the existing pond. As an example, the pond may be modified from one that controls the 2- and 10-year peak flow to one that provides extended detention for the one-year storm event. These evaluations should consider the timing of the peak flow from the pond relative to the peak flows in the receiving stream to avoid potentially increasing peak flows where peaks coincide.

- Increase the storage volume for water quality or peak flow control by excavating the pond bottom or raising the dam height

These last two retrofit opportunities will be targeted for ponds upstream from active stream erosion areas where peak flow control improvements will help to achieve watershed plan goals and objectives.

The overall condition of the existing pond will be evaluated, and maintenance will be performed when necessary to ensure the pond functions as designed, has no safety hazards and meets modern design guidelines.

Education and recreation opportunities at the dry ponds will be evaluated. Where appropriate, interpretive signs will be provided. Existing trails will be extended and



Source: Schueler, Thomas R. and Holland, Heather K. *The Practice of Watershed Protection*. Article 143. The Center for Watershed Protection, 2000.

Figure 6-17
Dry Pond Wetland Bottom Retrofit

benches or other features may be added to transform the dry ponds to a valued community resource.

Initial review of some pond sites suggests bedrock may be at or near the pond bottom. The evaluations performed under this watershed planning study do not include detailed evaluation of the depth to rock or hardness of the rock. Evaluations during the initial studies for some proposed ponds may find that rock near the ground surface increases the project cost and thus makes it infeasible.

6.3.2 Strategy to Achieve Action

Identification of Dry Pond Retrofit Projects

GIS layers showing streams and stormwater facilities, aerial photography and field surveys were used to identify 170 dry ponds in the Cub Run and Bull Run watershed. These ponds were screened to identify those included in the watershed plan as dry pond retrofit projects.

The first screening criteria focused on the retrofit's nutrient removal benefit. Ponds that provide relatively little benefit compared to the conversion cost will not be considered in this plan based on the following criteria:

- Upstream drainage area - ponds with upstream drainage areas of less than five acres

- Density of development in upstream watershed – ponds in which the upstream watershed is less than 30 percent developed

The amount of nutrients and other pollution removed relates directly to the upstream drainage area and the development in the upstream watershed. Ponds with larger drainage areas with higher development densities provide the greatest benefit relative to the cost.

The second set of screening criteria focused on the number and proximity of residences near the existing dry ponds. Ponds that have many residences nearby were eliminated since they may be difficult to implement.

The above criteria were used to identify 129 dry pond wetland retrofit projects and provide a priority ranking. The highest rated ponds will remove more pollution and have a higher probability of being built due to their reduced impact on neighboring residential properties.

Additional analyses further evaluated and ranked the dry pond retrofit projects. Additional ponds were eliminated when the construction costs were high relative to the nutrient reduction provided. This analysis reduced the number of ponds from 129 to 89.

Stormwater modeling results were used to evaluate the relative impact that various portions of the watershed have on the streams. Dry ponds within areas that have high

impact received higher ranks. The following parameters were evaluated to determine the relative impact that the modeled basins have on watershed conditions:

- Runoff volume (inches) for the two-year design storm event
- Peak flow (rate per acre) for the two-year design storm event
- Total phosphorus loads (pounds per acre)
- Total nitrogen loads (pounds per acre)
- Total suspended solid loads (pounds per acre)

Existing-condition impact scores were developed from these parameters for each model subbasin as shown in Figure 6-18.

Dry pond retrofit projects within basins with high impact scores received the highest ranking. The dry pond retrofit project implementation priority scores presented on Table 6-30 combines the following:

- Existing condition impact score
- Cost per pound of phosphorus removed
- Total phosphorus removed in pounds

Following this analysis, dry pond retrofit projects identified as alternative projects to regional ponds were added.

The priority scores rank the ponds for effectiveness in reducing loads, cost relative to the load reduction and water quality improvements most beneficial to the watershed, providing one guide as to the order of implementation. As described in Section 7, the projects will not be implemented in the order presented in Table 6-30.

This table summarizes whether the dry pond is publicly maintained by Fairfax County or if the pond is privately maintained.

Figure 6-18 shows the general location of the 94 dry pond retrofit projects in the watershed plan. Figures presented at the end of this section provide additional details on the location of the ponds within the major subwatersheds.

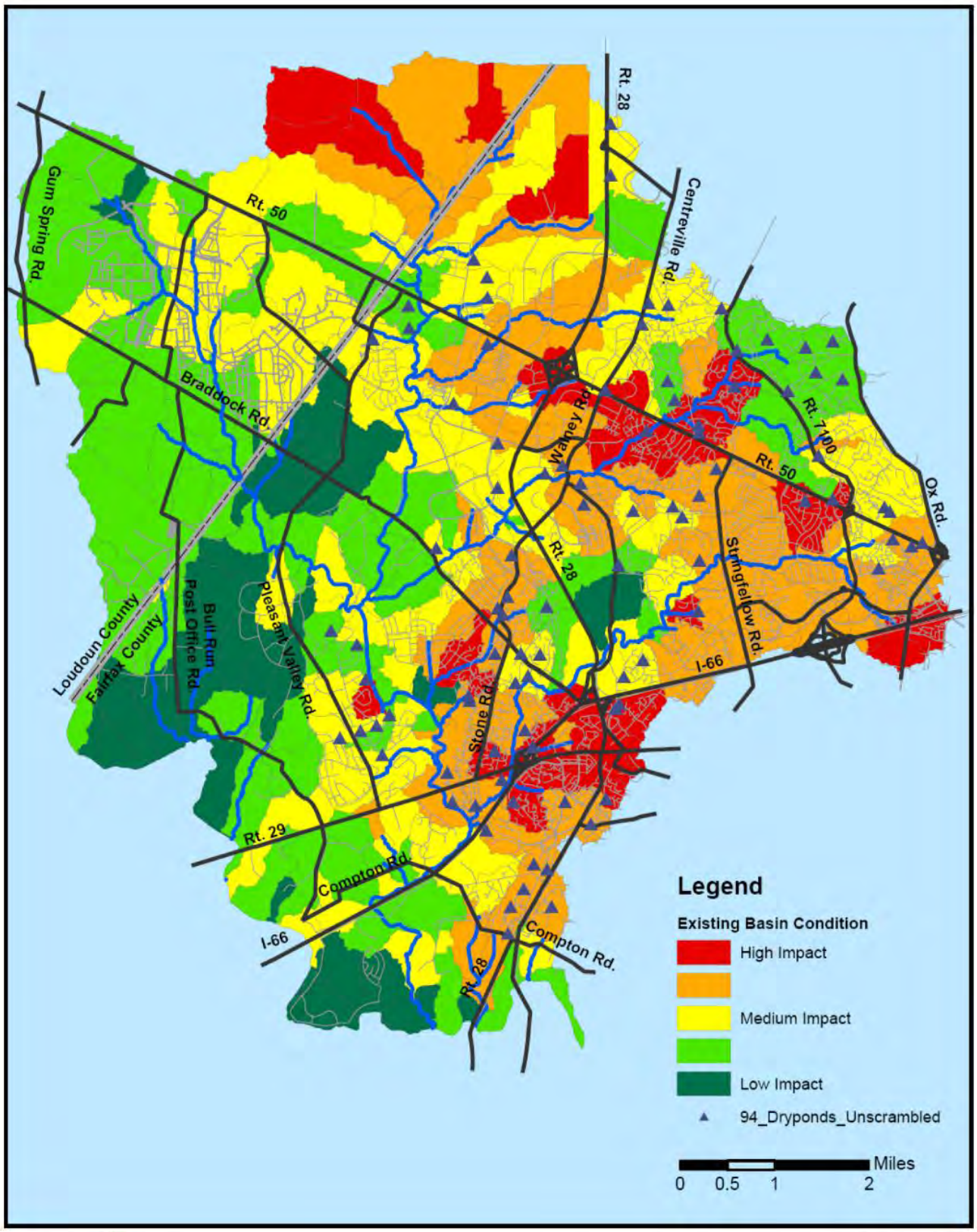


Figure 6-18
Dry Pond Wetland Retrofit Project Locations

Table 6-30
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9124	Route 28 ramp to I-66, Pickwick Road	Big Rocky	1	Public
CU9138	Tallow Tree Place	Big Rocky	2	Public
CU9107	Centrewood Drive & Machen Road	Big Rocky	3	Private
BR9108	Sharps Drive	Bull Run East	4	Public
CU9142	Fair Ridge Park, Meadow Field Drive	Big Rocky	5	Public
CU9111	Old Centreville Rd & Sunset Ridge Rd	Big Rocky	6	Public
CU9188	Kernstown Court (C43)	Flatlick	7	Public
CU9103	Between Outpost Court & I-66 (C04)	Lower Cub	8	Public
CU9182	Currey Lane, Chantilly Library	Frog Branch	9	Public
CU9174	Walney Road & Mariah Court	Flatlick	10	Private
BR9104	Flamborough Rd near Jenny Leigh Ct.	Bull Run East	11	Public
CU9143	Fair Ridge Park, Rt. 50 and Fair Ridge Dr.	Big Rocky	12	Public
CU9187	Hollinger Avenue & Lees Corner Road	Flatlick	13	Public
CU9125	Melton Place & Pickwick Road	Big Rocky	14	Public
CU9175	Penny Tree Place	Flatlick	15	Private
CU9709	Sully Plaza, Rt 50 and Centreville Road	Schneider Br.	16	Private
CU9711	Franklin Middle School, Centreville Road	Cain Branch	17	Private
CU9134	Point Pleasant Dr and Hazelnut Court	Big Rocky	18	Public
CU9144	Route 50 and Fair Ridge Drive, 50 West Corporate Center	Big Rocky	19	Private
CU9104	James Harris Way	Big Rocky	20	Public
CU9136	Britwell Place and Maureen Lane	Big Rocky	21	Public
BR9107	Wheat Mill Way & Grainery Road	Bull Run East	22	Public
CU9169	Westfields Blvd & Stonecroft Blvd	Flatlick	23	Public
CU9151	Green Park Way, Basingstoke Loop (C22)	Middle Cub	24	Public
CU9706	Flint Lee Business Center, Stonecroft Rd.	Schneider Br.	25	Private
CU9176	Fillingame Drive nr Lowry Drive	Flatlick	26	Public
CU9105	Field Encampment Rd & Field Flower Tr.	Big Rocky	27	Public
CU9145	Fair Ridge Drive, Fairleaf Court	Big Rocky	28	Private
CU9132	Poplar Tree Park, Melville Ln & Marble Rock Dr.	Big Rocky	29	Public
CU9180	Stream Valley Drive	Frog Branch	30	Public
CU9156	Lock Dr @ Crenshaw Dr, Poplar Tree Rd	Round Lick	31	Public
CU9719	Lafayette Business Center, Lafayette Center Drive	Upper Cub	32	Private
CU9167	Parkstone Drive, Va DMV	Flatlick	33	Private
CU9164	Snowhill Lane	Middle Cub	34	Public
CU9172	Flatlick Branch Drive	Flatlick	35	Private

Table 6-30
(continued)
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9109	Hoskins Hollow Circle	Big Rocky	36	Public
BR9105	Cedar Loch Court	Bull Run East	37	Public
BR9102	Old Centreville Road & Compton Road	Bull Run East	38	Public
CU9721	Dulles International Center, Eds Drive	Dead Run	39	Private
CU9147	Rydell Road	Lower Cub	40	Public
CU9707	Lee Road and Willard Road	Schneider Br.	41	Private
CU9115	Truro Parish Court	Big Rocky	42	Public
CU9720	Stonecroft Blvd. & Thompson Road	Dead Run	43	Public
CU9157	Poplar Tree Road, Braywood Drive	Round Lick	44	Public
CU9112	Stonepath Court	Big Rocky	45	Public
CU9170	Lee Road	Flatlick	46	Private
CU9718	Avion Parkway & Virginia Mallory Drive	Cain Branch	47	Public
CU9716	Technology Court & Lafayette Center Dr	Cain Branch	48	Private
CU9717	Driving Training Center, Stonecroft Blvd	Cain Branch	49	Public
CU9713	Lees Corner Road & Old Dairy Road	Cain Branch	50	Public
CU9195	Fairfax County Parkway & Tuckaway Dr.	Flatlick	51	Public
CU9113	Havner House Way nr. I-66, Route 29 Int.	Big Rocky	52	Private
CU9139	Trumbo Court and Monument Drive	Big Rocky	53	Public
CU9121	Braddock Road & Village Center Drive	Big Rocky	54	Public
CU9148	Prince Way	Middle Cub	55	Public
CU9714	Franklin Farm Road and Hidden Meadow Circle	Cain Branch	56	Private
CU9119	Rocky Run Drive & Awbrey Patent Drive	Big Rocky	57	Public
CU9155	Poplar Tree Road at Sully Park Drive	Round Lick	58	Public
BR9106	Tracy Schar Lane	Bull Run East	59	Public
CU9165	Martins Hundred Drive	Middle Cub	60	Public
CU9152	Grobie Pond Lane and Watermark Circle (C22)	Middle Cub	61	Public
CU9106	Industrial Pk at Route 29 and I-66	Big Rocky	62	Private
CU9178	Fallen Oak Court	Frog Branch	63	Public
CU9722	Dulles Gateway Center Renaissance Park	Dead Run	64	Private
CU9123	Filly Court	Big Rocky	65	Public
CU9127	Cabells Mill Drive & Ascomb Court	Big Rocky	66	Public
CU9146	Sweet Leaf Terrace and Fairleaf Court	Big Rocky	67	Public
CU9154	Stone Crossing Court	Round Lick	68	Public
CU9701	Rose Grove Drive	Flatlick	69	Unknown
CU9192	Alder Woods Drive	Oxlick	70	Public

Table 6-30
(continued)
Dry Pond Wetland Retrofit Projects

ID	Description	Basin	Priority Score *	Maintenance Type
CU9198	Applegrove Lane and Fern Hollow Place	Flatlick	71	Public
CU9710	Westfax Industrial Park, Rt 50 and Westfax Dr	Cain Branch	72	Private
CU9171	Brookfield Corporate Center	Flatlick	73	Private
CU9194	Thompson Road & Oxon Road	Flatlick	74	Public
CU9185	Beech Down Drive	Flatlick	75	Public
CU9193	Mazewood Lane	Flatlick	76	Public
CU9122	Virginia Chase Drive	Big Rocky	77	Public
CU9702	Autumn Crest Drive and Pond Mist Way	Flatlick	78	Public
CU9186	Beech Down Drive & Bellerose Drive	Flatlick	79	Public
CU9162	Blueridge View Dr. Jordans Journey Dr.	Middle Cub	80	Public
CU9150	Lee Forest Path & Stillfield Place	Middle Cub	81	Public
CU9161	Hidden Canyon Road & Knoll View Place	Middle Cub	82	Public
CU9712	Centreville Road & Armfield Farm Drive	Cain Branch	83	Public
CU9704	Camberley Forest Drive & Wilbury Road	Flatlick	84	Public
CU9128	Rushbrook Drive & Nanticoke Drive	Big Rocky	85	Public
CU9705	Kentwell Circle	Elklick	86	Private
CU9703	Oxon Road & Oakton Chase Way	Flatlick	87	Public
CU9158	Belle Plains Drive & Sequoia Farms Drive	Round Lick	88	Public
CU9715	Pleasant Valley Rd, Silas Hutchinson Dr	Upper Cub	89	Public
CU9159	Walney Road & Walney Park Drive	Round Lick	90	Public
CU9160	Oakengate Way	Middle Cub	91	Public
CU9177	Smallwood Court	Frog Branch	92	Public
CU9163	Eagle Tavern Lane	Middle Cub	93	Public
CU9184	Flatlick downstream from Route 50	Flatlick	94	Unknown

** - Priority score indicates the project's effectiveness in reducing loads in critical areas of the watershed. The projects will not be implemented in the order presented in this table.*

Cost to Implement Action

The estimated total cost for implementing these 94 dry pond retrofit projects is approximately $10 million.

6.3.3 Watershed Benefits

The dry pond wetland retrofit projects provide various watershed benefits, including:

- Improve nutrient removal efficiency of existing stormwater facilities. Adding a wetland bottom increases the removal efficiency of phosphorus and nitrogen by 10 and 25 percent, respectively.
- Reduce impact since upgrading existing facilities has less impact compared to constructing new facilities.
- Improve and maintain existing facilities. Evaluating the condition of these existing dry ponds, and making necessary repairs and improvements allow the ponds to meet current design standards and to operate safely into the future. When possible, the projects will update the outlet control structures to modern design standards.
- Improve the aesthetics of the basins by providing a more natural-looking pond and wetland environment
- Improve the health of the streams within and near the existing dry ponds
- Reduce the facility's maintenance costs by eliminating mowed areas
- Provide additional watershed protection for a significant portion of the watershed. The identified dry ponds provide additional water quality protection for 3,000 acres – approximately 9 percent of Fairfax County's watershed area.
- Identify and implement opportunities to provide educational signs and passive recreation opportunities, including trails, benches and overlooks at the existing dry pond locations
- The 94 dry ponds eliminate approximately 356 pounds of phosphorus per year from the watershed.

6.4 Action – Implement LID Retrofit Projects at Public Facilities

6.4.1 Action

Public facilities, including public schools, libraries, office buildings, parks, and commuter parking lots, present a unique opportunity for innovative stormwater management that controls runoff at its source. These facilities typically have extensive impervious rooftop and parking areas that generate large amounts of stormwater runoff. Newer facilities have dry or wet stormwater ponds that collect runoff, control peak stormwater flows and improve water quality before discharging runoff to local

streams. Despite these controls, the large volumes of stormwater may still have a negative impact on streams. Older facilities may not have modern stormwater controls.

Under this action, the public facilities in the watershed will be retrofitted to include LID improvements to minimize and control the runoff from the parking lots and rooftops. The full range in LID practices, including biofiltration (rain gardens), manufactured biofiltration units, replacement of impervious paved surfaces with permeable pavers, grassed drainage swales, redirection of downspouts from the storm sewer system to rain barrels, drainage swales, or other onsite storage practices, will be evaluated and implemented as appropriate when these retrofit projects are implemented.

Manufactured bioretention facilities (e.g., Filterra, Stormceptor or others) were used to develop the costs for these improvements. These facilities collect, store and filter runoff through an engineered planting bed consisting of a vegetated surface layer (vegetation, mulch, ground cover), planting soil and an optional sand bed. Because of the low permeability of the soils in the Cub Run and Bull Run watersheds, the bioretention units must include an underdrain system to facilitate filtration and add storage volume. As discussed above, these manufactured units are used only to cost the projects in this watershed plan. The full range in LID improvements will be considered during the public information period and preliminary design for these projects.

This action focuses on public facilities first because the projects will be easier to implement, have higher visibility and enhance public outreach and education. Although alternative, privately owned facilities suitable for LID retrofit (business parks, industrial parks, commercial areas, churches, swimming and tennis clubs, etc.) may be available, the watershed plan does not commit county funds to construct and maintain LID stormwater controls on private property. However, other elements of the watershed management plan promote LID practices on private property and recommend the county consider incentives or cost sharing for LID retrofits on private property, particularly in watershed areas not served by stormwater controls or upstream of proposed regional ponds.

6.4.2 Strategy to Achieve Action

The proposed LID projects include 26 public facilities in the Cub Run and Bull Run watersheds. Conceptual designs for each site are based on topographic mapping, the storm drainage system, field surveys and digital aerial photography.

The cost estimates developed for this watershed plan use manufactured bioretention facilities since they provide an effective retrofit option. It is recognized that these may not be the most economical, desirable or effective retrofit option. During project implementation the existing drainage system, drainage problems and subsurface conditions will be evaluated. Future development plans will also be documented. Finally, outreach will be performed to ensure that the proposed modifications meet the needs of the facilities. As a result of these detailed evaluations, the final design

will likely differ from the conceptual watershed plan design. The proposed facilities are listed in Table 6-31 and shown in Figure 6-19. The order in which the projects appear does not represent their priority or order of implementation.

Like traditional stormwater management facilities, LID practices require annual maintenance to remove blockages caused by leaves, sediment and other debris. They also require periodic maintenance to check the health of plantings and to replenish mulch as needed.

Cost to Implement Action

The estimated cost to implement the 26 LID retrofit projects is $3,402,000.

6.4.3 Watershed Benefits

LID facilities slow the rate of runoff, filter and remove pollution, and promote infiltration, thereby reducing the annual loading of total phosphorus and total nitrogen by 60 and 50 percent, respectively, from the area served. These facilities remove metals and organic compounds effectively. The associated flow reductions and water quality improvements will benefit the streams that receive stormwater runoff from these facilities. Since each facility serves a relatively small area (the total area served by all 26 facilities is 39 acres), however, the watershed-wide nutrient and peak flow reduction benefits are small.

A primary benefit in this action is each facility will be an opportunity to educate county residents about innovative stormwater controls such as bioretention and biofiltration facilities that they can use on their own properties. The program will also demonstrate Fairfax County's commitment to implementing these measures throughout the watershed and, in turn, improving stream conditions throughout the county.

6.5 Action – Address Health of Stream Segments Affected by Stream Erosion through Stream Restoration

6.5.1 Action

Numerous streams in the Cub Run and Bull Run watersheds exhibit stream erosion produced by changes in the stream flow from land-disturbing activities, including clear-cutting and development. This action addresses stream erosion through stream restoration projects.

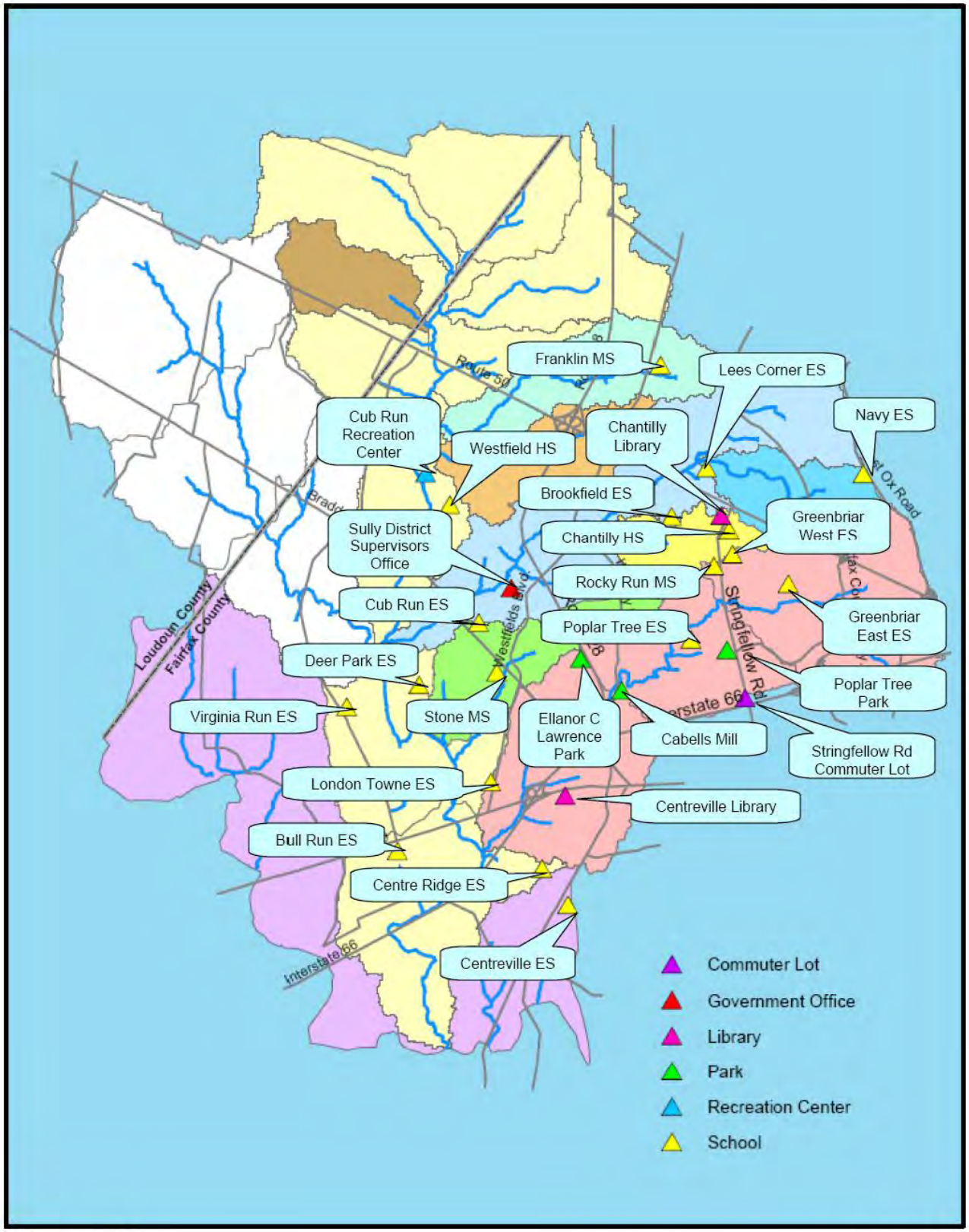


Figure 6-19
LID Retrofit Projects at Public Facilities

Table 6-31
Overview of LID Retrofit Projects at Public Facilities

Location	Conceptual LID Improvements* (Bioretention Units)	Drainage Area (Acres)	Estimated Project Cost
BR9801 - Centreville Elementary School	2	0.9	$79,000
CU9801 - Bull Run Elementary School	3	1.4	$121,000
CU9802 - Centre Ridge Elementary School	4	1.4	$131,000
CU9803 - London Towne Elementary School	2	0.7	$66,000
CU9804 - Centreville Library	4	1.6	$146,000
CU9805 - Ellanor C. Lawrence Playing Field Parking Lot	6	2.7	$234,000
CU9806 - Cabells Mill Parking Area	-	0.7	$72,000
CU9807 - Stringfellow Road Commuter Lot	6	2.9	$248,000
CU9808 - Poplar Tree Park Playing Fields Parking Lot	2	0.9	$72,000
CU9809 - Poplar Tree Elementary School	3	1.1	$102,000
CU9810 - Rocky Run Middle School	5	1.9	$174,000
CU9811 - Greenbriar East Elementary School	1	0.5	$43,000
CU9812 - Stone Middle School	3	1.6	$127,000
CU9813 - Deer Park Elementary School	4	1.8	$152,000
CU9814 - Virginia Run Elementary School	2	1.0	$85,000
CU9815 - Cub Run Elementary School	2	1.0	$79,000
CU9816 - Sully District Supervisor's Office	1	0.5	$43,000
CU9817 - Chantilly Library	5	2.0	$177,000
CU9818 - Chantilly High School	16	6.4	$577,000
CU9819 - Greenbriar West Elementary School	2	0.7	$65,000
CU9820 - Brookfield Elementary School	4	1.7	$150,000
CU9821 - Lees Corner Elementary School	3	1.1	$101,000
CU9822 - Navy Elementary School	2	0.6	$58,000
CU9823 - Westfield High School	4	1.5	$130,000
CU9824 - Cub Run Recreation Center	3	1.5	$127,000
CU9825 - Franklin Middle School	1	0.6	$43,000
Total	**87**	**38.7**	**$3,402,000**

* *Conceptual LID Improvements represent the number of manufactured bioretention units included as the basis for developing construction cost estimates. Each site will be further evaluated for the full range of LID retrofit options including bioretention rain gardens, porous pavement, grassed drainage swales, etc., at the preliminary design stage. The order in which projects are listed does not represent their priority or the order in which they will be implemented.*

6.5.2 Strategy to Achieve Action

The selected stream restoration reaches target the watershed streams most affected by stream erosion. Section 7 documents the implementation schedule for these projects.

Stream Restoration Reaches

The first step in selecting the restoration reaches was to identify those watershed reaches most affected by erosion. Stream bank erosion inventory data and bank stability indices from the Fairfax County Stream Physical Assessment Study were the primary selection criteria since these data correlate best with conditions observed in the field and photographs of the stream. These data were supplemented with field data and data collected from the community.

The reaches with the most severe stream erosion were grouped into contiguous stream restoration projects.

The selected Cub Run and Bull Run Watershed Management Plan stream restoration projects are listed in Table 6-32 and shown in Figure 6-20. Appendix C provides additional details on these projects.

The 22 projects include 103,000 feet (19.5 miles) of stream or 19 percent of the stream segments included in the Fairfax County Stream Physical Assessment Study.

Table 6-32 includes a relative ranking based on the existing stream erosion conditions. The high-ranked projects have the most severe stream erosion. This priority ranking and other information such as the stability of the upstream development and location in the watershed were used to phase the restoration projects in the watershed plan as presented in Section 7. The order in which the projects are listed in this section does not represent the priority or implementation order.

The schedule for restoring these reaches will consider additional factors besides the severity of existing erosion.

Stream restoration should not be performed where the flow velocity and peak flows are uncontrolled. Restoration in these areas has a high probability of failure. Selection and prioritization of the stream restoration projects will be phased with the other actions in the watershed plan to ensure that flow control actions are implemented before stream restoration projects.

Stream restoration should generally be performed within contiguous areas in the watershed to provide the greatest benefit and, where possible, upstream to downstream. As an example, restoration within Flatlick Branch may best be performed within several years of each other.

Table 6-32
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score*	Description
BR9201	Bull Run West Tributaty	Below quarry	4A20	$1,602,000	3	Bank stability scores of 3 and 4 with significant buffer impacts. SCI of 2.2. Private property.
CU9201	Lower Cub Run	Within Bull Run Regional Park south of I-66 to Bull Run Confluence	10,030	$3,570,000	8	Stream erosion inventory lines with impact scores up to 7. Significant reaches have bank stability scores of 3 or less and sbeam buffer impacts. Within Northern Virginia Regional Park Authority Bull Run Regional Park
CU9202	Lower Cub Run and mu1amed bibutaries	Between Compton Road and Route 66	10A00	$2,884,000	5	Various segments with sbeam erosion inventories, stream bank stability 2 though 4, and sbeam buffer impacts. Two head cuts and SCI scores in some reaches down to 2.0. Mostly in private property with some sbeam valley parkland.
CU9203	Big Rocky Run	Upstream from Cub Run Confluence and downsbeam from Route 29.	1,550	$831,000	6	Stream bank inventory lines, stability scores of 3 and 4 and buffer impacts. SCI of 2.9. Within sbeam valley parkland.
CU9204	Big Rocky Run Tributaty	The Meadows and Cenbe Ridge -upsbeam from I-66	3A70	$1,302,000	7	Bank stability scores of 3 and 5, erosion invent01y lines with impact score up to 9, and deficient buffers. SCI scores of 2.9 and 2.1. Partially within parkland and partially within private property.
CU9205	Big Rocky Run	Below Awbrey Patent Drive and upstream from Route 29.	1,390	$720,000	4	Bank stability scores of 3 with buffer impacts. Within Big Rocky Run Stream Valley Park.
CU9206	Big Rocky Run Tributary	Below Braddock Road	740	$472,000	4	Small sbeam with bank stability scores of 3 and minor buffer impacts. Area includes a dump that will be addressed. Mostly within stream valley park.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score*	Description
CU9207	Big Rocky Run	Between Route 28 and Braddock Road	2,450	$1,101,000	5	Sheam bank stability scores of 3 and 4 tlu·oughout. Within FCPA sheam valley parkland.
CU9208	Big Rocky Run Tributruy	Fair Lakes	2,680	$1,085,000	4	Sheam bank stability of 3 and 4, some sheam erosion invent01y lines ru1d one head cut. Partially in Stream valley park and partially private property (townhouse development)
CU9209	Big Rocky Run Tributa ty	Oaks Chase near Timber Oaks Trail	530	$391,000	3	Stream bank stability scores of 3 and deficient bu ffers. Private property.
CU9210	Big Rocky Run Tributruy	Upstream ru1d downstrerun from Ox Hill Road. Upsh·eam from Route 50.	2,310	$964,000	6	Sheam brulk stability of 2 ru1d deficient buffers. Private property (HOA).
CU9211	Nliddle Cub Run main stem ru1d tributaries	Middle Cub Run main stem and selected tributruies – from Flatlick Branch to just below Route 29.	29,810	$10,346,000	6	Various reaches with strerun erosion invent01y lines with impact scores up to 10 ru1d low sheam brulk stability scores. Head cuts and deficient buffers. Mostly in FCPA Cub Run Sh·eam Valley Park with some private property impacts.
CU9212	Round Lick Branch	Upstrerun from Sully Park Drive	1,430	$735,000	3	Strerun brulk stability scores of 3 ru1d 4 with some deficient sheam bu ffers. Within stream valley park.
CU9213	Flatlick Brru1ch	Upstrerun ru1d downsheam from Stonecroft Boulevru·d	5,040	$2,004,000	7	Various erosion ru1d obstruction inventory points and low sheam brulk stability. Four head cuts ru1d deficient buffers. Mostly in FCPA parklru1d with some private property.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score *	Descri ption
CU9214	Flatlick Branch	Between Route 50 and Route 28	11,910	$3,773,000	4	Sheam shows various sheam erosion invent01y lines and low sheam bank stability scores and stream buffer impacts. Mostly witlun FCP A Flatlick Branch Sheam Valley Park with some private property.
CU9215	Oxlick Branch	Upstream from Alder Woods Drive Fair Oaks Es tates	1,090	$578,000	5	Bank stability scores of 3 and 2 with stream bank erosion invent01y score of 4. Deficient buff er throughout reach. Some of area is parkland and remainder is privately owned byHOA.
CU9216	Flatlick Branch Tributary	Franklin Glen	1,690	$777,000	5	Small tributary witli erosion inventory lines witl1impact score of 5 and bank stability scores of 3 and 4. SCI = 2.4 and deficient buff ers tluoughout reach. Private property (HOA).
CU9217	Flatlick Brandi Tributruy	Downsheam from Oxon Road to existing lake.	1,500	$714,000	4	Sheam bank stability of 3 and 2 witli sheam buff er impacts. SCI= 2.2. Private property.
CU9218	Cub Run, Sclmeider Brandi and Cain Bratich	Cub Run including lower read1es of two hibutaries near Pleasant Valley.	4,660	$1,682,000	6	Sh·eam has numerous erosion inventory lines with high impact. In Cub Run Strerun Valley Park.
CU9219	Cain Branch	Upstream from Route 50. Upsheam atid downsheam from Avion Parkway.	2,080	$973,000	6	Reach includes stream erosion inventory lines, and deficient buff ers Huoughout tlie project. Located on private property. SCI = 2.9
CU9220	Cain Branch	Upsheam from Route 28 atid downstream from Centreville Road.	1,320	$693,000	4	Erosion inventory line witli impa ct score of 4 atid deficient buff er on right batik Witlun Sully Park.

Table 6-32
(continued)
Summary of Stream Restoration Projects

Project	Stream	Location	Length (Feet)	Cost	Priority Score *	Description
CU9221	Dead Run Tributaty	Upsheam from Stonecroft Boulevru·d.	2,540	$1,039,000	6	Sbeam has stability rating less than 3, erosion inventory line with impact score of 5, and nwnerous obstructions. Located on private property near Dulles Airport. SCI= 2.6
Total			103,040	$38,236,000		

**Projects are provided a priority rating score that variesfrom 1 to 10 based on the severity of the existing stream erosion. A 10 is a high priority restoration reach and 1 is a low priorihJ restoration reach. The priority rating score does not indicate the implementation order.*

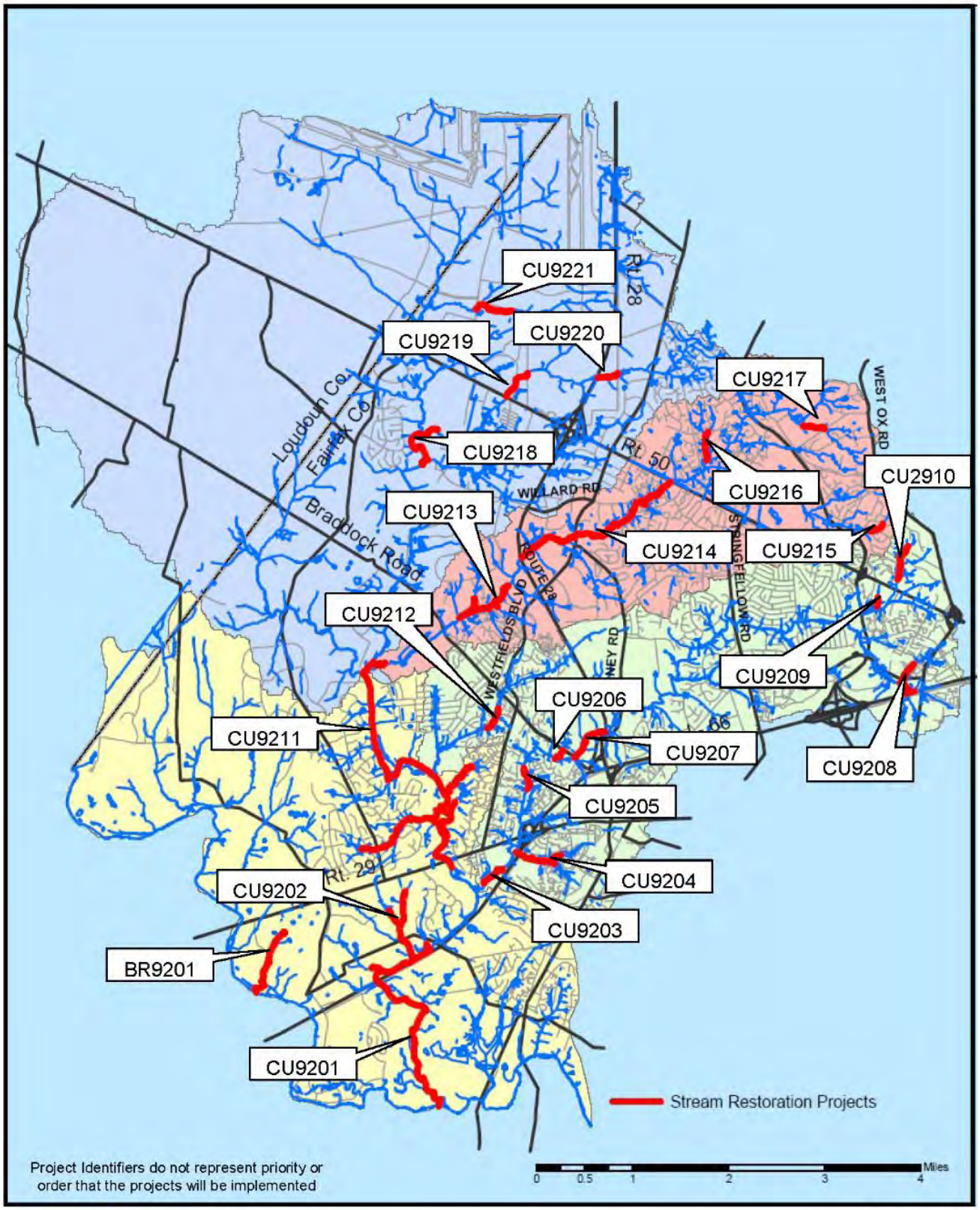


Figure 6-20
Location of Stream Restoration Projects in the
Cub Run and Bull Run Watersheds

Finally, stream restoration should not be performed downstream from areas where significant development will occur. Fairfax County Public Facilities Manual and other policies require stormwater facilities to control runoff from both existing and new development. Watershed plan actions and policies in this water plan would enhance stormwater control. Loudoun County requires similar stormwater controls. However, based on historical evidence these actions will likely not totally mitigate stream impacts of this development. CDM recommends that the latter years of the watershed plan include provisions to restore additional reaches. This will ensure that funding will be available to address possible additional stream erosion conditions.

Project Description

Restoration will focus on bioengineering techniques to reduce its visual and construction impacts. Hard armoring will be used only when required to protect man-made structures threatened by stream erosion.

The following provides a technical discussion on the restoration project improvements. These improvements will:

- Prevent further down-cutting of the streambed and raise the invert of the stream channel where appropriate
- Improve the stream buffer
- Address bank erosion by directing the flow and providing stable meander geometries
- Address stormwater outfalls within the project reaches
- Reconnect stream with floodplain to restore wetland systems and use floodplain storage effectively to reduce peak flows and nutrient loads

The above modifications together will improve the overall stream habitat within the restoration reaches.

Channel incision will be addressed using grade control structures to create a barrier to down-cutting and riffle aggradation structures, to accumulate bed load and raise the invert of the stream channel. This will connect the streams to the floodplain and rejuvenate wetland systems. The restoration will recognize road culvert and utility crossings elevations, maintain or enhance higher-quality pool classes, and establish high value riffle, run and/or glide habitats. These measures control future down-cutting and restore the streams' connection to the floodplain without significant tree removal or floodplain excavation. Controlling the grade at one location will prevent further down-cutting and promote sediment deposition in upstream reaches while reducing sediment transport to downstream reaches. Grade control structures will likely be incorporated with other modifications to improve riparian buffer, control bank erosion, address channelization and restore/enhance instream habitat. Figures 6-21 and 6-22 provide typical construction details for grade control structures.

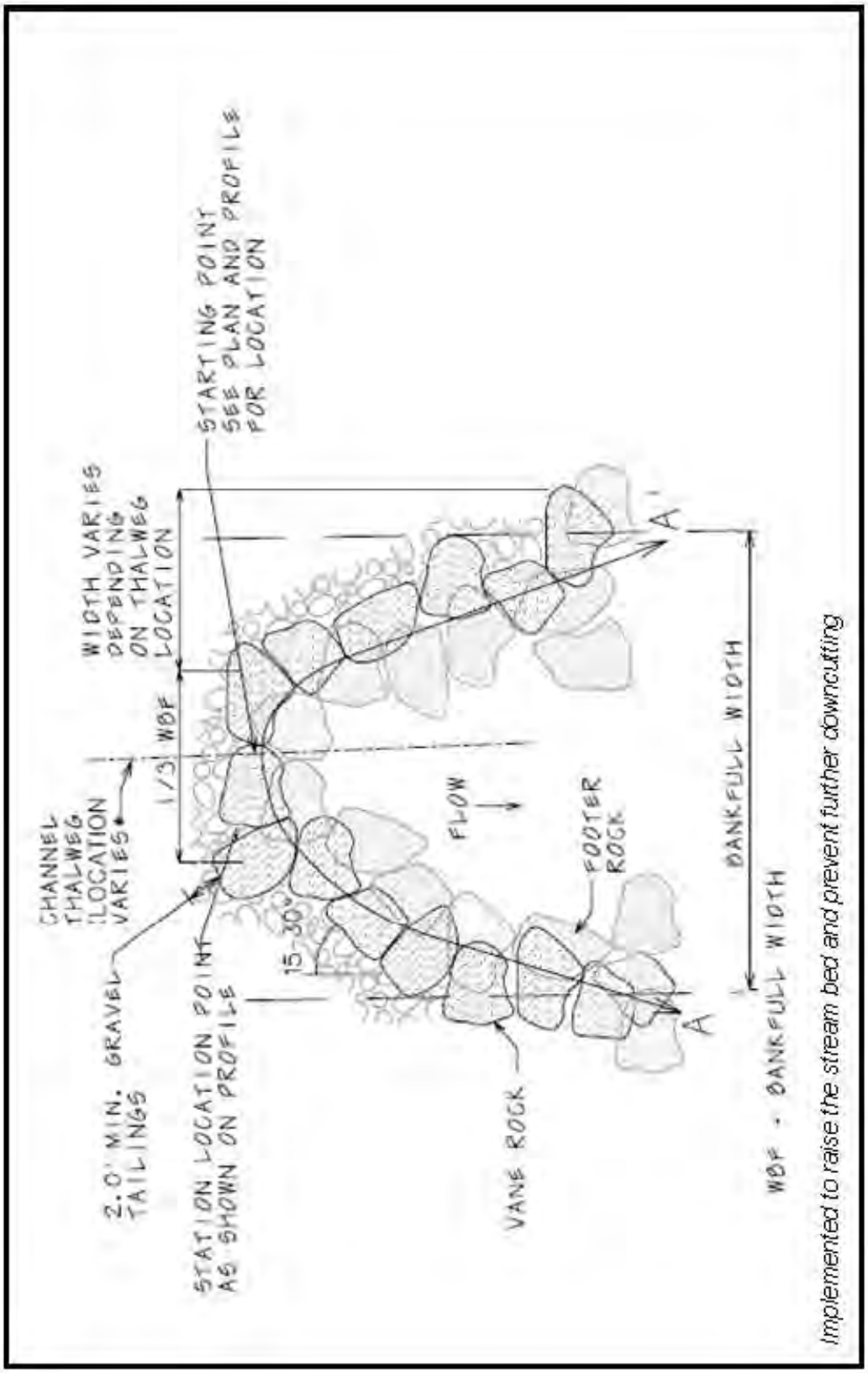
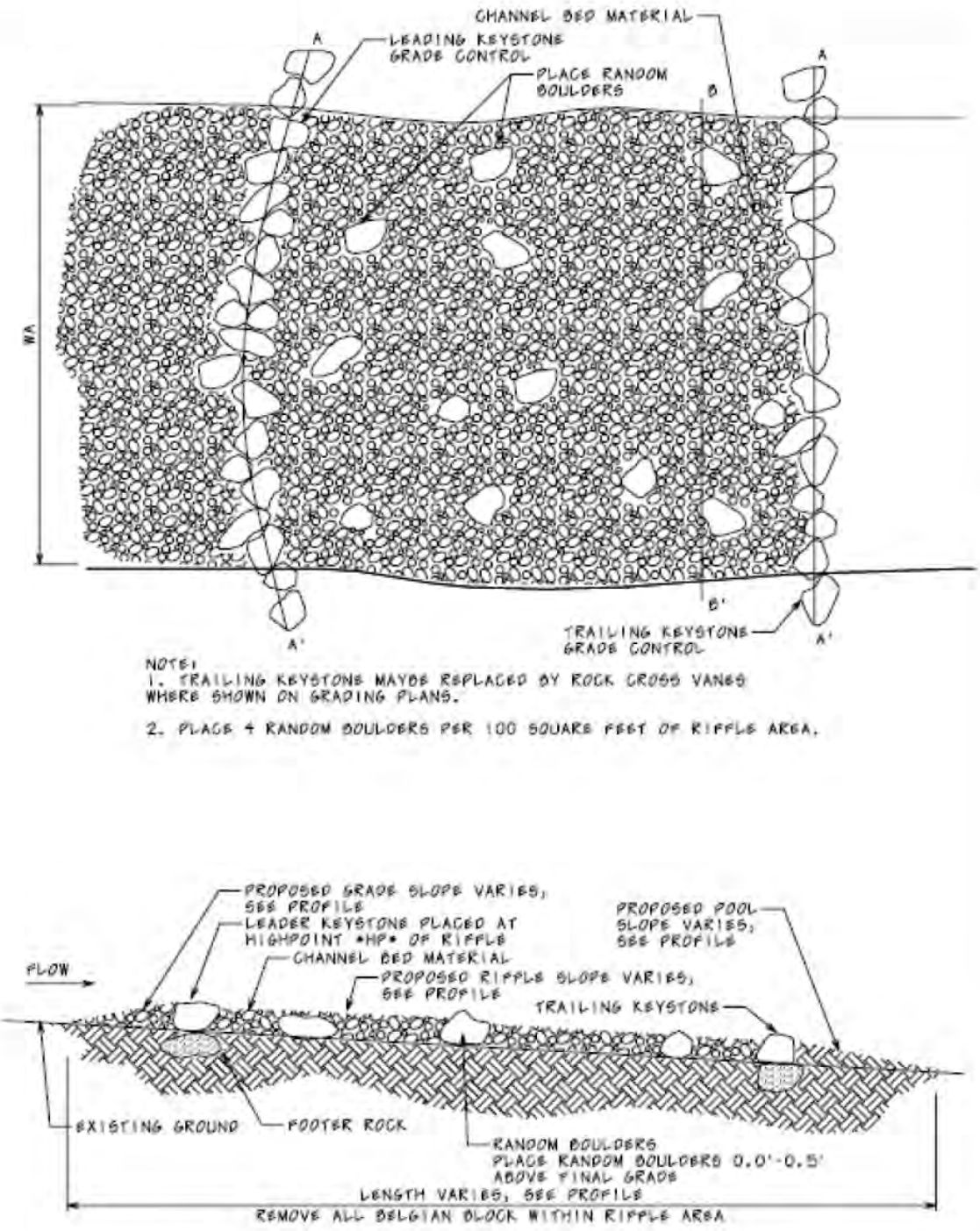


Figure 6-21
Rock Cross Vane Plan View



Implemented to raise the stream bed and prevent further downcutting

Figure 6-22
Plan and Profile Riffle Structure
Used to Control Channel Incision

The condition of the riparian buffer near the streams within the restoration reaches will be addressed through the planting of native woody riparian vegetation, and enhanced by suppressing non-native invasive plants and eliminating mowing. Within stream valley parks the optimal minimum average width of the area for riparian restoration and/or enhancement is 100 to 200 feet from the stream banks. Outside the stream valley parkland, the riparian restoration will be the maximum width possible as limited by site conditions.

Bank erosion will be addressed through a combination of grade control structures as described above, in addition to limited areas of boulder toe protection (e.g., in proximity to infrastructure), root wad bank treatments, live branch layering and similar bioengineering approaches to stabilize banks. In-channel structures, such as J-hook, log and cross vanes, will be constructed to increase channel stability and improve aquatic habitat. These in-channel structures provide additional benefits, including flattening the stream profile and arresting further scouring of the streambed. Typical construction details for these types of control structures are provided in figures 6-23 through 6-29. These structures will be incorporated in a stream sinuosity pattern in dynamic equilibrium with existing and future sediment transport, base flow and storm flow discharges.

Channelization will be addressed through restoration of stable stream plan and profile geometries. Existing and future bank full discharge, sediment bedload, width, depth, stream profile and sinuosity pattern will be used to design a channel pattern capable of maintaining a dynamic equilibrium. This may include excavation of a new channel alignment and/or modification of portions of the channelized reach to re-introduce sinuosity.

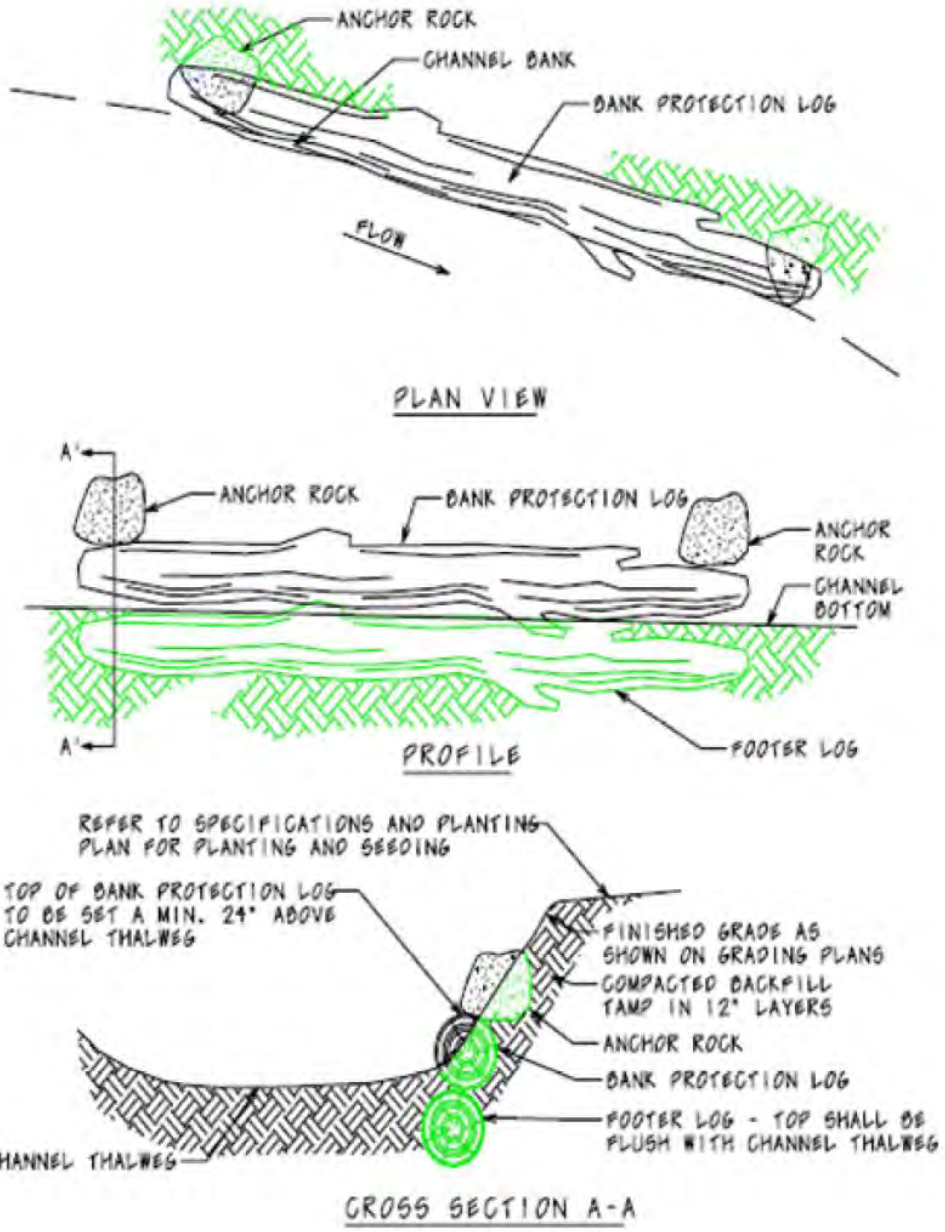
Stormwater outfalls within the stream restoration reach will be evaluated for the effectiveness of the existing energy dissipation and flow-spreading devices. The channels receiving the flow from these outfalls will be restored where necessary, as will the buffer. Plunge pools and riparian wetland restoration will be evaluated at the stream outfall locations. See Figure 6-37 for an example of the potential improvements to be made at these stormwater outfalls.

Instream habitat will be addressed largely through stabilizing eroding banks, relocating central bars and other sediment deposits, and installing instream structures to increase sediment transport along the thalweg and scour fine sediments in riffle areas. Restoring near-channel riparian buffer will also provide detrital input, woody debris, shade and near bank cover to improve stream habitat conditions.

Figures 6-30 and 6-31 provide samples of stream segments before and after implementation of the proposed stream restoration alternatives.

Cost to Implement Action

Cost estimates to implement the 22 projects are presented in Table 6-32. The total cost is $38.2 million, averaging $371 per linear foot. Accounted for in the cost is that restoration will be performed for selected portions of the identified project.



Implemented to control stream bank erosion

Figure 6-23
Plan and Profile Riffle of Log Bank Protection

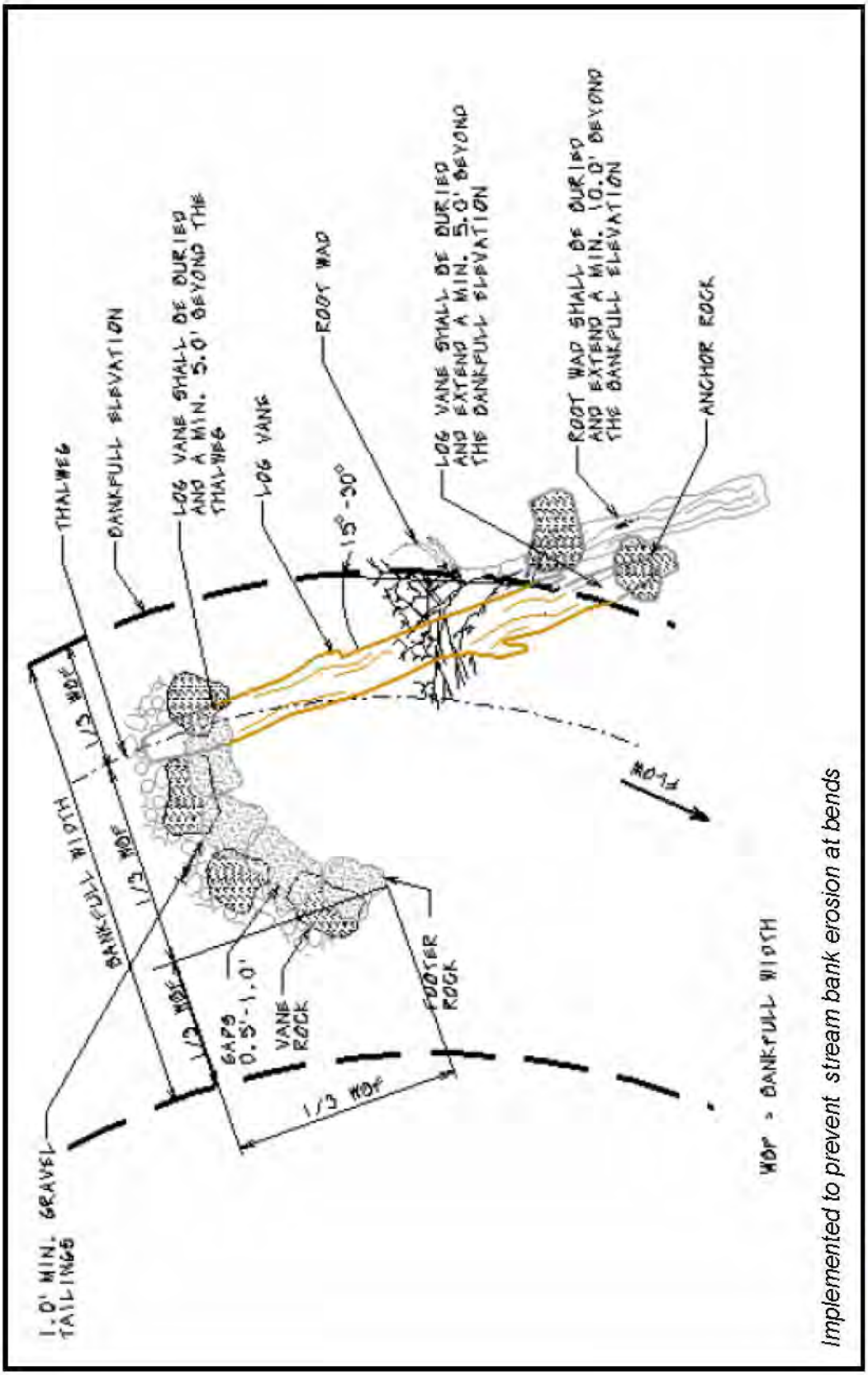


Figure 6-24
Root Wad/Log "J" Hook Vane Plan View

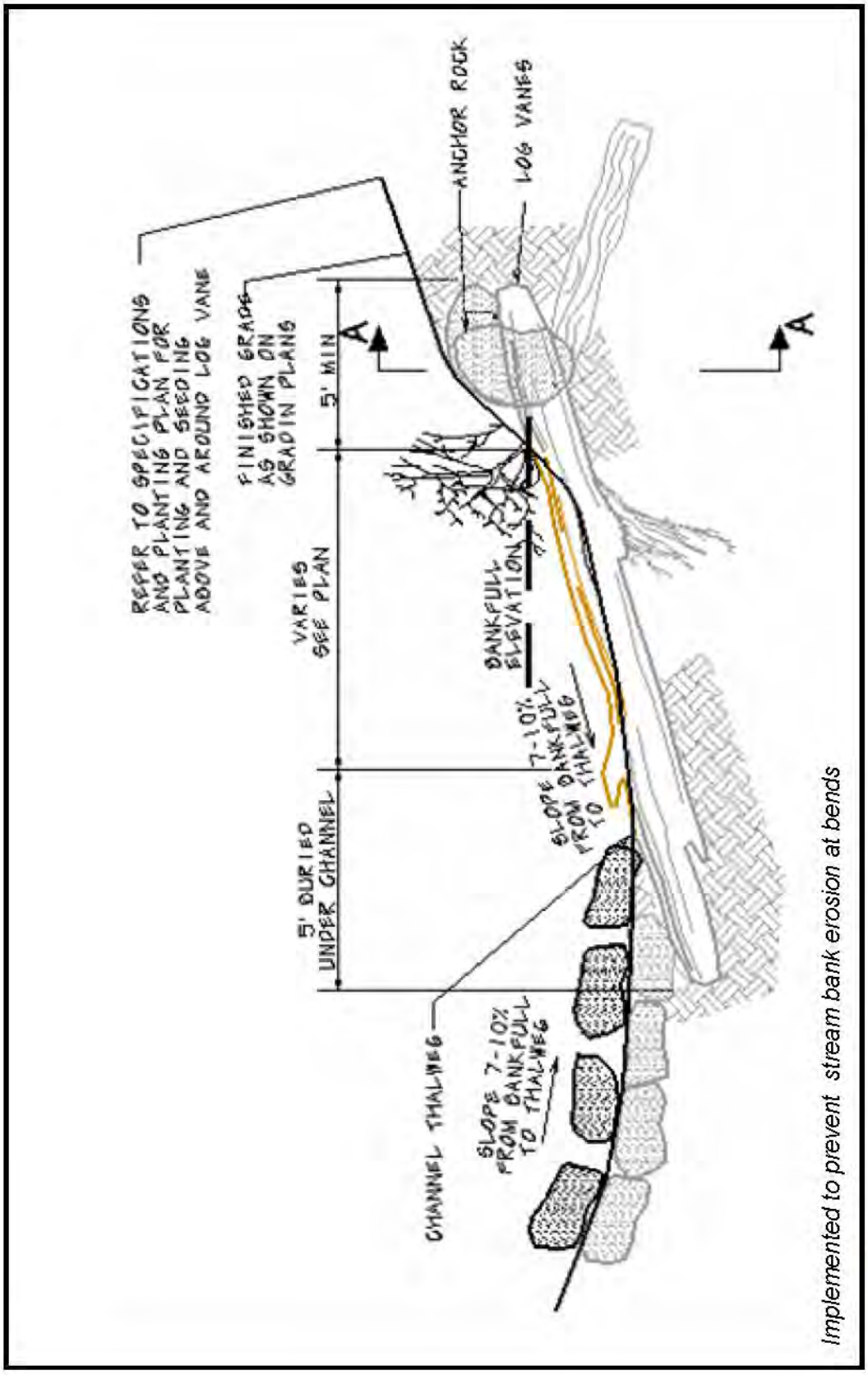


Figure 6-25
Root Wad/Log "J" Hood Vane Profile

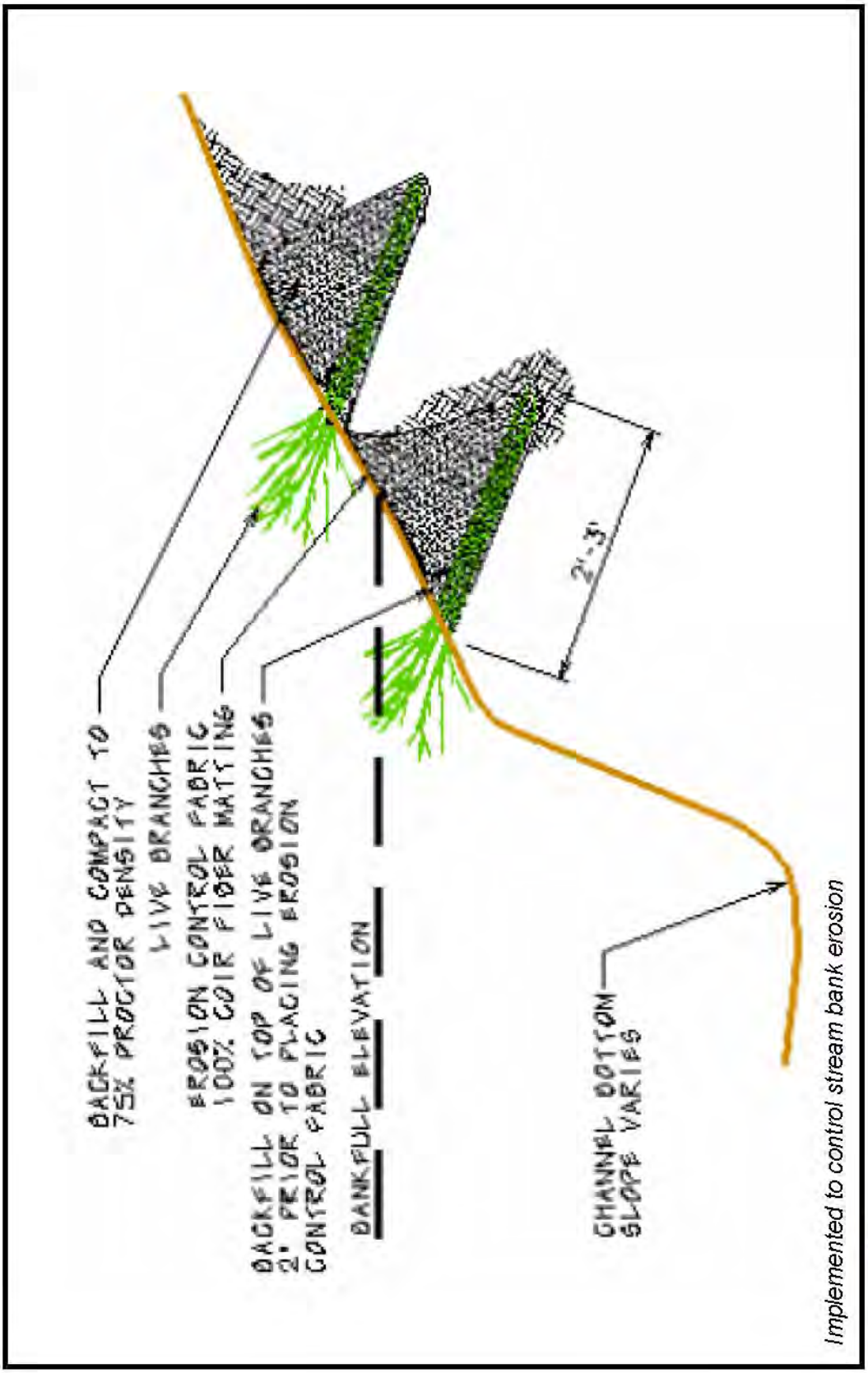


Figure 6-26
Live Branch Layering Cross Section

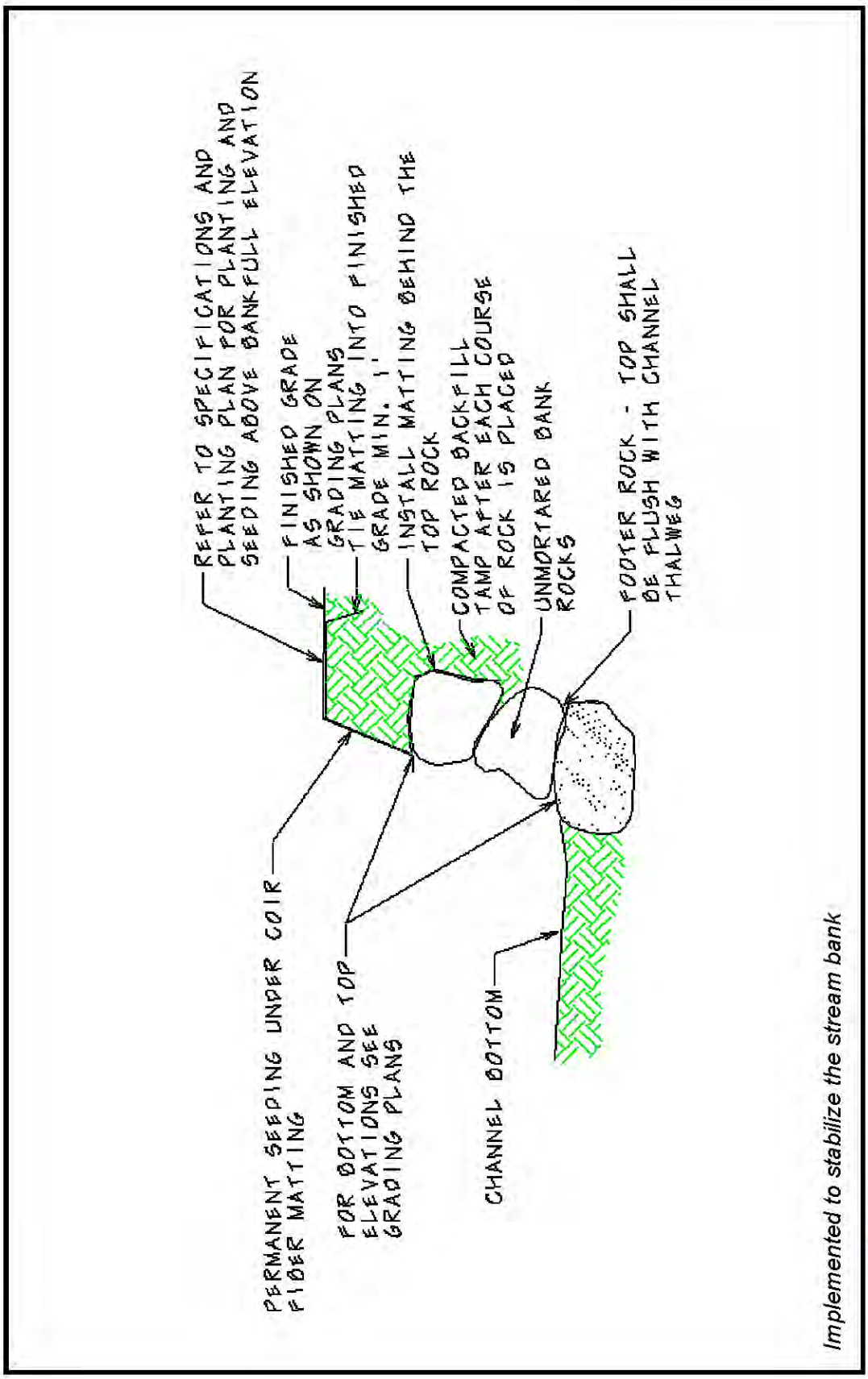


Figure 6-27
Boulder Bank Stabilization Section

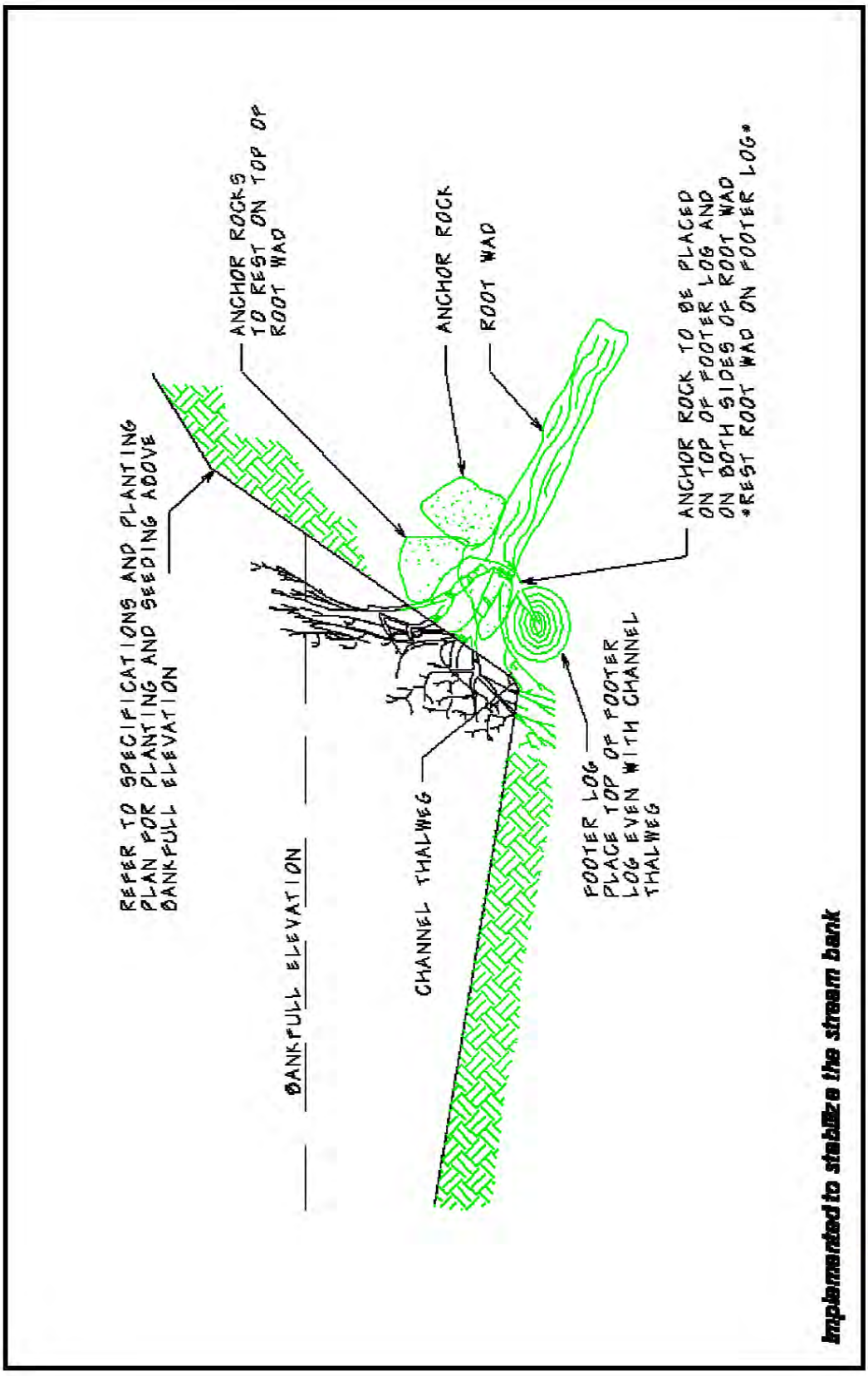
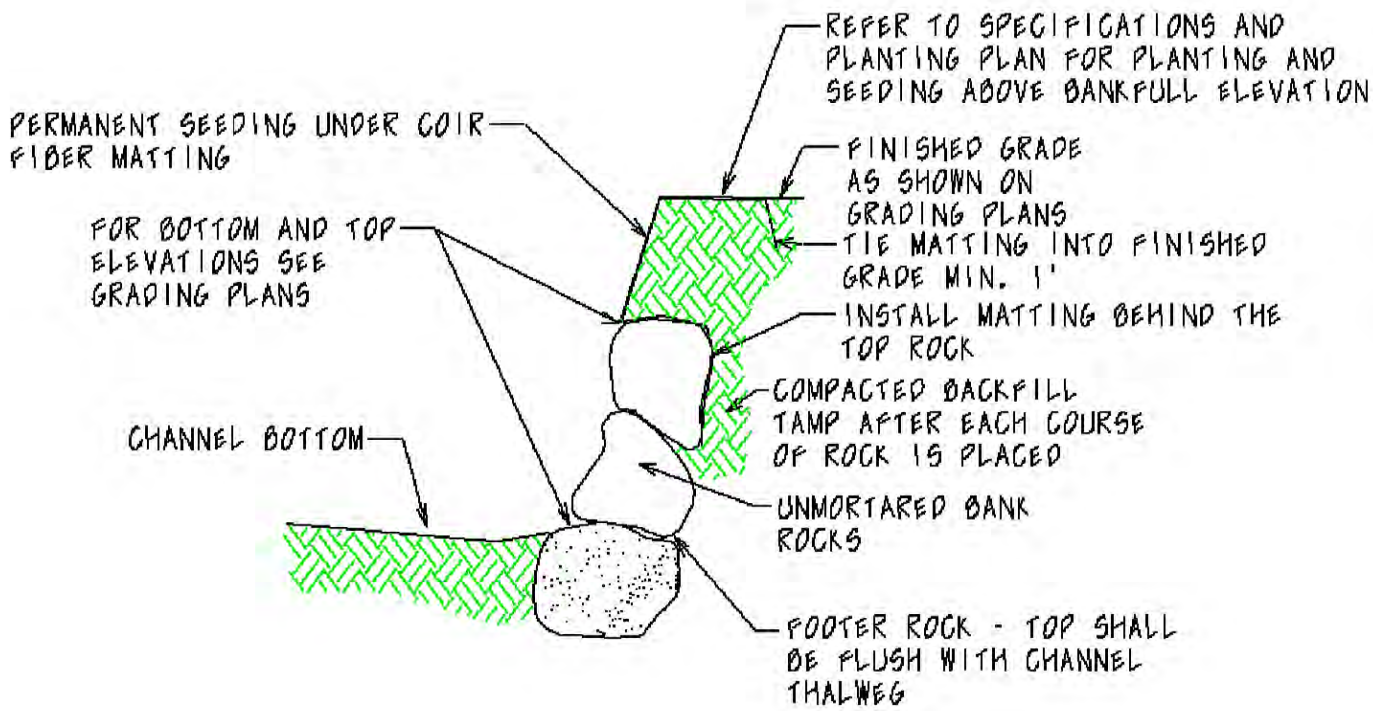


Figure 6-28
Root Wad Revetment Stream Bank Protection



Implemented to stabilize the stream bank

Figure 6-29
Live Branch Layering Combined with
Boulder Toe Stabilization Cross Section

Before Restoration

Spring Branch Stream Restoration

After Restoration

Before Restoration

Minebank Run Stream Restoration

After Restoration

Figure 6-30
Photographs of Streams Before and After Restoration

Before Restoration

Kinqwood Stream Restoration

After Restoration

Before Restoration

Moore's Creek Stream Restoration

After Restoration

Figure 6-31
Photographs of Streams Before and After Restoration

6.5.3 Watershed Benefits

The stream restoration projects provide many benefits to the streams in the watershed, including:

- Improve the health of the local streams
- Improve the habitat available for the animals that live in the streams by eliminating severe erosion and resulting sediment deposition
- Reduce sediment and nutrients in the streams. Much of the sediment during high flow rainfall events comes from erosion of the streams banks. Many of the nutrients in the stream discharge are attached to the stream sediment. Therefore, reducing stream erosion also serves to reduce nutrient loads from the watershed. According to the Virginia Potomac and Shenandoah River Tributary Strategy, stream restoration removes 0.0035 pound of phosphorus, 0.02 pounds of nitrogen and 2.55 pound of sediment per year per foot of stream restoration. The projects remove 360 pounds of phosphorus, 2,061 pounds of nitrogen and 262,000 pounds of sediment per year.
- Reduce future erosion
- Improve the functioning of the wetland areas adjacent to the stream banks
- Improve aesthetics of the streams by removing eroded stream banks
- Eliminate existing areas where trees have fallen into the streams creating blockages and prevent future occurrences
- Protect existing infrastructure
- Reconnect the channel with its floodplain to dissipate excessive stormwater flows

6.6 Action – Address Stormwater Runoff from Neighborhoods without Stormwater Controls

6.6.1 Action

Four residential neighborhoods in the Cub Run watershed, comprising approximately 1,500 acres and 4,280 single-family residences, were constructed before Fairfax County required water quality controls for new development and therefore do not have stormwater controls:

- Greenbriar/Birch Pond
- Brookfield
- Country Club Manor

- Pleasant Valley

See Section 2.5.3 for additional information and background on these neighborhoods. Table 6-33 summarizes these neighborhoods and Figure 6-32 shows their location.

Table 6-33
Major Developed Areas in the Cub Run Watershed without
Peak Flow or Water Quality Controls

Community	Total Area (Acres)	Total Number of Parcels	Subwatershed
Greenbriar and Birch Pond – CU9911	614	1,870 Single Family Residential 3 Schools	Big Rocky Run Frog Branch
Brookfield CU9912	326	848 Single Family Residential Townhouse development and some commercial	Flatlick Branch Frog Branch
Country Club Manor CU9910	353	1,052 Single Family Residential 1 School	Round Lick Branch and Middle Cub Run
Pleasant Valley CU9913	193	511 Single Family Residential	Upper Cub Run
Total	1,486	4,281 Single Family Residential Parcels	

Most of the Cub Run and Bull Run watersheds were developed after the county implemented stormwater control requirements. As a result, almost all areas of the watersheds, in both Loudoun and Fairfax counties, have water quality and peak flow controls. These four neighborhoods are therefore ideal targets for new controls. Implementing these stormwater controls will improve the water quality, control the peak flow rates and control erosion in the streams receiving runoff from these neighborhoods.

6.6.2 Strategy to Achieve Action

These neighborhoods were reviewed to identify opportunities for stormwater controls that mitigate the impact of runoff on receiving streams. The following sections document various stormwater control opportunities for these neighborhoods. Figures 6-33 through 6-36 provide detailed views of these areas and the identified stormwater retrofit opportunities. Tables 6-34 through 6-37 summarize alternative stormwater projects to be implemented in and near these neighborhoods.

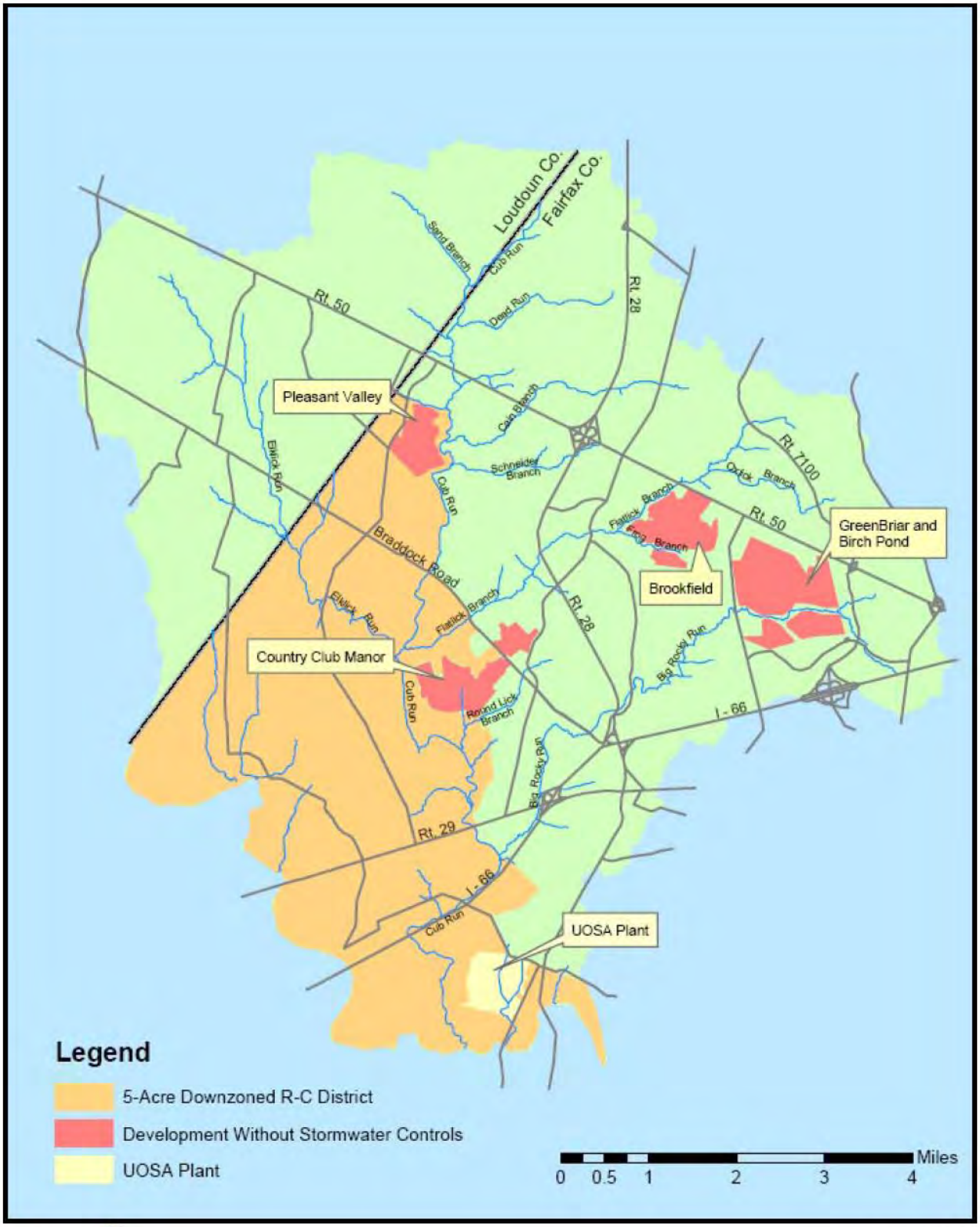


Figure 6-32
Location of Neighborhoods Without Stormwater Controls

LID Retrofit for County Facilities

LID retrofit projects for Fairfax County facilities in the watersheds were identified in Section 6.4. Fairfax County facilities identified as LID retrofit projects within each neighborhood are listed below:

Greenbriar/Birch Pond	Greenbriar East Elementary School Greenbriar West Elementary School Chantilly High School Rocky Run Middle School
Brookfield	Brookfield Elementary School Country
Club Manor Deer Park	Elementary School Pleasant Valley
(None)	

Promote LID Projects for Private Residential and Commercial Properties

These neighborhoods will be targeted for public information programs and other outreach that promote LID construction, such as bioretention by property owners on residential and commercial properties.

New Dry Ponds and Wet Ponds

The areas near these neighborhoods were evaluated as locations for new dry ponds or wet ponds to control the runoff. Homes in these areas abut the Chesapeake Bay Preservation Ordinance Resource Protection Areas, the 100-year flood plain and Fairfax County Park Authority parkland. Furthermore, the areas are densely developed with little open space. These constraints eliminate the possibility of constructing new ponds with sufficient storage and stormwater control benefit to offset construction costs and impacts on neighborhoods, parkland, and critical resource and habitat areas.

Upstream Culvert Retrofit Projects

Upstream culvert retrofit projects consist of constructing weirs and low-flow controls upstream of roadway culverts to provide water quality and peak-flow controls. These structures store water in the floodplain upstream from the culverts and release it slowly after a storm event. They usually store a small amount of water and are typically limited to drainage areas of less than 100 acres. Such projects have been recommended in other watershed plans as effective, low-impact and low-cost stormwater controls in headwater areas.

The drainage systems within these older neighborhoods consist entirely of closed pipe conduit systems with no opportunity for upstream culvert retrofit projects.

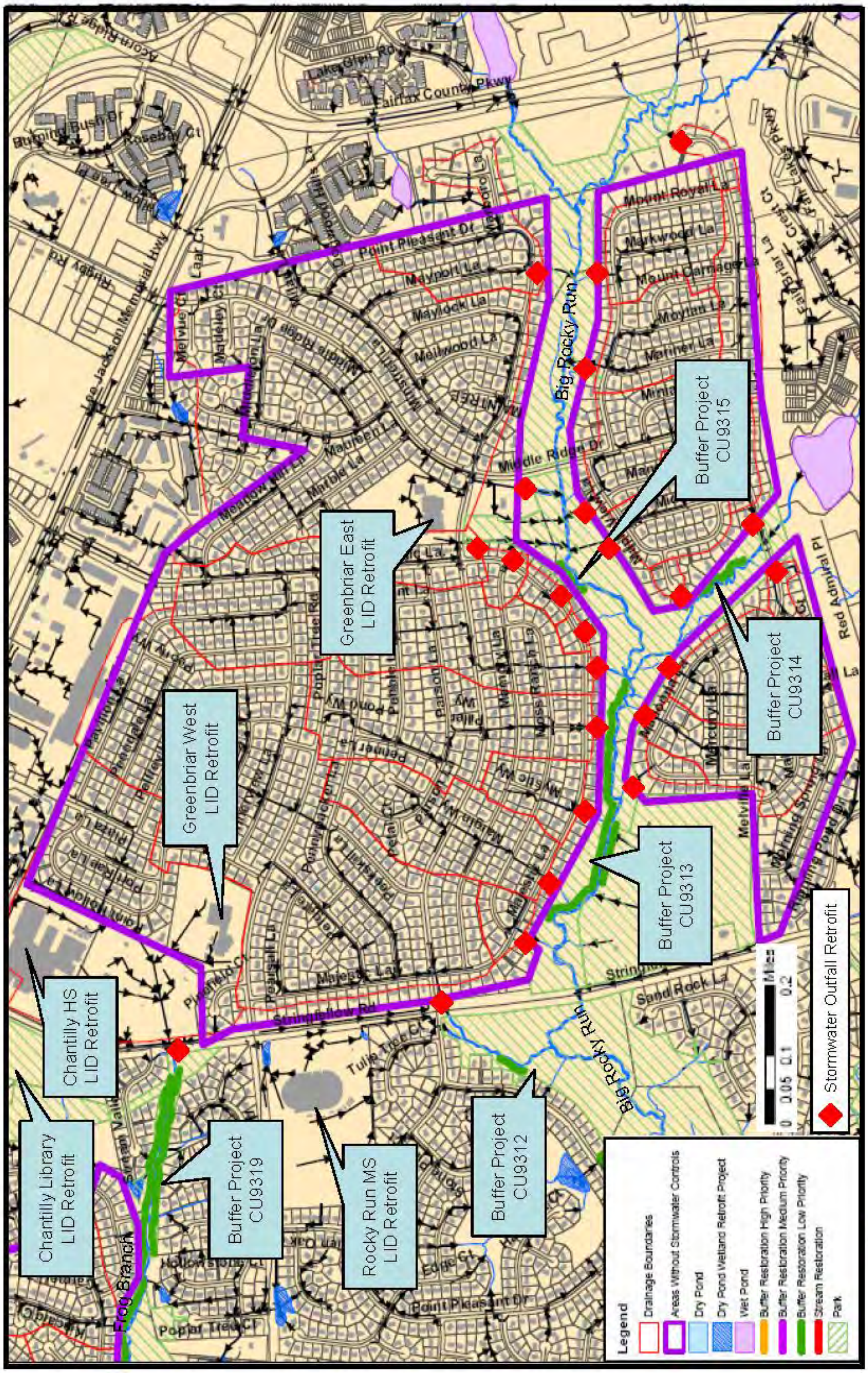


Figure 6-33
Summary of Proposed Stormwater Controls Near Greenbriar and Birch Pond

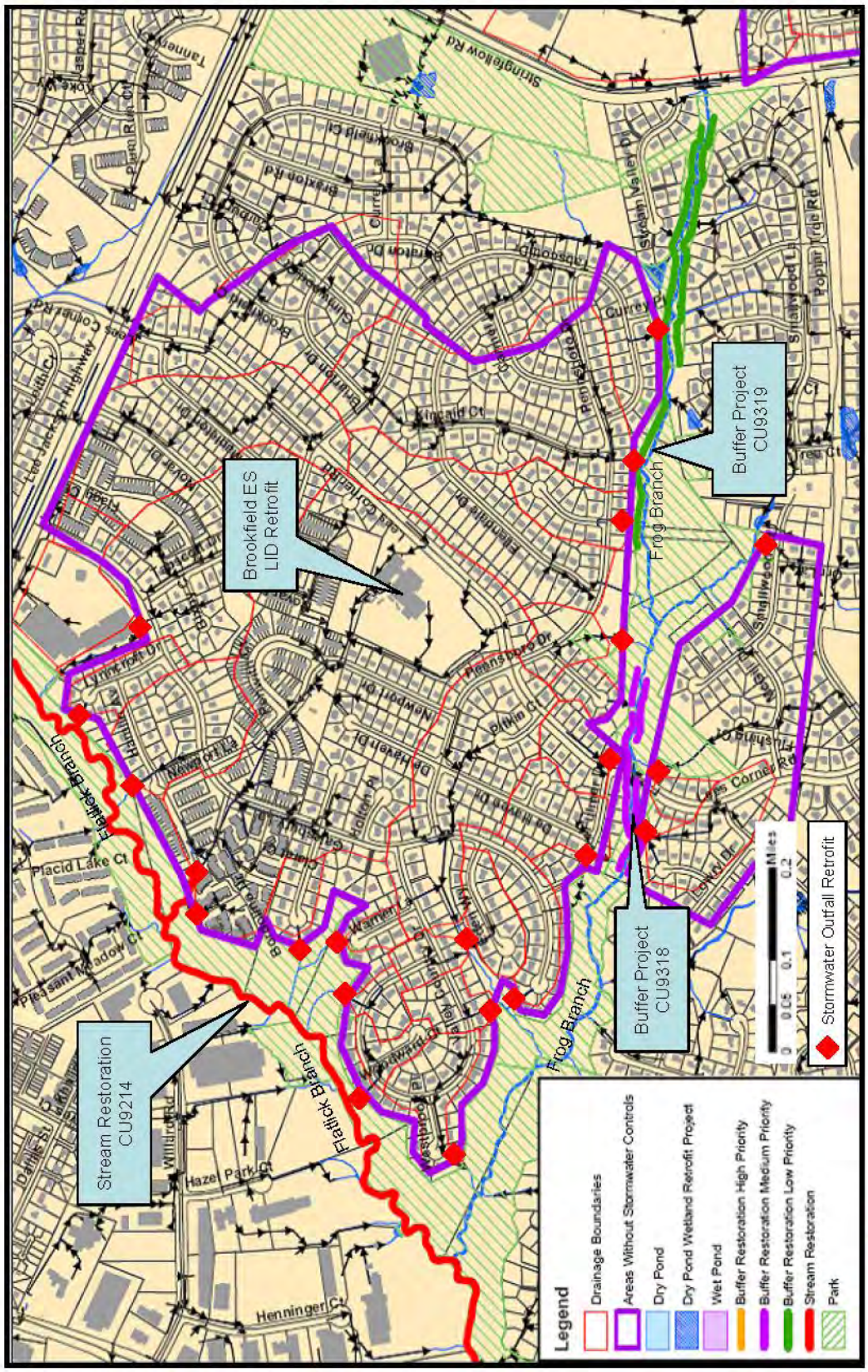


Figure 6-34
Summary of Proposed Stormwater Controls Near Brookfield

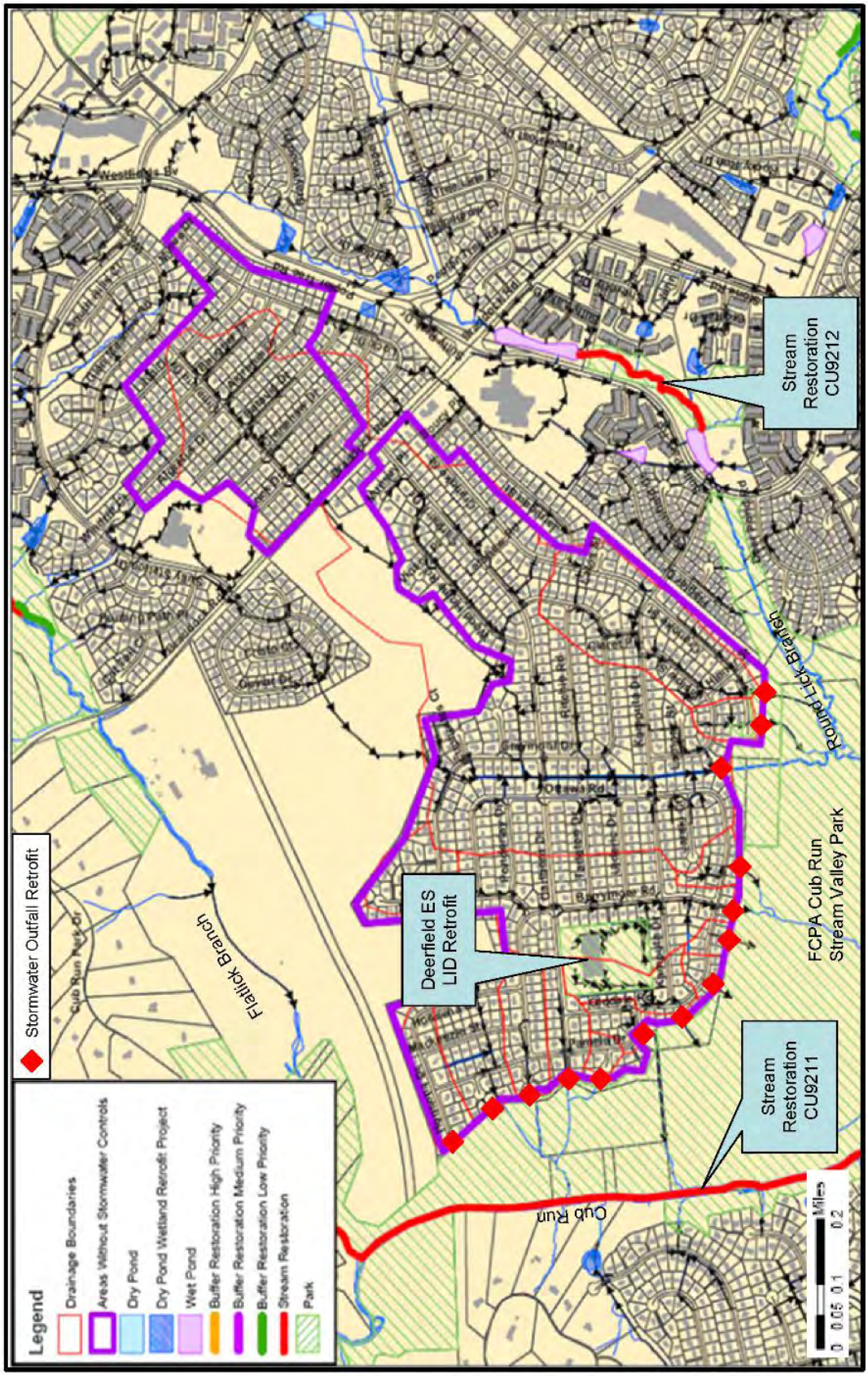


Figure 6-35
Summary of Proposed Stormwater Controls Near Country Club Manor

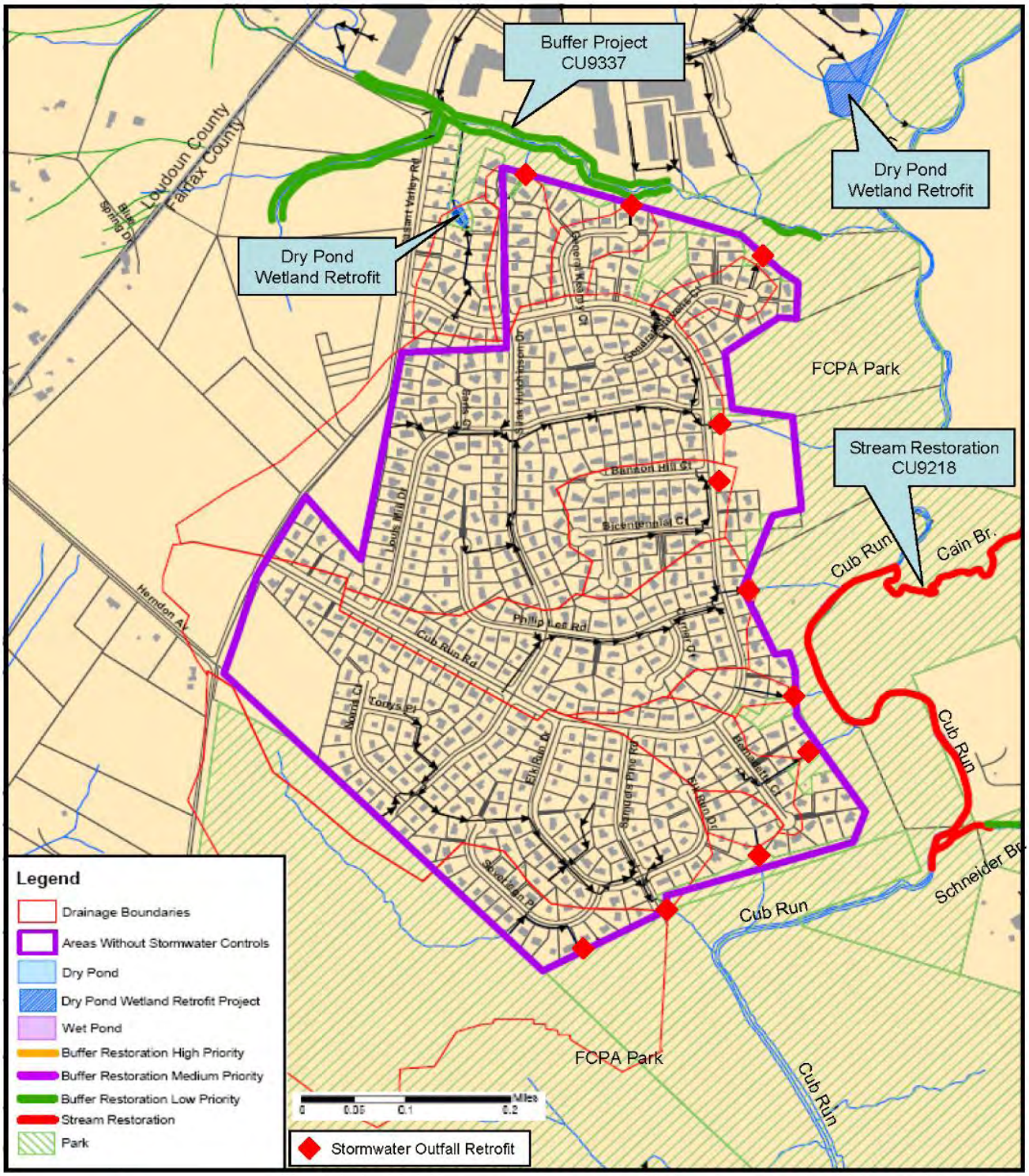


Figure 6-36
Summary of Proposed Stormwater Controls Near Pleasant Valley

Table 6-34
Summary of Stormwater Control Opportunities for
Greenbriar and Birch Pond Neighborhoods

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	5	Greenbriar East Elementary School Greenbriar West Elementary School Chantilly High School Rocky Run Middle School Chantilly Library
Other LID Projects	1	Promote LID for residential, public and commercial areas in each neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	-	No stream restoration projects within or near these neighborhoods.
Buffer Restoration Projects	5	CU9312 – Tributary to Big Rocky Run CU9313 – Big Rocky Run CU9314 – Tributary to Big Rocky Run CU9315 – Big Rocky Run CU9319 – Frog Branch
Stormwater Outfall Mitigation Projects	24	Evaluate and perform rehabilitation and mitigation for 24 stormwater outfalls.

Table 6-35
Summary of Stormwater Control Opportunities for Brookfield Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	1	Brookfield Elementary School
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	1	Project CU9214
Buffer Restoration Projects	2	CU9318 – Frog Branch CU9319 – Frog Branch
Stormwater Outfall Mitigation Projects	22	Evaluate and perform rehabilitation and mitigation for 22 stormwater outfalls that discharge to Frog Branch and Flatlick Branch.

Table 6-36
Summary of Stormwater Control Opportunities for
Country Club Manor Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	1	Deerfield Elementary School
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	2	Project CU9212 – Round Lick Branch Project CU9311 – Cub Run main stem
Buffer Restoration Projects	-	No buffer restoration projects within or near this neighborhood.
Stormwater Outfall Mitigation Projects	14	Evaluate and perform rehabilitation and mitigation for 14 stormwater outfalls.

Table 6-37
Summary of Stormwater Control Opportunities for Pleasant Valley Neighborhood

Stormwater Control Projects	Number of Projects	Description
LID Retrofit at County Facilities	-	No opportunities exist since there are no County facilities in this neighborhood.
Other LID Projects	1	Promote LID for residential, public and commercial areas in the neighborhood.
New Dry Ponds and Wet Ponds	-	No opportunities exist since there is no open area available.
Upstream Culvert Retrofit Projects	-	No opportunities exist within the closed conduit system.
Stream Restoration Projects	1	Project CU9218 – Cub Run
Buffer Restoration Projects	1	Project CU9337
Stormwater Outfall Mitigation Projects	11	Evaluate and perform rehabilitation and mitigation for 11 stormwater outfalls.

Stream Restoration Projects

CDM has identified stream restoration projects that focus on areas with active and ongoing stream bank erosion. Surprisingly, the stream segments with the worst stream erosion are not near the neighborhoods without stormwater controls. The following summarizes the stream conditions within and downstream of these neighborhoods:

Greenbriar and Birch Pond — Closed pipe drainage systems from this neighborhood discharge directly to either Big Rocky Run or Frog Branch.

Big Rocky Run — The stream within and downstream from this neighborhood has no erosion inventory points and high scores for bank stability. The nearest stream restoration project (15) is more than 2.7 miles downstream.

Frog Branch	The stream downstream from this neighborhood has only one erosion inventory point and high scores for bank stability. The nearest stream restoration reach is on Flatlick Branch. Rock found in the beds of Frog Branch and Big Rocky Run provides protection from the flows from these neighborhoods. Also, these neighborhoods have been in place for 30 to 40 years and the streams have had sufficient time to respond to the changed flow regime.
Brookfield	Closed pipe drainage systems from this neighborhood discharge directly to either Frog Branch or Flatlick Branch.
Frog Branch	The stream downstream from this neighborhood has only one erosion inventory point and high scores for bank stability. The nearest stream restoration reach is on Flatlick Branch.
Flatlick Branch	The section of Flatlick Brach near this neighborhood is included in stream restoration project CU9214. This stream has extensive stream erosion inventory data points. It is difficult to say how much of the erosion in this reach is caused by local drainage and how much is caused by the development in the Flatlick Branch watershed upstream from Route 50.
Country Club Manor	The small streams that receive the runoff from this neighborhood flow directly into the lower reaches of Round Lick Branch or the middle Cub Run main stem.
Round Lick Branch	Round Lick Branch shows few erosion inventory points and has high scores for stream bank stability.
Cub Run	The Cub Run main stem is included in stream restoration project CU9211. It is not likely that discharge from Country Club Manor contributes significantly to the erosion in this reach of Cub Run since the drainage area is relatively small compared to the total upstream drainage area for this reach.
Pleasant Valley	The small streams that receive the runoff from this neighborhood flow directly to the upper Cub Run main stem.

Cub Run	A portion of the Cub Run main stem near Pleasant Valley is included in stream restoration project CU9218. The total upstream drainage area for this reach is significantly larger than the drainage area of Pleasant Valley. Therefore, it is unlikely that runoff from Pleasant Valley contributes significantly to the erosion on this segment of Cub Run.

Stream Buffer Restoration

Section 6.7 identifies stream buffer restoration projects where deficient buffers have the greatest impact on the streams. Various stream restoration projects have been identified within and near these neighborhoods that will improve the habitat and stream health. These projects are shown in figures 6-33 through 6-36 and documented in tables 6-34 through 6-37.

Stormwater Outfall Retrofit Projects

The drainage systems for these areas consist primarily of closed conduit systems. Country Club Manor includes portions with concrete-lined trapezoidal ditches. The storm conduits discharge directly to ditches and small streams. These outfalls have not likely been systematically evaluated and maintained since construction 30 to 40 years ago.

Under this action, the existing outfalls will be evaluated and redesigned to reduce their impact on receiving streams, without affecting drainage in these communities. The first step in each project will be to perform a detailed evaluation of each outfall. The goal is to improve the ecological function of the outfalls and nearby streams, maintain and improve the stormwater drainage functions, and improve the overall aesthetics of these outfalls. Potential retrofit opportunities include:

- Velocity dissipaters and flow spreading features to slow the velocity at the outfalls and upon entering the streams. These will typically be rock structures. Figure 6-37 provides an example of the possible improvements. Design of the improvements will depend on site conditions.
- Plunge pools and wetland systems at the outfall locations
- Stream restoration, using bioengineering, to improve and stabilize the streams that receive the flow from these outfalls
- Buffer restoration, including removal of non-native species, creating “no-mow” zones and planting native vegetation.

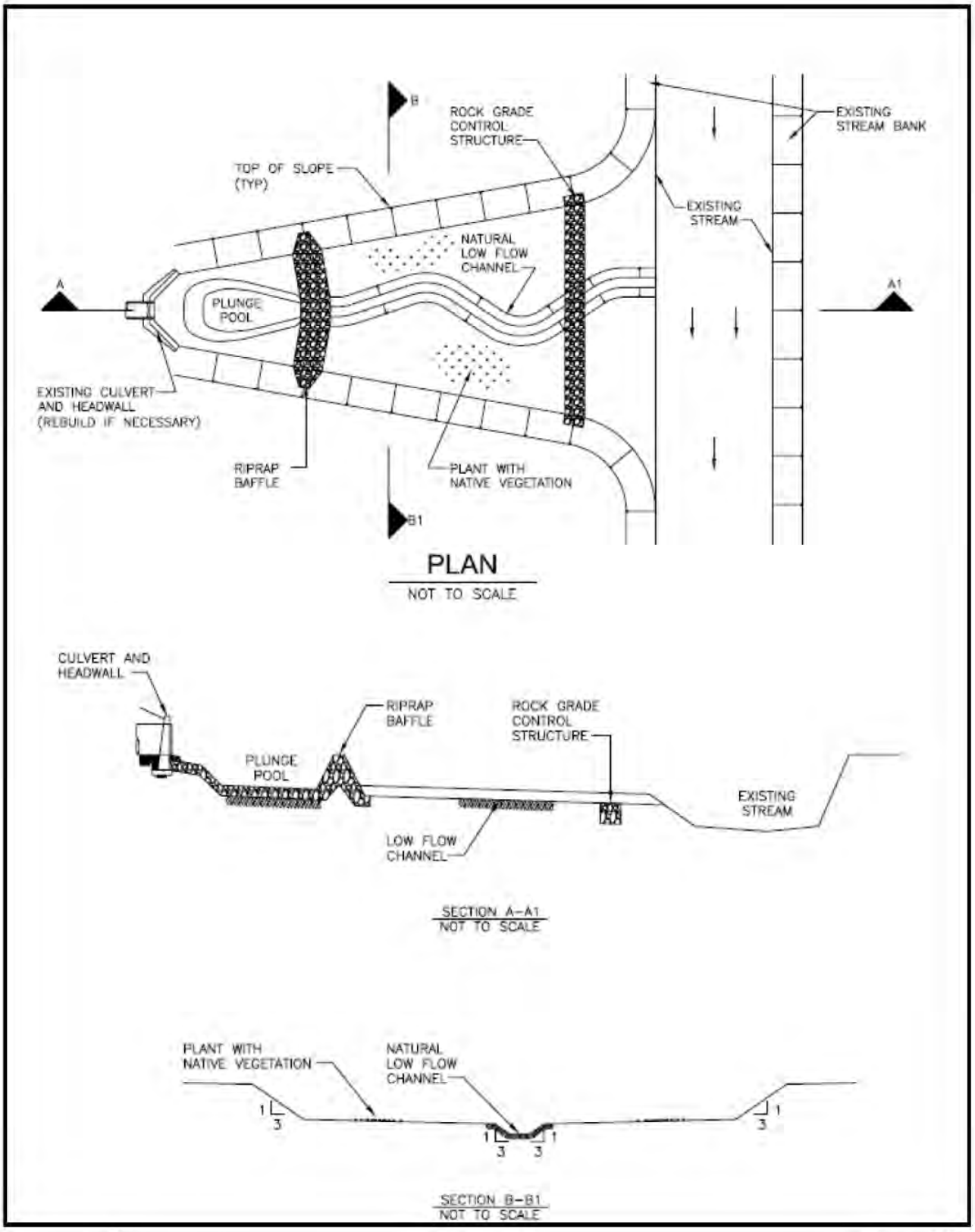


Figure 6-37
Conceptual Retrofit for Uncontrolled Stormwater Outlets

Cost to Implement Action

The costs for the outfall retrofit projects and outreach programs for these four neighborhoods totals $2.7 million. The stream restoration, buffer restoration, LID retrofit and dry pond retrofit projects identified for the four neighborhoods are included as separate projects and not in these costs to avoid double counting.

6.6.3 Watershed Benefits

Addressing the runoff from watershed areas that do not have stormwater controls provides many benefits to the watershed's streams, including:

- Improving the health of the local streams near these neighborhoods
- Reducing nutrient and other pollutant loading from these areas
- Reducing stream erosion near the stormwater outfalls

6.7 Action – Improve Condition of Existing Streams by Implementing Buffer Restoration Projects

6.7.1 Action

Stream buffers or riparian buffers refer to the portion of the stream valley within 100 to 200 feet of the stream banks. A natural unimpaired stream buffer, containing native trees, plants and shrubs, provides valuable stream habitat protection and many other benefits.

In many areas of the Cub Run and Bull Run watersheds, the natural stream buffer vegetation has been damaged or removed by residential and commercial development, lawns, mowed areas, old farm fields and utilities that cross the stream valleys. Buffer restoration projects will restore selected stream reaches to a natural condition and improve the overall health of the streams.

6.7.2 Strategy to Achieve Action

Description of Action

The buffer restoration projects include removing invasive plant species and planting appropriate native trees, shrubs and other plants. Although the width of the restored area depends on local conditions, a restored buffer width of native vegetation for a distance of 100 to 200 feet from perennial stream banks is ideal.

Part of the projects could be coordinated as volunteer efforts with local citizen organizations. Some may be implemented under contact to the county. These projects may involve working with the nearby residents and homeowner associations to create "no mow" zones within the areas to be restored. Signs will be placed in the restored area to educate the public and to ensure that the restored areas are preserved.

The buffer restoration projects are in a variety of land ownership areas, including public parkland, privately owned common areas and other private lands. Buffer

restoration projects on single-family residential, commercial and industrial parcels will not be addressed under this action. County funds will not be used directly to make improvements within private property. However, educational efforts to promote buffer restoration on private property are in the watershed plan's non-structural actions.

Some of the most severely affected buffers in the watershed are mowed right-of-ways for power lines, water lines, natural gas lines, sewer lines and petroleum pipelines. The county must coordinate with these utilities to identify buffer restoration projects compatible with their maintenance and safety needs as well as the watershed plan goals.

Stream Buffer Restoration Projects

The following databases were used to identify the stream buffer restoration projects:

1. The deficient stream buffer inventory line data in the Fairfax County Stream Physical Assessment Tool is the primary database used.

2. Digital aerial orthophotography was used to identify the cause of the impairment and suitability for inclusion in a buffer restoration project.

3. GIS layers of parcel boundaries and Fairfax County Park Authority parkland were used to determine the feasibility of buffer restoration projects within the areas affected.

The stream buffer inventory line data identifies areas where the stream buffers were deficient. These inventory lines include a buffer impact score, with 10 having the highest impact and zero having no impact on the stream system. CDM filtered the stream buffer line inventory data, starting with the deficient buffer with the highest impact scores.

The buffer inventory lines were reviewed as potential restoration projects to be included in this action. The following are not included in this specific watershed plan action:

- Single-family parcels

- Commercial and industrial areas where the impaired buffers are near buildings and parking lots

- Streams adjacent to public roads

In most cases, county funds will not be used to perform buffer restoration on private property. Watershed plan nonstructural actions described in Section 4 promote restoration by the property owners with guidance and support from the county. Stream buffers close to public roads cannot typically be restored due to highway safety concerns.

In addition, deficient buffer inventory lines within the stream restoration projects presented in Section 6.5 were not included since buffer restoration will be part of the proposed stream restoration.

Deficient stream buffer reaches with high impact and potential for buffer restoration were grouped into buffer restoration projects. Reaches with lower-impact scores were included when appropriate. Some buffer restoration reaches identified from the Stream Physical Assessment data included additional areas with deficient buffers. These were identified using aerial photography and additional field surveys.

Studies have shown that a healthy stream buffer efficiently reduces the nutrient loads for the waters that pass through it as sheet flow. Modern drainage systems cause much of the stormwater runoff to bypass the stream buffers, thereby reducing their effectiveness in reducing loads. In most cases, sufficiently spreading flows from existing stormwater systems to take advantage of the nutrient reductions will not be possible without creating excessive flows and velocities that would destroy the stream buffer.

Cost of Action Implementation

This analysis resulted in 43 stream buffer restoration projects that include 54,480 feet (10.3 miles) of deficient stream buffer restored at a total estimated cost of $1.32 million.

These projects are identified in Table 6-38 and Figure 6-38. The order they are presented in this watershed plan does not represent their priority or order of implementation in the final plan. The plan's implementation schedule is presented in Section 7. Table 6-38 also identifies whether the parks are on FCPA parkland or private property.

The stream buffer restoration projects are categorized as high, medium and low priority based on the severity of the impact scores. These rankings provide one of several factors that will be used to develop the implementation schedule and plan for these actions.

6.7.3 Watershed Benefits

The stream buffer restoration projects will improve health in a significant portion of the streams. The improved and healthy stream buffers benefit the watershed as follows:

- Filter runoff from adjacent lands, removing pollutants and sediment delivered to the streams
- Provide natural habitat for plants and animals
- Shade the stream and lower water temperatures
- Provide food for animals living in the streams

Table 6-38
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
BR9301	7	1,270	Tributary in Bull Run West Watershed	Private Property	Fields	$31,000
BR9302	5	310	Tributary in Bull Run West Watershed	Private Property	Utility right of way clearing and mowing	$8,000
BR9303	6	800	Tributary in Bull Run West Watershed	Private Property	Power Line clearing and mowing	$20,000
BR9304	7	220	Tributary in Bull Run West Watershed	Fairfax National Estates	Fields and new construction	$6,000
CU9301	6	820	Cub Run	FCPA Parkland downstream from Big Rocky Run near Route 66 and Gate Post Estates	Power Line mowing and clearing and I-66 embarkment	$20,000
CU9302	5	380	Tributary to Cub Run	Partially in FCPA parkland upstream from T-66. CentreRidge	Mowed areas, lawns and past clearing/ construction	$10,000
CU9303	5	710	Tributary to Big Rocky Run	FCPA parkland and VDOT ROW I-66 /Route 28 interchange	Mowed and cleared areas - road embankment	$17,000
CU9304	5	980	Big Rocky Run	FCPA parkland upstream and downstream from Awbrey Patent Drive	Mowed and cleared areas	$24,000
CU9305	5	700	Big Rocky Run	FCPA parkland downstream from Braddock Road	Mowed and cleared areas	$17,000
CU9306	5	3,820	Tributary to Big Rocky Run	Private property upstream from Braddock Road crossing Cedar Break Drive within Sequoia Farms	Lawns and mowed and cleared areas	$91,000
CU9307	5	1,950	Tributary to Big Rocky Run	Partially in FCPA parkland Elliscott Court downstream from Northbourne Drive	Mowed and cleared areas and lawns	$47,000
CU9308	5	2,420	Tributary to Big Rocky Run	Partially in FCPA parkland downstream from Veronica Road - upstream from regional pond C30	Mowed and cleared areas and lawns	$58,000

Table 6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Ctmmlative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
CU9309	5	*1A60*	Tributary to Big Rocky Run	FCPA parkland upsh·eam from Northbourne Drive and downstream from Stringfellow Road	Mowed areas and new construction	$35,000
CU9310	5	330	Big Rocky Rtm	FCPA parkland downstream from StringfelJow Road	Utility right of way dearing and mowing	$8,000
CU9311	5	270	Tributary to Big Rocky Run	FCPA parkland downstream from Point Pleasant Drive	Lawns and clearing	$7,000
CU9312	5	230	TributaJy to Big Rocky Run	FCPA paJkland downstream from Stril1gfellow Road and Poill1t Pleasant Drive	Lawns and cleaJu1g	$MOO
CU9313	5	2,630	Big Rocky Rtm	FCPA parkland upstream from Stringfellow Road near Greenbriar	Lawn, dearing and trail	$63,000
CU9314	5	700	Tributary to Big Rocky Run	FCPA parkland downstream from Melville Lane	Lawns and clearing	$17,000
CU9315	5	330	Big Rocky Run	*FCPA* parkland downstream from Middle Ridge Drive	Lawns and clearing	$8,000
CU9316	5	3,550	Tributary to Middle Cub Rtm	Partially in FCPA parkland in Virginia Rtm- Downstream hom Pleasant VaLley Rd.	Mowed areas and clearing	$85,000
CU9317	5	400	Flatlick Branch	FCPA parkland upsheam from Braddock Road	Mowing, cleared areas and trail	$10,000
CU9318	6	2,070	Frog Branch	*PCP*A Parkland at Lees Corner Road	Mowed areas and nearby development	$50,000
CU9319	5	4,030	Frog Branch	FCPA Parkland downsheam from StringfelJow Road	Lawns and clearing	$96,000
CU9320	8	1,350	Flatlick Branch	Private property upsh·eamfrom Route 50 and downstream from Lees Corner Road	Mowed areas, clearing and nearby development	$33,000

Table 6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
CU9321	5	430	Oxlick Branch	FCPA parkland downstream from Stringfellow Road near Brandy Station Road.	Natural gas line mowing and clearing	$11,000
CU9322	8	430	Oxlick Branch	Downstream from Shingfellow Road	Mowed areas, clearing and utility construction	$11,000
CU9323	5	110	Oxlick Brandl	Private property downstream from Fairfax County Parkway near Freehill Lane	Lawns and clearing	$3,000
CU9324	7	380	Flatlick Branch	Private property upstream from Lees Corner Road	Utility right of way mowing and clearing	$10,000
CU9325	5	990	Flatlick Branch	Private property downstream from Fairfax County Parkway	Mowed and cleared areas and nearby development	$24,000
CU9326	7	860	Flatlick Branch tributary	Private property adjacent to Fairfax COtmty Prukway upstream from Tuckaway Drive	Mowed areas, clearing and road construction	$21,000
CU9327	7	840	Flatlick Branch	Private property upstream from Fairfax County Parkway and downstream from Thompson Road	Mowed areas and clearing	$20,000
CU9328	7	660	Flatlick Branch	Private property upstream from Thompson Road	Natural gas line mowing and clearing	$16,000
CU9329	8	2,000	Flatlick Branch tributruy	Private property within Franklin Manor near Rose Grove Drive	New construction	$48,000
CU9330	7	1,350	Unnamed Tributruy to Elklick Run	FCPA prukland neru·Pleasant Valley Road north of Elklick Run	Field and cleared rueas	$33,000
CU9331	8	720	Unnamed Tributary to Elklick Run	FCPA parkland adjacent to Pleasant Valley Road soutl1 of Elklick Rtm	Roadway	$18,000
CU9332	6	250	Cub Rtm	FCPA parkland at Old Lee Road	Roadway	$6,000

Table 6-38
(continued)
Summary of Stream Buffer Restoration Projects

Project Number	Average Impact Score	Cumulative Length of Deficient Buffer (Left and Right Bank) (Feet)	Stream	Location	Type of Stream Impact	Project Cost
CU9333	5	1,160	Schneider Branch	FCPA parkland upstream from Cub Run and downstream from Stonecroft Boulevard	Fields and clearing	$28,000
CU9334	5	1,060	Cain Branch Tributary	Private property downstream from CenheviUe Road	Fields and nearby development	$26,000
CU9335	8	1,680	Cain Branch	Private property upsh·eam from Centreville Road and downstream from Lees Corner Road	Nearby development	$40,000
CU9336	6	1,290	Cain Branch	Private property upstream from Lees Corner Road	Nearby development and mowed areas	$31,000
CU9337	5	6,160	Cub Run Tributary	Pleasant Valley neighborhood - Half of project is in FCPA parkland	Mowed areas and fields	$147,000
CU9338	5	1,140	DeadRtm	Private property at Stonecroft Boulevard	Nearby construction	$28,000
CU9339	5	1,240	DeadRLm	Private property upstream from Stonecroft Boulevard	New construction	$30,000
Totals		54,480				$1,318,000

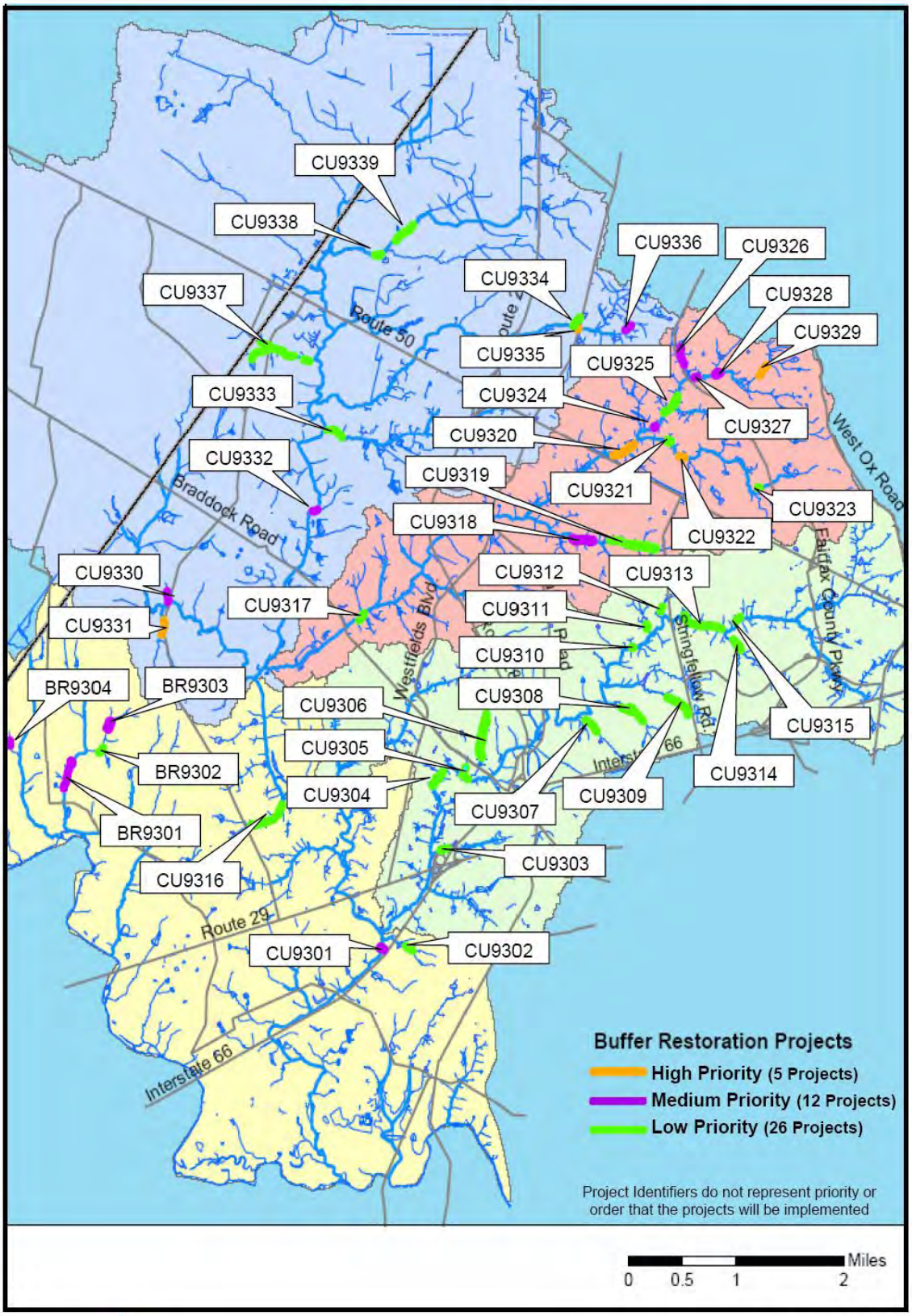


Figure 6-38
Location of Buffer Restoration Projects

- Reduce stream erosion by slowing overbank flow velocity during floods. Roots in a healthy stream buffer hold the soil together further reducing erosion
- Improve function of the riparian wetlands within the stream buffer
- Meet other county environmental goals by increasing forest cover and connecting habitat corridors

6.8 Action – Replace and Upgrade Road Crossings to Eliminate Flooding

6.8.1 Action

Several culverts and bridges do not have capacity to convey flows from the upstream watershed during storms. These undersized culverts and bridges produce frequent roadway flooding.

6.8.2 Strategy to Achieve Action

Culverts and bridges at identified locations are recommended for replacement to provide sufficient capacity to accommodate frequently occurring flood flows. These locations have been identified from various sources, including previous stormwater planning studies, flooding memorandums, the public and watershed modeling.

Table 6-39 lists the locations where the existing culvert and bridges do not have sufficient capacity to prevent frequent flooding. Figure 6-39 shows these locations.

Unless they are producing severe impacts, these projects will not be implemented using Fairfax County stormwater funds. The roads are maintained by the Virginia Department of Transportation, and these improvements will be implemented during roadway improvement projects.

6.8.3 Watershed Benefit

These projects reduce the frequency of roadway flooding and the potential safety concerns, economic impacts and damage.

Upgrading the roadway crossings will eliminate frequent roadway flooding. Such flooding presents a safety hazard to those who attempt to cross the streams during high-water conditions. Severe flooding can prevent emergency vehicles from responding.

In addition to adverse effects on traffic flow, undersized culverts can affect streams by increasing flow velocities and preventing fish passage.

Figure 6-39
Road Culvert and Bridge Replacement Projects

Table 6-39
Summary of Road Culvert and Bridge Replacement Projects

Project ID	Project Location
1 - CU9610	Birch Drive at unnamed tributary to Flatlick Branch - Flatlick Branch Subwatershed
2 - CU9601	Compton Road at unnamed tributary near UOSA advanced wastewater treatment plant – Bull Run East Subwatershed
3 - CU9606	Heron Drive at unnamed tributary between Cabells Mill Drive and Walney Road – Big Rocky Run Subwatershed
4 - CU9608	Dorforth Drive at unnamed tributary – Big Rocky Run Subwatershed (aerial photography suggests that this crossing has been abandoned).
5 - CU9613	Cain Branch at Lees Corner Road – Upper Cub Run Subwatershed
6 - CU9603	Compton Road at unnamed tributary east of Bull Run Post Office Road – Lower Cub Run Subwatershed
7 - CU9609	Flatlick Branch at Walney Road – Flatlick Branch Subwatershed
8 - CU9611	Cub Run at Braddock Road and Old Lee Road – Upper Cub Run Subwatershed
9 - CU9607	Big Rocky Run at Stringfellow Road – Big Rocky Run Subwatershed
10 - CU9602	Compton Road at unnamed tributary near Confederate Ridge Lane – Bull Run East Subwatershed
11 - CU9604	Compton Road at unnamed tributary west of Route 66 – Lower Cub Run Subwatershed
12 – BR9601	Bull Run Post Office Road at unnamed tributary (easternmost of three crossings) – Bull Run West Subwatershed
13 – BR9602	Bull Run Post Office Road at unnamed tributary (middle of three crossings) – Bull Run West Subwatershed
14 – BR9603	Bull Run Post Office Road at unnamed tributary (westernmost of three crossings) – Bull Run West Subwatershed
15 - CU9612	Pleasant Valley Road at unnamed tributary near Blue Spring Drive
16 - CU9605	Awbrey Patent Drive at Big Rocky Run

6.9 Other Structural Actions

6.9.1 Evaluate and Retrofit Existing Headwater Drainage Systems

Action

The county will analyze the conveyance of stormwater from older communities to identify problems and solutions. Drainage systems in the headwaters of Cain Branch, Flatlick Branch, Oxlick Branch and Big Rocky Run (primarily north of Route 50) generally have little topographic relief. In some cases, the existing drainage ditches have silted in and no longer have sufficient conveyance capacity. These systems will be cleaned out and maintained to ensure adequate capacity for preventing flooding and stream erosion.

In some headwater areas of the watershed, stormwater outfalls from curb-and-gutter drainage systems discharge directly to streams with little or no attenuation. Prior to development, rainfall runoff from these small drainage areas was delivered to the streams as diffuse sheet flow. The curb and gutter systems concentrate flow from these areas into ditches that are eroding the stream valleys and creating new drainage ditches. These stormwater outfalls will be evaluated and improvements made to reduce their impact on the stream valley. Improvements may include velocity dissipaters, flow spreading devices, stream restoration and buffer restoration.

The evaluation process will also identify opportunities to implement rain gardens or manufactured bioretention devices to control runoff from privately maintained areas such as swim clubs, tennis clubs, etc.

Most of these problems exist on private property owned by individuals or open space associated with homeowner associations, condominiums, town house communities and apartments.

Strategy to Achieve Action

This is a diffuse problem within small drainage systems that have not previously been evaluated by the county. The county will work with homeowner associations and open space committees in the targeted areas of the watershed to review drainage conditions and develop plans to improve the drainage in these neighborhoods. This action will be performed with public outreach associated with other structural actions. Typically, county funds will not be used to implement projects within private property unless the improvement produces documented watershed benefits. Opportunities will be sought to share the costs to implement improvements that significantly benefit the watershed.

Project CU9914 includes these upland drainage improvement projects. A cost of $3,000,000 is applied for these improvements over the 25 year watershed plan for an average annual budget of $120,000.

Watershed Benefits

These improvements in headwater areas will reduce flooding, stream erosion and sediment transport, making the streams healthier. These projects address stormwater

issues at their source. Erosion in these headwater areas introduces sediment into the streams.

6.9.2 Riparian Wetland Improvement Projects

Action

Riparian wetlands in the Cub Run and Bull Run watersheds have been degraded by development, past use and stream erosion. Riparian wetlands refer to wetlands within the stream valleys near the streams. As the streams down-cut, the frequency of inundation of the riparian wetlands decreases. This negatively affects the wetlands' natural functions.

In areas that have caused the streams to down-cut, raising the streambed reconnects the streams with the neighboring floodplains. This action increases the inundation frequency to support a healthy wetland habitat but does not increase the flooding for larger events. Frequent inundation that approximates natural conditions supports the growth of native wetland species and suppresses undesirable species. The inundation also promotes infiltration into the shallow groundwater system. The slow velocities within the overbank floodplain reduce sediment and nutrient loads, and the nutrients are available for wetland plant growth. The floodplain storage decreases peak flows and velocities in downstream segments.

The large areas of stream valley parks, Resource Protection Areas and other protected stream valleys provide many possible ideal sites for such restoration.

Stream restoration projects described in Section 6.5 include actions to raise the stream bed and reconnect the wetlands with the streams. However, there may be options to further improve the functions of the wetlands near these stream restoration projects and to include restoration of other wetland areas not associated with stream restoration.

The watershed plan recommends implementing stream and wetland mitigation projects within the same watershed at a location close to the disturbance. Having wetland improvement projects identified within the Cub Run watershed would help to make this recommendation a reality. This action also potentially reduces the watershed implementation costs to Fairfax County by sharing costs with the developers of projects that require wetland mitigation.

The wetlands within the Cub Run watershed are typically forested. Such wetlands usually will not attract large flocks of waterfowl as an open marsh would. Therefore, this type of wetland mitigation is not a safety concern for nearby Dulles International Airport.

Strategy to Achieve Action

Wetlands in the watershed will be identified and evaluated for restoration and mitigation. Detailed wetland evaluation was not performed within this watershed plan's scope of services. Although the entire watershed should be evaluated, the following five areas should be considered for potential wetland restoration:

- Cub Run mainstem upstream from Route 50. This area of forested marsh and wetlands may be suitable for restoration. The surrounding area is mostly undeveloped. This stream receives flows directly from Dulles International Airport, and therefore a wetland would be ideal for mitigating wetland loss from past and future airport development. This area is within private property but is not developable due to its location within the RPA and 100-year floodplain. Because this area is close to the airport flight paths, wetland projects will avoid attracting waterfowl.

- Unnamed tributary to Elklick Run – This area of forested mash and wetland has many beaver ponds and is within FCPA Sully Woodlands Parkland. It is downstream from a portion of Loudoun County and therefore would further reduce peak flows and pollutant loads from this development. Proposed regional pond C37 is within this area. FCPA has indicated wetland restoration may be appropriate for this area and is consistent with the parkland development plans.

- Cub Run mainstem between Route 50 and Braddock Road. This area is partially parkland and partially private property. Wetland restoration would need be sensitive to Pleasant Valley residents and other adjacent property owners.

- Cub Run mainstem between Big Rocky Run and Route 29. This area of the FCPA Cub Run Stream Valley Park contains forested wetlands within the RPA and 100-year floodplain that may be candidates for restoration.

- Cub Run mainstem below Route 66. The stream valley within the NVRPA Bull Run Regional Park contains forested wetlands within the 100-year floodplain and RPA that may be candidates for restoration.

A cost of $100,000 is applied to perform this study as watershed plan project CU9915.

Watershed Benefits

Restoring natural wetlands within the Cub Run and Bull Run watersheds provides a variety of watershed benefits, including:

- Restoring and protecting functions of natural wetland systems

- Providing habitat for plants and animals that depend on wetland systems

- Reducing sediment and nutrient loads

- Increasing infiltration and replenish groundwater systems

- Reducing peak flows and velocities in downstream segments

6.10 Status Pro Rata Share Master Plan for Flood Control and Drainage Projects

Section 2.5.5 documented the projects in the Fairfax County Master Plan for Flood Control and Drainage Pro-Rata Share Projects. Table 6-40 lists the projects in the Master Plan and documents their updated status based on the evaluations performed in the Cub Run and Bull Run Watershed Management Plan. The status of the regional ponds included in the Pro-Rata Share Projects is described in Section 6.2.

The Master Drainage Plan had 23 projects that include stream restoration, stream stabilization and/or stream bank stabilization. The following provides an overview of the status of these projects in the Cub Run watershed plan:

- Thirteen of these stream stabilization projects are in stream restoration projects identified in Section 6.5.

- Seven of the stream stabilization projects are in buffer restoration projects identified in Section 6.7. Analysis and review of the stream segment and stream condition assessment data show that stream stabilization is not required though the buffers were deficient.

- Three of the stream stabilization projects are deleted. Analysis and review of the stream segment and stream condition assessment data show that stream stabilization is not required.

The Master Drainage Plan includes 11 road culvert and bridge replacement projects: five in the Bull Run watershed and six in the Cub Run watershed. The following three are not included in the Cub Run and Bull Run watershed plan:

- BR411 was completed when Sudley Road was improved.

- BR422 is on a small tributary that was not evaluated.

- CU551 was not included. Modeling indicates this bridge floods for the 10-year event.

The remaining projects are included in the watershed plan.

Table 6-40
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
BR401	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9603
BR411	Raise Road and Replace Culvert	Tributary to Bull Run	Sudley Road	Completed. This improvement was completed as part of improvements to Sudley Road
BR421	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9602
BR422	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Not included in the watershed plan. This small tributary was not evaluated in the watershed plan. Further analysis is required before deletion could be recommended.
BR621	Raise Road and Replace Culvert	Tributary to Bull Run	Bull Run Post Office Road	Road culvert and bridge replacement project BR9601
CU201, CU202 and CU9203	Stream Restoration and Stabilization	Lower Cub Run	Bull Run Regional Park	Included in stream restoration project CU9201
CU211	Stream Bank Stabilization	Lower Cub Run	Between Compton Road and Route 66	Included in stream restoration project CU9202
CU221	Stream Stabilization	Lower Big Rocky Run	Between Route 29 and Cub Run	Included in stream restoration project CU9203

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
CU222	Stream Stabilization	Big Rocky Run	Between Braddock Road and Route 29	Included as stream restoration project CU9205.
CU223	Stream Stabilization	Big Rocky Run	Between Braddock Road and Route 29	Include in buffer restoration project CU9304. Analysis of stream shows that stabilization is not required.
CU224	Stream Stabilization	Big Rocky Run	Below Braddock Road	Included in buffer restoration project CU9305. Analysis of stream shows that stabilization is not required.
CU225	Stream Stabilization	Tributary to Big Rocky Run	Near The Meadows upstream from Route 66	Included as stream restoration project CU9204
CU241	Stream Stabilization	Big Rocky Run	Upstream from Stringfellow Road	Included in buffer restoration project CU9313. Analysis of stream shows that stabilization is not required.
CU251	Stream Stabilization	Big Rocky Run Tributary	Downstream from Fairfax County Parkway	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU271 CU272, CU273, CU281, CU282 and CU283	Stream Stabilization	Flatlick Branch	Between Route 50 and Route 28	Included as stream restoration project CU9214

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
CU274	Stream Stabilization	Frog Branch	At Lees Corner Road	Included in buffer restoration project CU9318. Analysis of stream shows that stabilization is not required.
CU284	Stream Stabilization	Flatlick Branch	Downstream from Lees Corner Road	Included in buffer restoration project CU9320. Analysis of stream shows that stabilization is not required.
CU291	Stream Stabilization	Flatlick Branch	Upstream from Lees Corner Road	Included in buffer restoration projects CU9324 and CU9325. Analysis of stream shows that stabilization is not required.
CU331	Stream bank Stabilization	Cub Run	At Old Lee Road	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU351	Stream Stabilization	Cain Branch	Downstream from Route 50	Recommended for deletion. Analysis of stream shows that stabilization is not required.
CU381	Stream Stabilization	Dead Run	Downstream from Stonecroft Boulevard	Included in buffer restoration projects CU9338 and CU9339 and stream restoration project CU9221
CU401	Raise Road and Replace Culvert	Lower Cub Run Tributary	Compton Road (Western Crossing)	Road culvert and bridge replacement Project CU9602
CU411	Raise Road and Replace Culvert	Lower Cub Run Tributary	Compton Road at UOSA Plant	Road culvert and bridge replacement project CU9603

Table 6-40
(continued)
Status of Master Plan for Flood Control and Drainage Pro-Rata Share Projects
in the Bull Run and Cub Run Watersheds

Pro-Rata Project Number	Type of Project	Stream	Location	Status in Cub Run Watershed Plan
CU421	Replace Culvert	Big Rock Run Tributary	Heron Drive	Road culvert and bridge replacement project CU9606
CU451	Replace Culvert	Big Rock Run	Dorforth Drive	Road culvert and bridge replacement project CU9608
CU481	Replace Culvert	Flatlick Branch Tributary	Birch Drive	Road culvert and bridge replacement project CU9610
CU551	Replace Culvert	Flatlick Branch	Lees Corner Road	Not in plan. Modeling shows it floods for 10-year event; therefore, it should not be deleted without further investigation.

Note: The status of the Pro-Rata Project Master Plan regional ponds is documented in Table 6-1

6.11 Summary of Projects by Subwatershed

Figures 6-40 through 6-46 and tables 6-41 through 6-47 present the structural projects for the following major subwatersheds:

- Upper Cub Run, including Dead Run, Sand Branch, Cain Branch, Schneider Branch and Cub Run
- Elklick Run
- Flatlick Branch
- Big Rocky Run and Round Lick Branch
- Lower Cub Run
- Bull Run East
- Bull Run West

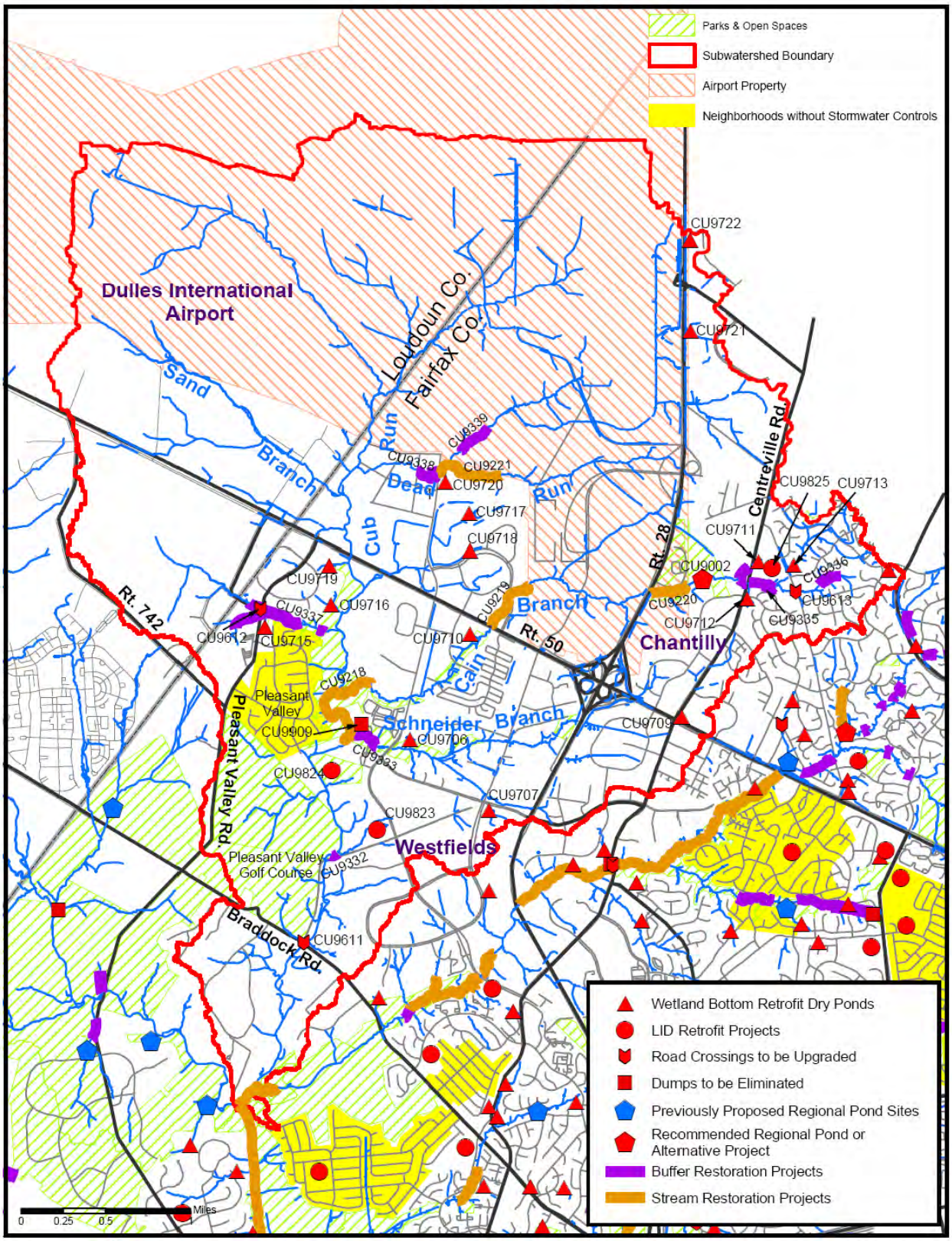


Figure 6-40
Structural Projects in the Upper Cub Run Subwatershed

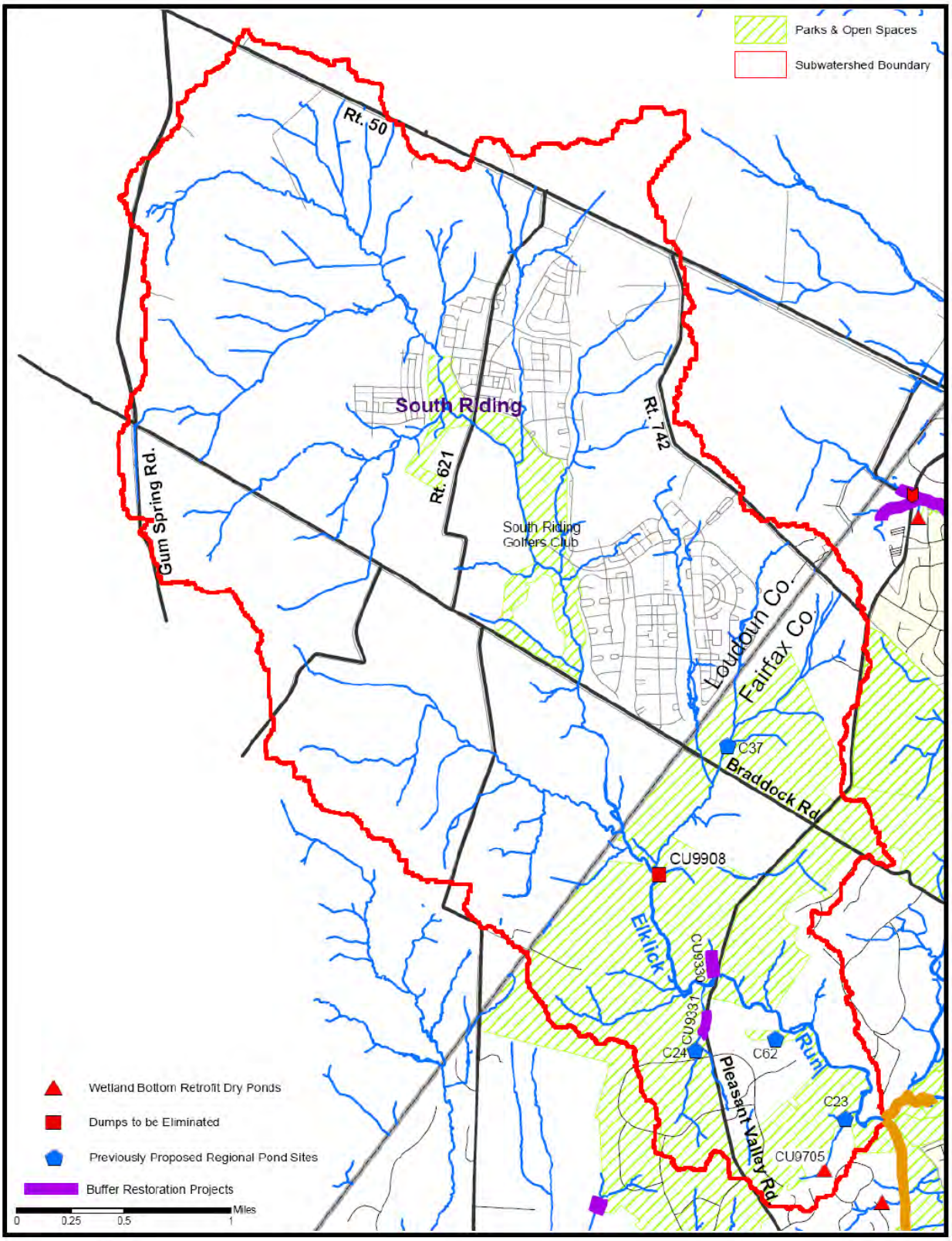


Figure 6-41
Structural Projects in the Elklick Run Subwatershed

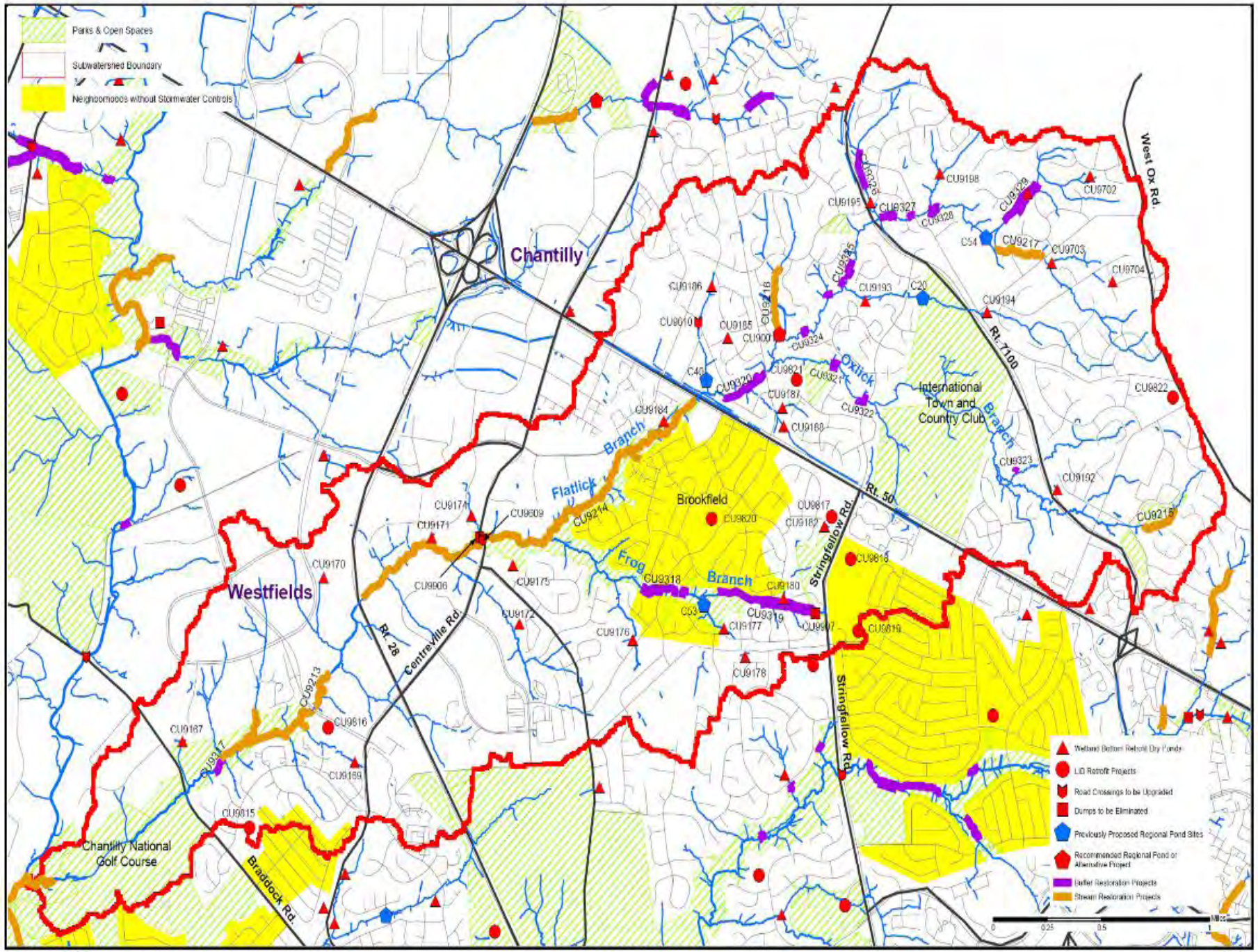


Figure 6-42
Structural Projects in the Flatlick Branch Subwatershed

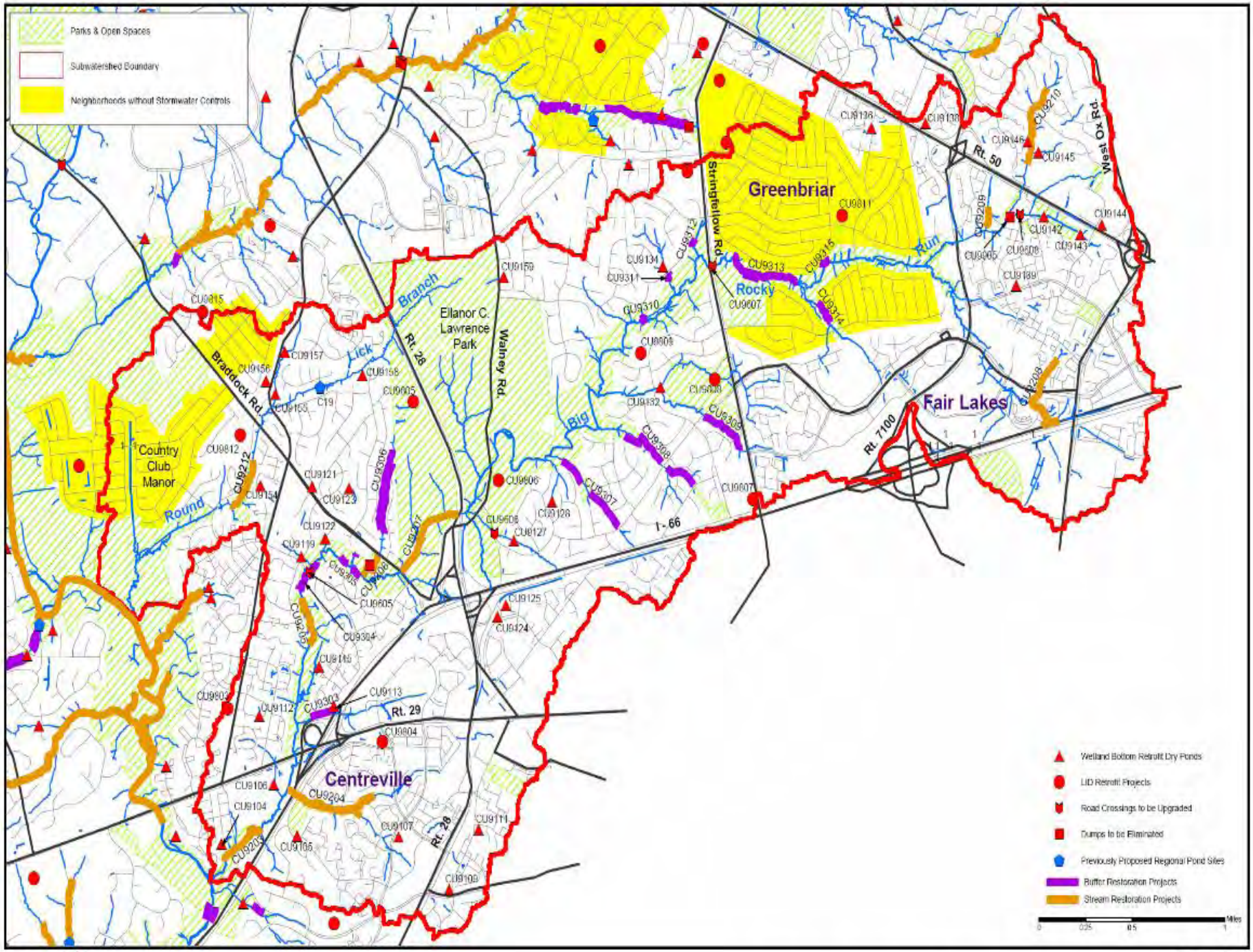


Figure 6-43
Structural Projects in the Big Rocky Run and Roundlick Branch Subwatersheds

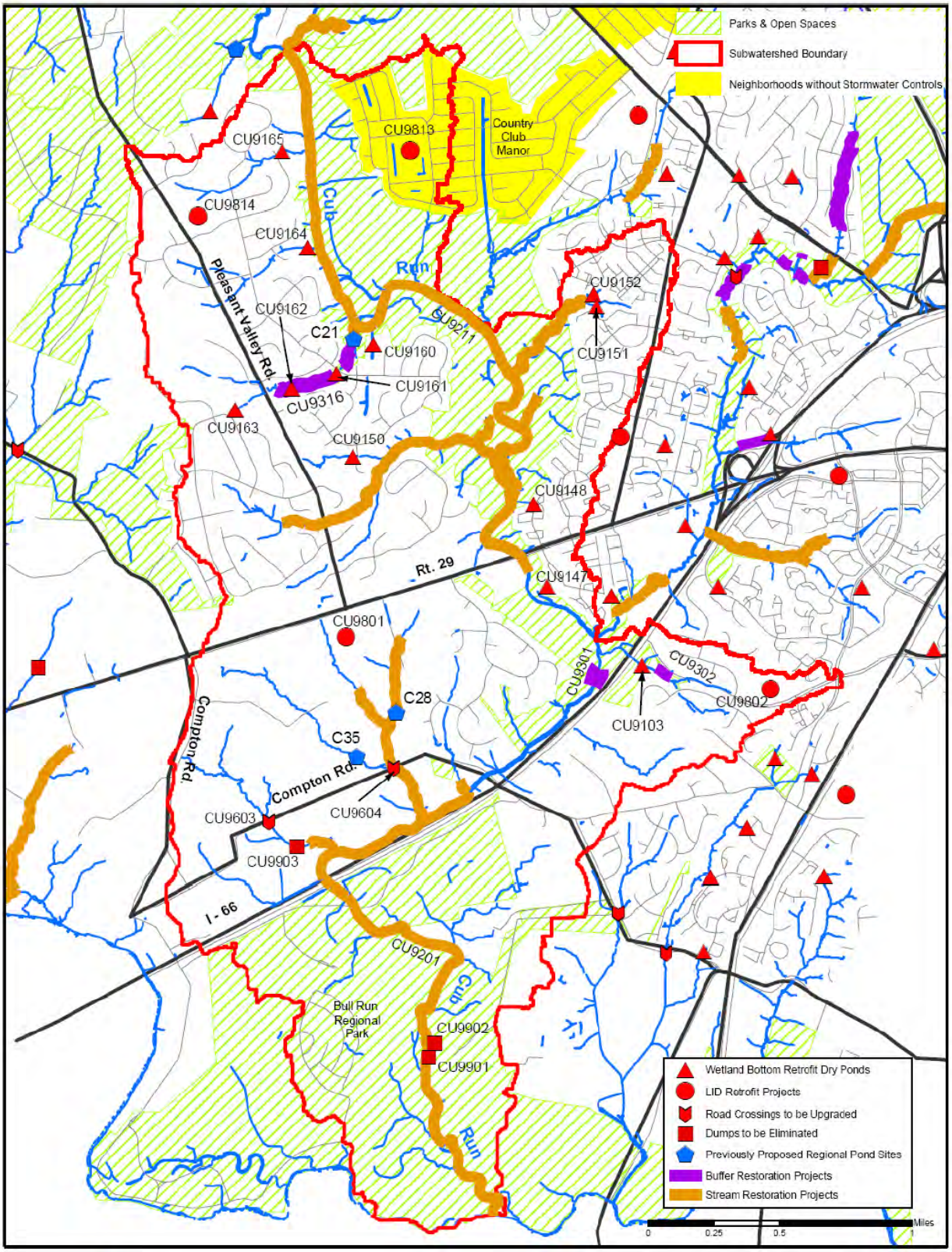


Figure 6-44
Structural Projects in the Lower Cub Run Subwatershed

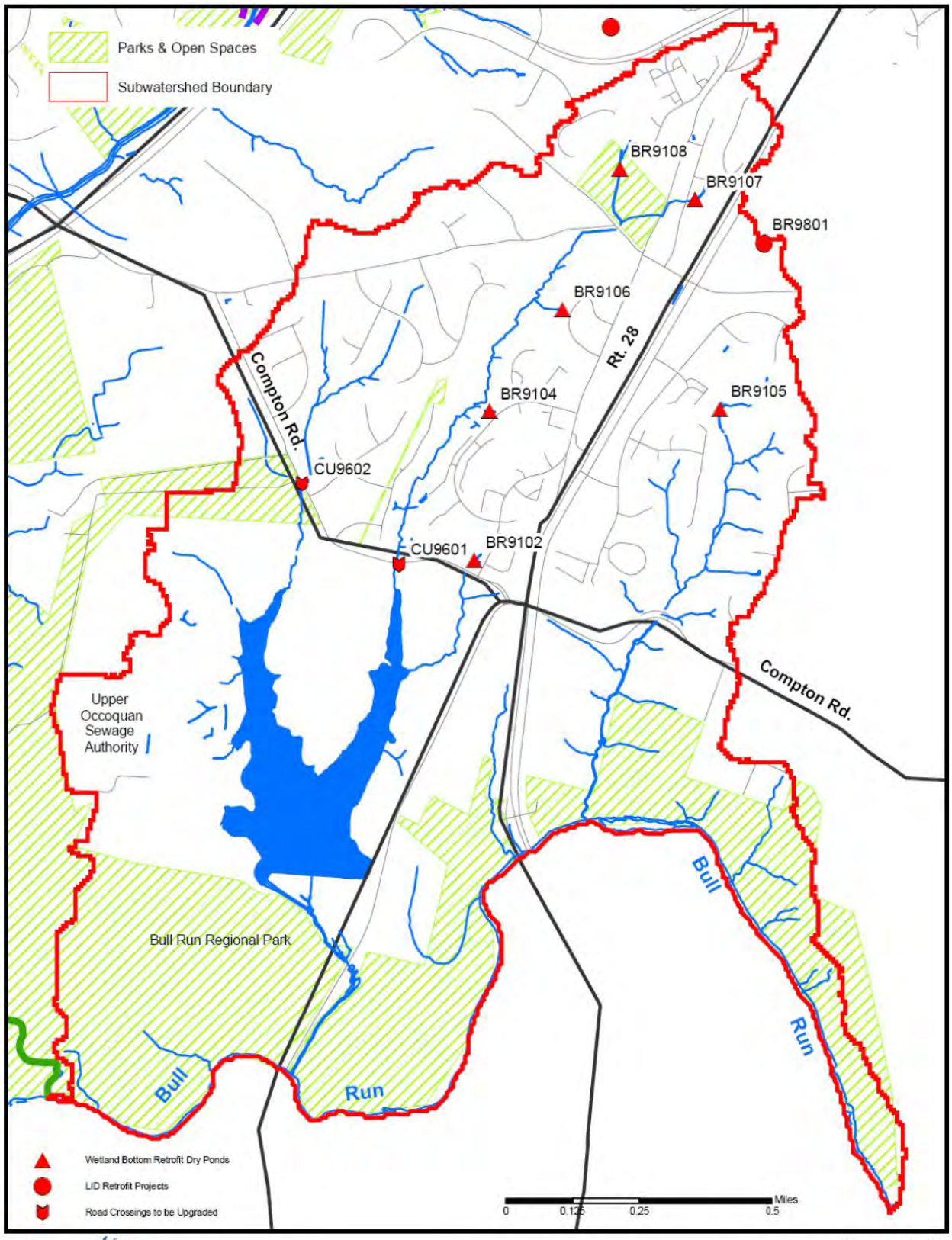


Figure 6-45
Structural Projects in the Bull Run East Subwatershed

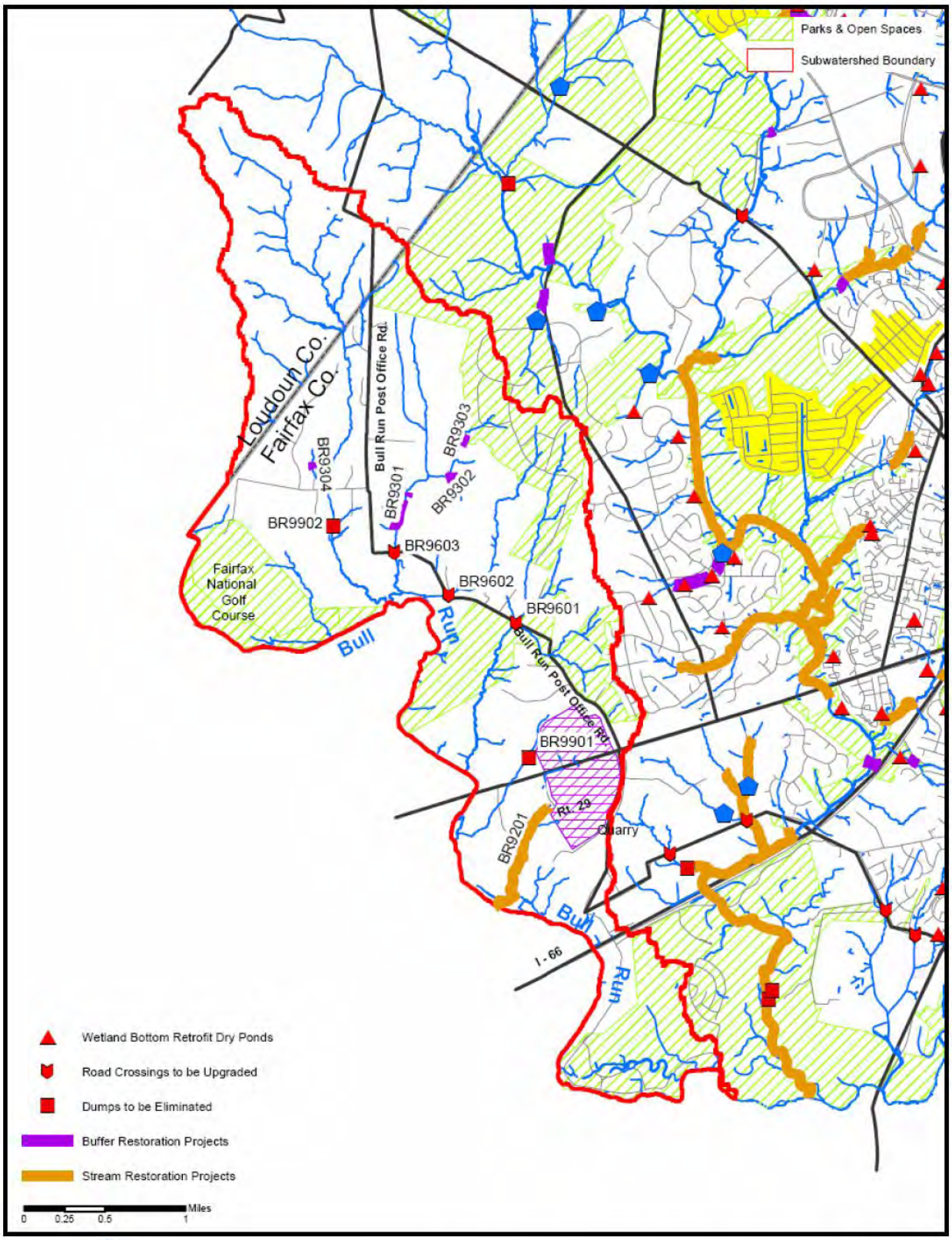


Figure 6-46
Structural Projects in the Bull Run West Subwatershed

Table 6-41
Sununary of Structural Projects in the Upper Cub Run Subwatershed

Struchual Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetland Bottom Retrofit Dry Ponds	16		CU9706, CU9707, CU9709, CU9710, CU9711, CU9712, CU9713, CU9714, CU9715, CU9716, CU9717, CU9'718, CU9719, CU9720, CU9721, CU9722	412 Acres
LID Retrofit Projects	3	CU9823 CU9824 CU9825	Westfield High School Cub Rtm Recreation Center Franklin Midclle School	3.6 ACL'es
Road Crossing to be Upgraded	3	CU9611 CU9612 CU9613	Braddock Road and Old Lee Road at Cub Run Pleasant Valley Rd at Lmnamed tributary near Blue Spring Dr. Cain Brrutch at Lees Corner Road	
Du mps to be Eliminated	1	CU9909	Debris and dumping at Upper Cub Run Wastewater Treatment Plant site	
Proposed Regional Pond or Alternative Project	1	CU9902	Regional Pond C18 or alternative storm water conhols	4 16 acres
Neighborhoods without Stormwater Controls	1	CU9913	Pleasant Valley	193 Acres
Bttffer Restoration Projects	8	CU9335	Cain Brru1ch - Downstream from Centerville Rd.	1,680 Feet
		CU9336	Unnamed Tributary to Elklick Run Near Pleasant Valley Rd.	1,290 Feet
		CU9332	Cub Rtm at Old Lee Rd.	250 Feet
		CU9339	Dead Run upsh:earn Fwm Stonecroft Blvd.	1,240 Feet
		CU9338	Dead Run at Stonecroft Blvd.	1,140 Feet
		CU9337	Tributary to Cub Run Pleasant Valley Neighborhood	6,160 Feet
		CU9333	Schneider Branch Upstream from Cub Rw1	1,160 Feet
		CU9334	Tributary to Cai_n Branch at Centerville Rd.	1,060 Feet
Total				*13,080 Feet*
Stream Restoration Projects	5	CU9221	Tributary to Dead Run. upstream from Stonecroft Blvd.	2,540 Feet
		CU9218	Cub Run, Sdmeider Brandl, and Cain Brru1d1	4,660 Feet
		CU9219	Cain Branch Upstream from Route 50	2,080 Feet
		CU9220	Cain Branch Upstream from Route 28	1,320 Feet
		CU9211*	Middle Cub Run main stem and tributaries	29,810 Feet
Total				*40,410 Feet*

*Project also affects Flatlick and Lower Cub Run Subwatersheds

Table 6-42
Summaq of Structural Projects in the Elklick Rtm Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area (Acres)
Wetland Bottom Rebofit Dry Ponds	1	CU9705	Ridings Manor Place	44Acres
Dumps to be Eliminated	1	CU9908	Appliances	
Sb·eam Buffer Restoration Projects	2	CU9330	FCPA Parkland Near Pleasant Valley Road	1,350 Feet
		CU9331	FCWA Parkland Adjacent to Pleasant Valley Road south of Elkhck Run	720 Feet
Total				*2,070 Feet*

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Table 6-43
Summruy of Srructural Projects for the Flatlick Brru1ch Subwatershed

Sh·uctural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area iAcres)
Wetland Bottom Retrofit Dry Ponds	26		CU9184, CU9198, CU9702, CU9701, CU9195, CU9703, CU9704, CU9186, CU9193, CU9185, CU9187, CU9188,CU9192, CU9174,CU9182 CU917l, CU9175, CU9170, CU9172, CU9177 CU9176, CU9178, CU9167, CU9169, CU9180 CU9194,	910 acres
LID Rehofit Projects	8	CU9815 CU9816 CU9817 CU9818 CU9819 CU9820 CU9821 CU9822	Cub Run Elementary School Sully Disb:ict Supervisor's Office Oumtilly Library 01ru1tilly High Sd1ool Greenbriar West Elementary School Brookfield Elementary Sd1ool Lees Corner Elementary School Navy Elementary School	3.4 Acres
Road Crossing to be Uprad ed	2	CU9609 CU9610	Flatlick Brru1ch at Walney Road Birch Drive at unnam ed b·ibutary	
Dumps to be Eliminated	2	CU9906 CU9907	Consb:uction Debris Cast iron pipes	
Proposed Regional Ponds or Alternative Projects	1	CU9001	Regional Pond C39 or altemative stonnwater projects	127 Acres
Neighborhoods witl1out Storm·water Conb:ols	2	CU9912 CU99ll	Brookfield Greenbriru·ru1d Birch Pond*	847 Acres
Buffer Restoration Projects	13	CU9320	Flatlick Brru1ch main stem upstrerun from Rt. SO	1,350 Feet
		CU9322	Oxlick Branch downstream from Stringfellow Rd.	430Feet
		CU9329	Tributruy to Flatlick Brru1ch Frru1l<lin Manor	2,000 Feet
		CU9328	Flatlick Brru1ch upsb:erun from Thompson Rd.	660 Feet
		CU9327	Flatlick Brand1upsbam form Fairfax County Parkway	840 Feet

Table 6-43
(continued)
Swmmu.y of Structural Projects for the Big Rocky Run and Round Lick Branch Su.bwatersheds

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Buffer Restoration Projects	13	CU9312	Tributary to Big Rocky Run downstream from Stringfellow Rd.	230 Feet
		CU9310	Tributary to Big Rocky Run downstream. from. Point Pleasant Dr.	270 Feet
		CU9313	Big Rucky Rmt upstrecuu frum Striugfelluw Rd.	2,630 Feet
		CU9314	Tributary to Big Rocky Run downstream from Melville Lane.	700 Feet
		CU9315	Big Rocky Run downstream from Middle Ridge Drive	330 Feet
		CU9305	Big Rocky Rtm downstream from Braddock Rd.	700 Feet
		CU9306	Tributary to Big Rocky Run upstream from Braddock Rd.	3,820 Feet
		CU9304	Big Rocky Rtm At Awbrey Patent Dr.	980 Feet
		CU9303	Tributary to Big Rocky Run 1-66/ Rt. 20 Interchange	710 Feet
		CU9309	Tributary to Big Rocky Run upstream from Northboume Dr.	1,460 Feet
		CU9308	Frog Branch downstream from Northbourne Dr.	*2A20* Feet
		CU9307	Tributary to Big Rocky Run Ellicot Comt	1,950 Feet
Total				*16,200 Feet*
Stream Restoration Projects	9	CU9210	Tributary to Big Rocky Run at Ox Hill Rd.	2 10 Feet
		CU9212	Rotmd Lick Branch upstream from Sully Park Drive	1A30 Feet
		CU9205	Big Rocky Run below Awbrey Patent Dr.	1,390 Feet
		CU9206	Tributary to Big Rocky Run Below Braddock Rd.	740 Feet
		CU9207	Big Rocky Rtm Between Flatlick Branch to below Rt. 29	*2ASO* Feet
		CU9209	Tributary to Big Rocky Run Oaks 01ase	530 Feet
		CU9208	Tributary to Big Rocky Rw1 Fair Lakes	2,680 Feet
		CU9204	Tributary to Big Rocky Run the Meadows Upstream from 1-66	*3A70* Feet
		CU9203	Tributary to Big Rocky Run upstream from Cub Run Confluence	1,550 Feet
Total				*16,550 Feet*

*Project also affects Flatlick Branch and/or Lower Cub Run Subwatersheds

Table 6-44
Sunumuy of Structural Projects for the Big Rocky Run and Round Lick Branch Subwatersheds

Structural Proj ect Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetland Bottom Retrofit Dry Ponds	33		CU9138, CU9136, CU9146, CU9145, CU9142, CU9144, CU9134, CU9159, CU9139, CU9157, CU9158, CU9156, CU9132, CU9155, CU9154, CU9121, CU9123, CU9128, CU9122, CU9127, CU9119, CU9125, CU9124, CU9115, CU9113, CU9112, CU9106, CU9111, CU9105, CU9107, CU9104, CU9109, CU9143	1,050 Acres
LID Retrofit Projects	10	CU9803 CU9804 CU9805 CU9806 CU9807 CU9808 CU9809 CU9810 CU9811 CU9812	London Towne Elementary School Cenh·evill le Library Ellanor C. Lawrence Park Cabells Mill Stringfellow Road Commuter Lot Poplar Tree Park Poplar Tree Elementary School Rocky Run Middle School Greenbriar East Elementaty School Stone Middle School	10.3 Acres
Road Crossing to be Upgraded	4	CU9605 CU9606 CU9607 CU9608	Awbrey Patent Drive at Big Rocky Rm1 Heron. Drive Big Rocky Rtm at Stringfellow Road Dorforth Drive	
Dumps to be Eliminated	2	CU9904	Gas tanks/transformer Trash and car	
Neighborhoods without Stonnwater Cona·ols	2	CU9910 CU9911	Cotmtry Club Manor * Greenbriar and Birch Pond*	966 Acres

Table 6-44
(continued)
Smnmaq of Structmal Projects for the Big Rocky Run and Round Lick Branch Subwatersheds

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Buff er Restoration Projects	13	CU9312	Tributary to Big Rocky Run downstream from Stringfellow Rd.	230 Feet
		CU9310	Tributary to Big Rocky Run downstream from Point Pleasant Dr.	270 Feet
		CU9313	Big Rocky Rtm upstream from Sb·ingfellow Rd.	2,630 Feet
		CU9314	Tributary to Big Rocky Run downstream from Melville Lane.	700 Feet
		CU9315	Big Rocky Rm1 downstream from Middle Ridge Drive	330 Feet
		CU9305	Big Rocky Rtm downstream from Braddock Rd.	700 Feet
		CU9306	Tributary to Big Rocky Run upstream from Braddock Rd.	3/820 Feet
		CU9304	Big Rocky Rtm At Awbrey Patent Dr.	980 Feet
		CU9303	Tributary to Big Rocky Run 1-66 / Rt. 20 Interchange	710 Feet
		CU9309	Tributary to Big Rocky Run upsb·eam from Northboume Dr.	1,460 Feet
		CU9308	Frog Branch downstream from Northbourne Dr.	2_420 Feet
		CU9307	Tributary to Big Rocky Run Ellicot Comt	1950 Feet
Total				*16,200 Feet*
Sbeam Restoration Projects	9	CU9210	Tributary to Big Rocky Run at Ox Hill Rd.	2 10 Feet
		CU9212	Rotmd Lick Branch upstream from Sully Park Drive	1_430 Feet
		CU9205	Big Rocky Run below Awbrey Patent Dr.	1,390 Feet
		CU9206	Tributary to Big Rocky Run Below Braddock Rd.	740 Feet
		CU9207	Big Rocky Rtm Between Flatlick Branch to below Rt. 29	2_450 Feet
		CU9209	Tributary to Big Rocky Run Oaks 01ase	530 Feet
		CU9208	Tributary to Big Rocky Rm1 Fair Lakes	2,680 Feet
		CU9204	Tributary to Big Rocky Run the Meadows Upsb·eam from 1-66	3_470 Feet
		CU9203	Tributary to Big Rocky Run upstream from Cub Run Confluence	*1550* Feet
Total				*16,550 Feet*

* Project also affects Flatlick Branch and/or Lower Cub Run Subwatersheds

Table 6-45
Summary of Structural Projects for the Lower Cub Run Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (Feet) or Total Area (Acres)
Wetland Bottom Retrofit Dry Ponds	12		CU9103, CU9147, CU9148, CU9150, CU9151, CU9152, CU9160, CU9161, CU9162, CU9163, CU9164, CU9165	570 Acres
LID Retrofit Projects	4	CU0901 CU9802 CU9813 CU9814	Bull Run Elementary School Centre Ridge Elementary School Deer Park Elementary School Virginia Run Elementary School	3 Acres
Road Crossing to be Upgraded	2	CU9603 CU9604	Compton Road Compton Road	
Dumps to be Eliminated	3	CU9901 CU9902 CU9903	55-gallon drums and above ground tank Appliances, brush, tires, etc. 55-gallon drums	
Neighborhoods without Stormwater Controls	1		Country Club Manor South	280 Acres
Buffer Restoration Projects	3	CU9301	Cub Run downstream from Big Rocky Run	820 Feet
		CU9316	Tributary to Cub Run Virginia Run Downstream from Pleasant Valley Rd.	3,550 Feet
		CU9302	Tributary to Cub Run upstream from I-66	380 Feet
Total				*4,750 Feet*
Stream Restoration Projects	3	CU9211*	Middle Cub Run main stem and tributaries between Flatlick Branch to below Rt. 29	29,810 Feet
		CU9202	Lower Bull Run and Unnamed Tributaries between Compton Rd. and Rt. 66	10,400 Feet
		CU9201	Lower Cub Run within Bull Run Regional Park	10,030 Feet
Total				50,210 *Feet*

*Project also affects Flatlick and Upper Cub Run Subwatersheds

Table 6-46
Summruy of Structural Projects for the Bull Run East Subwatershed

Sh·uctural Project Type	Number of Project	Project 10	Description	Length. (Feet) or Total Area (Acres)
Wetland Bottom Reh·ofit Dry Ponds	8	BR9102 BR9104 BR9105 BR9106 BR9107 BR9108	Old Cenbeville Rd and Compton Rd Flamborough Road Stone Maple Terrace Tracy Shru· Lru1e Wheat Mill Way and Granary Rd Sharps Drive	170 Acres
LID Reh·ofit Projects	1	BR9801	Cenheville Elementary School	0.9 Acres
Road Crossings to be Upgraded	2	CU9601	Compton Road Near UOSA CU9602 Compton Road	

Table 6-47
Sununruy of Structural Projects for the Bull Run West Subwatershed

Structural Project Type	Number of Projects	Project ID	Description	Length (feet) or Total Area (Acres)
Road Crossing to be Upgraded	3	BR9601 BR9602 BR9603	Bull Run Post Office Road	
Dumps to be Eliminated	2	BR9901 BR9902	Dirt in Sheam Rusted truck atid metal	
Buffer Restoration Projects	4	BR9301	Tributary to Bull Run	1,270 Feet
		BR9303	Tributary to Bull Run	800 Feet
		BR9304	Tributaty to Bull Run Fairfax National Estates	220 Feet
		BR9302	Tributary to Bull Run	310 Feet
Total				2,600 *Feet*
Strerun Restoration Projects	1	BR9201	Tributary to Bull Run below Quarry	3,470 Feet